Residential Onsite Wastewater Treatment Systems:

An Operation and Maintenance Service Provider Program

SECOND EDITION

Consortium of Institutes for Decentralized Wastewater Treatment

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Second Edition

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Chapter 1

Introduction

This chapter provides an overview of the relationship among public health, environmental issues, and the growing importance of operation and maintenance (O&M) applications for an expanding decentralized wastewater treatment industry. It will:

- Outline program implementation.
- Discuss wastewater characteristics.
- Define inspection procedures.
- Introduce operational checklists that can be used to document essential information about system performance and to identify key maintenance issues.

The O&M Service Provider Program is designed to set best practice standards for service visits to onsite wastewater treatment systems. The focus of these materials is single-family residential systems. The United States Environmental Protection Agency (U.S. EPA), and state and local government entities all recognize the importance of onsite and decentralized wastewater treatment systems as an essential component of the wastewater infrastructure. Through routine service visits and proper maintenance, onsite wastewater treatment systems can be a permanent and effective part of the wastewater infrastructure.

As licensing and certification programs develop, these materials can provide the educational resources to support training for practitioners seeking licensing and/or certification. This manual is only a training manual. It does not take the place of a certification program, but it can be used as part of a certification program.

Definition of terms

Acceptable is a condition in which a component is performing its intended purpose and is considered to be in an operable state.

Compensation is the action of being paid a fair price for a proper service.

Inspection is the process of identifying the current status of a system for reporting purposes.

Maintenance is the action of performing routine planned activities.

Malfunction is a condition in which a component or an entire system is not performing its intended purpose.

Management is a term describing all the steps necessary to conduct operational services, including maintenance, monitoring, and compensation.

Mitigation is the act of fixing a system that is in failure. Fixing the system should be preceded by an evaluation of all the components (source, collection and storage, pretreatment, final treatment, and dispersal) to determine the reason for the malfunction. Certain jurisdictions may require a permit before mitigation occurs.

Monitoring is the action of verifying performance requirements for a regulatory authority.

Operation is the action of assessing the functionality of each component of the system.

Performance Requirements are specific and measurable parameters that effluent must meet.

Repair is the action of fixing or replacing substandard or damaged components. Repairs may be required repairs, recommended repairs, or upgrades and may require a permit from the local regulatory authority.

Replacement is the process of exchanging a component with an equivalent component.

Reporting is the action of submitting a detailed report of Operation and Management activities performed on a system.

Service is the action of performing activities such as, but not limited to, inspection, assessment, and maintenance of system components.

Troubleshooting is the act of identifying and correcting sources of system malfunction.

Unacceptable is a condition in which a component is not operable. This condition indicates the need for implementing maintenance, upgrades, repairs, or further investigation.

Upgrade is the action of creating a better system by adding or modifying a component to improve the level of treatment provided by a system or facilitate system management.

What is an O&M service provider?

An onsite wastewater treatment system O&M service provider is a professional trained in the operation and maintenance of onsite wastewater treatment technologies.

A profession has specific criteria. These are:

- A defined body of knowledge
- Standards for admission
- Standards for retention
- Criteria for expulsion

These training materials are intended to define the current **body of knowledge** required to perform O&M on onsite wastewater treatment systems.

Standards for admission are defined as the level of experience and expertise required to perform O&M. A person's abilities may be measured with a certification exam. Typically, an organization or entity administers exams and certifies an applicant's familiarity with the defined body of knowledge.

Standards for retention are actions the person must take to maintain professional certification. Participation in continuing education activities such as short courses, conferences, self-study, and lectures may be required. Generally, continued certification requires that the professional earn a minimum number of continuing education units (CEUs) during a specific time period (for example, eight contact hours per year).

Because professionals are expected to conduct themselves in a certain manner, organizations have **criteria for expulsion**. For example, there are specific activities that should be performed during any service visit. Documentation that a service provider does not consistently perform the minimum required activities can result in a loss of certification. Failing to effectively evaluate systems while determining operational status or reporting inaccurate information are additional examples of criteria for expulsion.

How does an O&M professional function?

The O&M professional may be self-employed or employed by an O&M service company or Responsible Management Entity (RME). The O&M professional performs a variety of services for the end user (system owner) that include:

- Assessing the onsite wastewater treatment system to determine operational status.
- Performing routine activities required to keep the system operational.
- Responding to emergencies in a timely manner.
- Collecting and recording information regarding operational status of treatment components and recommending timely maintenance, replacement, or pumping of various components as required.
- Monitoring system performance through collection and analysis of effluent samples when appropriate.
- Reporting system operational status and/or system performance to homeowner, regulatory community, and others.
- Serving as an informational resource for the homeowner.

Troubleshooting of onsite wastewater treatment systems requires advanced knowledge and is not considered a function of the entry level O&M service provider.

What is an onsite wastewater treatment system?

Residential onsite wastewater treatment systems collect, treat, and disperse wastewater generated at a single-family residence (Figure 1-1). These systems are located at or near the home.

An onsite wastewater treatment system may include:

- Wastewater source (user, facility, or homeowner)
- Collection and storage
    - Plumbing from facility to pretreatment devices
    - Holding tanks
    - Incinerating and composting toilets
- Pretreatment components
    - Septic tanks
    - Trash tanks
    - Processing tanks
    - Aerobic treatment units
    - Media filters
    - Membrane biofilters
    - Constructed wetlands
    - Lagoons
    - Disinfection devices
- Final treatment and dispersal components
    - Trench and bed distribution
    - Evapotranspiration beds
    - Low pressure distribution
    - Drip field
    - Spray field
    - Outfalls

(NOTE: This manual is not promoting any specific technologies. The technologies that are covered in this manual are the most commonly used technologies in the field. O&M service providers should always use caution and be familiar with manufacturer-specific requirements.)

Program implementation and development

A concerted effort has been made to develop a complete set of materials for servicing residential systems. These forms may be used for evaluating commercial or industrial systems; however, additional operational checklists may be needed for the complete evaluation of systems other than those serving single-family residences.

This program will cover key aspects of O&M inspection procedures, data collection, and the use of operational checklist forms. This information can be integrated into the O&M professional's business model, and used to analyze and report ongoing critical and essential information.

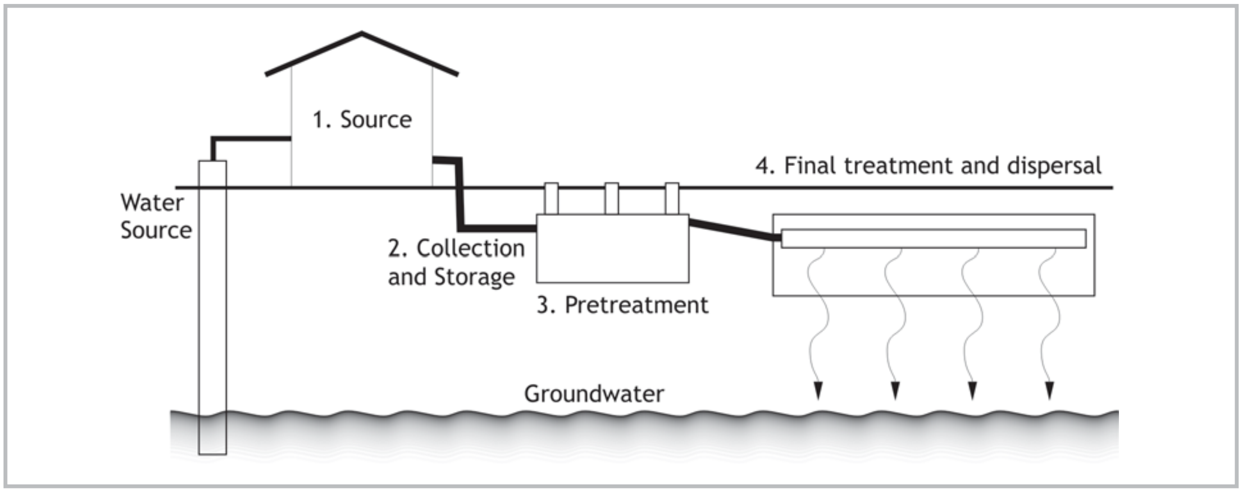


Figure 1-1. An example of an onsite wastewater treatment system illustrating a basic treatment train.

By tracking system status, trend analysis can be performed on customer systems. With this information, the O&M professional will be able to effectively address and communicate the O&M issues of onsite wastewater treatment systems.

Why perform O&M service visits?

O&M is essential to the long-term performance of onsite wastewater treatment technologies. All system components require maintenance.

O&M service visits can provide early detection of problems that could result in malfunction of onsite wastewater treatment systems if left uncorrected. Early detection makes it possible to take remedial action before a system becomes a public health hazard, a detriment to the environment, or a liability for the homeowner.

Public health

Wastewater is a public health concern because sewage can contain disease-causing pathogens. The pathogens must be removed from the wastewater before it reaches surface water or groundwater resources. Soil-based treatment systems need an unsaturated zone for pathogen removal. This treatment is obtained by physical (filtration), chemical (adsorption and transformation), and biological (degradation and predation) processes with subsequent die-off or inactivation of the pathogens.

Onsite wastewater treatment systems may include treatment components to remove nutrients or additional pathogens before distribution and dispersal to the soil. These systems must be operational to achieve desired levels of treatment and meet performance requirements.

Environmental protection

Environmental regulations are a major force leading to changes in the management of onsite wastewater treatment systems. It once was assumed that proper management of wastewater was achieved when sewage effluent did not back up into the house or surface in the yard. Now, an additional component for proper treatment is required. Proper treatment is achieved when contaminants of concern are removed before effluent reaches surface water or groundwater resources.

The EPA has implemented many watershed protection programs that affect the onsite wastewater treatment industry. Examples include the Total Maximum Daily Load (TMDL) of potential pollutants allocated to stream segments and the Coastal Zone Management Program (CZMP) that applies to coastal water resources.

Because onsite wastewater treatment systems are considered to be non-point sources of contaminants and a possible source of pollution in watersheds, these EPA watershed programs influence how onsite wastewater treatment systems are managed to achieve system performance. The EPA has national guidelines for management of onsite and clustered (decentralized) wastewater treatment systems. The guidelines can be found at:

http://cfpub.epa.gov/owm/septic/home.cfm

System reliability

System reliability describes the life-cycle performance of onsite wastewater treatment systems as a result of their engineering, installation, and design. All system components from the source to the final dispersal system must be functional within expectations. Advanced treatment systems have several additional components that must be functional to achieve wastewater treatment. These components each have operating limits and maintenance activities that must be performed to keep the entire system operating. Servicing or maintaining the components should extend their operational life and improve system reliability.

Customer satisfaction

A properly performing system is a key to customer satisfaction. If the unit has problems that result in loss of property use or value, the customer will naturally be unhappy and vent his or her frustration to the maintenance provider, the permitting authority, and anyone else who will listen. Customer dissatisfaction negatively affects the entire industry.

Why is an O&M service provider program important?

The expansion of the onsite wastewater treatment industry combined with the integration of management has created an opportunity for professionals entering the market. Expanded services are needed due to the increasing use of systems that require routine O&M service visits, the increasing number of systems being placed in close proximity to one another, and more stringent performance requirements set by regulatory authorities. The demand for services has resulted in a greater number of people entering the profession and a need to standardize services offered.

Standardization of services helps consumers understand their systems' service requirements and encourages consistent O&M. People seeking services from an O&M service provider deserve proper service for a fair price. The industry must define what it considers to be the minimum level of service that should be provided.

A series of operational checklist forms has been developed to assist the industry in meeting this challenge. The forms have been developed to uniformly evaluate currently available technologies. The purpose of these forms is to identify and record the critical factors for determining system performance, and to develop a tracking mechanism for later troubleshooting and repair of the system if needed.

Defining the role of management

Management is a term that is generally used to describe several different activities. These roles are described below.

Program management is the overarching framework for providing long-term, successful, and sustainable function of onsite wastewater treatment systems as a component of our wastewater infrastructure. This includes the organizational management necessary to carry out all aspects of the program.

Personnel management describes the operation of a business and the people performing the operational evaluation of the system components.

System management involves operating the individual system. These training materials focus on activities associated with system management or performance of O&M activities on all components of residential onsite wastewater treatment systems. This promotes proper system function and ensures that water quality treatment standards are met. O&M activities may range from relatively simple (gravity) to complex when advanced technologies are required.

System complexity and the risk to public health and environment are directly related. As system complexity increases, environmental consequences of improper wastewater treatment increase. Generally, the site is assessed for its ability to provide effective wastewater treatment in the soil. Sites with deep, well-drained soils can use a septic tank for pretreatment and a trench distribution system for final treatment and dispersal. The soil provides most of the treatment, and the system operation is relatively simple. As the depth of available treatment soil on the site decreases, the system requires either additional pretreatment components to reduce the contaminants in the effluent prior to dispersal or a different type of distribution technology. As the depth of well-drained soil decreases even further, the complexity of required pretreatment and distribution technologies increases.

A system discharging wastewater via an outfall poses the greatest risk. Even though disinfection is generally required, most of the treatment occurs in the pretreatment components. The effluent then leaves the system via saturated flow directly to the surface, without the added treatment from the soil treatment system. The second highest level of risk is associated with surface distribution. The potential for human contact with effluent increases because effluent is applied on the ground surface. Dispersal of wastewater and nutrient uptake still occurs in the soil; this therefore provides some treatment of the effluent. Subsurface distribution is desirable because it limits human contact with wastewater and provides additional polishing and treatment.

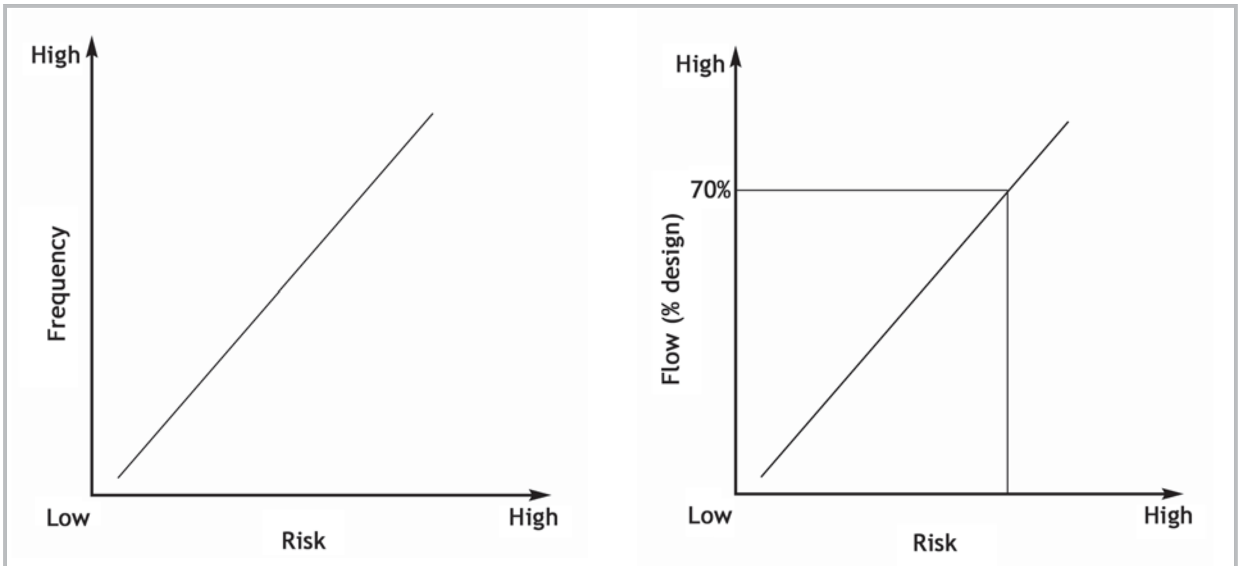
Development density is another parameter used to establish the relative risk for a site. A site of one acre or less in a subdivision where all facilities are served by onsite wastewater treatment systems has a greater risk than one facility on several hundred acres of land. The potential for contaminant loading is greater for the subdivision of small lots compared to single facilities on large tracts of land. The increase in risk of human exposure to wastewater and environmental risks caused by developmental density should lead to an increase in O&M frequency.

Monitoring and maintenance frequency

The frequency required for both monitoring and maintenance is related to the complexity of the treatment process, system reliability, and the quality and quantity of wastewater loading. However, monitoring frequency is also determined on the basis of public and environmental risk. Maintenance frequency is determined by the risk of failure due to site- and watershed-scale factors, as well as by performance requirements. (Figures 1-2 (a) and (b)).

Monitoring frequency is typically mandated by code or regulation. A system constructed on a site with a higher risk rating would not be expected to have the same monitoring frequency as a system on a site with a lower risk rating. The system operating permit sometimes requires the homeowner to maintain a current service agreement with a local O&M service provider.

System performance is directly affected by the quantity of wastewater being treated relative to the design capacity of the system. Systems perform best if the actual average daily flow is less than 70 percent of the design capacity. If the actual average daily flow is greater than 70 percent of design capacity, peak flows probably exceed



a. Graph comparing the frequency of maintenance to risk.

b. Graph comparing the flow rate of a system to risk.

Figure 1-2. Graphs comparing frequency of maintenance and flow rate of a system to risk.

design capacity. Therefore, the system is operating in a mode where greater attention will be needed, and the number of O&M service visits should be increased. If the load averages more than 70 percent, the treatment system can be augmented with additional components, such as a flow equalization tank and a timer. This flow equalization tank and timer will assist in limiting the risk of hydraulically overloading the following treatment components. Treatment components used prior to a flow equalization tank must be adequately sized to accept and treat peak (surge) flows.

Procedures for implementing a service program and use of O&M checklists

A series of forms and operational checklists are presented and used throughout this program. The forms are presented in a logical sequence that reflects the different stages of a service visit. The following is a standard procedure that can serve as a guideline for the use of the checklists in a service program.

Step 1: Contact with a Client

- When a client contacts the company to request an estimate for a service contract or when a new client is solicited, a file should be established in the client's name.
- The company should begin to collect information needed to develop a reasonable estimate for the contract.
- Complete Section A (Client Contact Information) of **Form 1-1. System description (SD)** (page 11) with the following information:
  - Owner's contact information: Name, address, phone numbers.
  - A system reference number for the filing system and for use on all checklists associated with this system.
  - Property identification number as appropriate.
  - Directions to the site.

Step 2: Gathering system information

- A careful assessment of the system at this point allows the service provider to closely estimate the time needed for an initial system inspection and subsequent service visits, and thus provide an accurate cost estimate to the homeowner.

- Additionally, the provider can determine what, if any, improvements or upgrades are needed to facilitate system maintenance.
- The amount of documented system information available will vary.
  - Ask the homeowner for any and all information the homeowner might have.
  - Consult the local permitting authority and request copies of all permit records, including:
    - System design
    - As-built plans
    - Local O&M frequency requirements
    - Monitoring requirements
- If documentation is available…
  - Using the documentation, complete the Section B (System Documentation Available) of **Form 1-1. System description** (SD) (page 11) with information regarding design and installation of the system. Include contact information for the designer and installer if it is available.
  - Note the design flow assigned to the system.
  - In Section C (Operational Checklists) of **Form 1-1. System description** (SD) (page 11) indicate which Operational Checklists are needed on the basis of the components included in the system.
- If documentation is NOT available…
  - Complete Section D (No System Documentation Available) of **Form 1-1. System description** (SD) (page 12) with facility and system details.
  - This will require a system inspection to thoroughly document the nature of the system components and determine what upgrades or improvements are needed to facilitate system maintenance.
- Residential survey
  - The service provider may choose to evaluate the source of the wastewater with **Form D-1. Residential evaluation survey** (RES) (page 263). This survey provides valuable information that may influence system performance and therefore the estimate of costs. Form D-1 can be found in Appendix D.

Step 3: Develop a cost estimate

- Using the information gathered, determine the type and frequency of O&M activities required for the system.
- Include monitoring and maintenance requirements mandated by the regulatory authority, designer, and/or manufacturers.
- Develop a cost estimate for an O&M service agreement, taking into consideration travel, personnel, and administrative overhead.

Step 4: Finalize the service contract

- Negotiate a service agreement with the client.
- Be sure to specify:
  - Services included in the contract price.
  - What activities require additional fees.
  - Terms for compensation.
  - What upgrades or improvements are needed to facilitate maintenance.
- Be sure that the homeowner understands his or her responsibilities as well, such as:
  - Maintaining reasonable water use in the home.
  - Ensuring that detrimental items are not put into the system.
  - Confining pets during system inspections.
  - Ensuring that children are not present during system inspections.
- Contracts like these are best executed in writing for clear communication and to protect all parties.

- Each party should receive an original signed copy of the agreement. The permitting authority may also require a copy.

Step 5: Prepare to conduct a service visit

- Transfer information to Section A (Client Contact Information), Section B (System Documentation), and Section C (Operational Checklists) on **Form 1-2. System evaluation** (SE) (page 20) from **Form 1-1. System description** (SD) (page 11).
- Print out or copy the required Operational Checklists listed in Section C on **Form 1-2. System evaluation** (SE) (page 20).
- Collect additional information and items required for locating and completing the O&M service such as:
  - Files containing System Description, permit documents, or as-built drawings identifying the components and their location.
  - Copies of any previous system inspections.
  - Necessary tools for conducting operation and maintenance (See Appendix C for a list of Suggested Tools).
  - Locator map identifying the site location.
  - Item to document your presence at the site (e.g., business card, copy of documents, summary note, or door hanger).

Step 6: Conduct a service visit using Form 1-2. System evaluation (SE), Section D (page 20)

- **Item 1:** Record the date and time of the O&M service visit (**Form 1-2. System evaluation** (SE)).
- **Item 2:** Note observation and assessment of the site (on lot and in neighborhood). (NOTE: During the first O&M service visit, the **Form 4-1. Site assessment** (SA) (page 46) should be completed to conduct a thorough assessment of the site. During subsequent service visits, Item 2 on **Form 1-2. System evaluation** (SE) (page 20) will be used to evaluate and note any changes to the site. Changes may indicate the need to reassess the entire site using **Form 4-1. Site assessment** (SA) (page 46).)
  - **Item 2.a:** Evaluate the presence and source of any odor within 10 feet of the system perimeter.
  - **Item 2.b:** Evaluate the site for surfacing of wastewater or breakouts from the system components.
  - **Item 2.c**: Evaluate the site and neighborhood for construction, utility work, or changes to drainage patterns. These items may lead to changes in surface and subsurface water movement that could affect the system.
  - **Item 2.d**: Verify that all system components are present and have not been modified. (NOTE: If components have been replaced, removed, or upgraded, note these modifications on **Form 1-1. System description** (SD) (page 11) or on the as-built drawings.)
  - **Item 2.e**: If there are lids to system components at grade or on risers, check that they are present and make sure they are secure.
  - **Item 2.f**: Make sure there has been no traffic on the onsite wastewater treatment system.
- **Item 3**: Assess flow passing through the system. An estimate of the average daily flow is needed for comparison to the permitted flow rate.
  - **Item 3.a:** Indicate which method is used to estimate flow through the system.
- A water meter on the potable water line to the house may provide this information. However, water used for activities external to the house (filling swimming pools, watering lawns, and/or washing cars)

will add extra flow that may not reach the system. Water meter readings can be compared on subsequent visits to determine the flow through the system. The average gallons per day through the system can be determined by dividing the difference between readings by the number of days since the last reading.

- If the system includes a dosing tank and controls, use the information recorded from elapsed time meters and/or cycle counters to calculate the flow. Indicate if it is from **Form 6-2. Pump: Demand-dosed (PDD)** or **Form 6-3. Pump: Timer-dosed (PTD)**.
- If a flow meter is included in the discharge line, total flow through the pump tank can be used to estimate average daily flow. This is not typically found in most systems.
- As a last resort, flow can be estimated based on 50 to 70 gallons per day per person.
- **Item 4**: Complete the operational checklists associated with tanks, pumps/control systems, and pretreatment components (forms discussed in Chapters 5, 6, and 7). Make sure power is available to all necessary components. Open or uncover all components that must be evaluated and observe their condition. Record information on the operational checklists.
- **Item 5**: Complete operational checklists for final treatment and dispersal components (forms discussed in Chapter 8). This includes any field observations or records of conditions in trenches.
- **Item 6**: List any changes in components or modifications to the system that were noted during the evaluation. This allows detailed updates to **Form 1-1. System description (SD)** (page 11) to be made in the office.
- **Item 7**: Confirm site status at the conclusion of the O&M service visit.
  - Verify that controls are set in the appropriate mode. Items that should operate in an automatic mode should be set to automatic. Make sure any items that were set in the continuous run mode for evaluation of the component are reset to the appropriate mode.
  - Make sure power is available to all necessary components.
  - Revisit all components to verify the lids are on and properly secured.
  - Gather the tools used to evaluate the system components and return them to your vehicle for use at the next site.
  - Verify that no sewage is on the ground surface.
  - Before leaving the site, leave some type of documentation for the facility owner (e.g., business card, copy of documents, summary note, or door hanger). This will let the facility owner know that you performed your required duties.
- **Item 8**: Record any additional comments or summary considerations on the system evaluation form.
- **Item 9**: Note the overall system condition. The system is either acceptable or unacceptable. Note whether maintenance is needed, was performed, or if mitigation is required.

Step 7: Reporting

- File forms with appropriate entities. Aside from the homeowner, this may include the permitting authority or any other group that requires a copy of the information.
- **Form 1-2. System evaluation (SE)** (page 20) will typically provide the required information to permitting authorities, but some entities require a copy of all materials generated during the service visit.

Form 1-1. System description (SD).

(This form is used for the initial system evaluation for the facility and the site. It should be kept on file, and a copy should accompany the service provider at each O&M service visit. Any changes to the system facility should be recorded on the form, along with the date the change was noted.)

System ref. #:________________

A. Client contact information

Name of owner:____

Phone:________________________________ T:____R:____Sec:____No.:______

Cell:________________________________ E-mail:________________________________

Site address/county:____

____

Mailing address/county (if different):_______________________________________

____

Directions to site:____

B. System documentation available (If no documentation, fill out Section D.)

Date installed:__________________

Installer:____ License #:__________________

Phone:__________________ Cell:__________________________ Fax:__________________________

E-mail:____

Designer:____ License #:__________________

Phone:__________________ Cell:__________________________ Fax:__________________________

E-mail:____

Previous service provider:______________________________ License #:__________________

Phone:__________________ Cell:__________________________ Fax:__________________________

E-mail:____

Design flow: ________________Gal per day

C. Operational checklists:

Identify operational checklists for components included in system. Number the components of the treatment train in order in the spaces provided after the titles.

Form 4.1 Site assessment on File. ❑ Yes ❑ No

Tanks and advanced treatment component operational checklists (Chapters 5, 6 and 7):

❑ Pump: Demand-dosed system: ______
❑ Pump: Timer-dosed system: ______
❑ Holding tank: ______
❑ Septic/trash/processing (tank): ______
❑ Pump tank(s): ______
❑ Media filter: ______
❑ Aerobic treatment unit: ______
❑ Constructed wetland: ______
❑ Lagoon: ______
❑ Disinfection unit –chlorine: ______
❑ Disinfection unit –ultraviolet light: ______
❑ Disinfection unit –ozone: ______

Final treatment and dispersal component operational checklists (Chapter 8):

❑ Gravity distribution: _______
❑ Evapotranspiration bed: _______
❑ Mound system: _______
❑ Bottomless sand filter: _______
❑ Bottomless peat filter: _______
❑ Low-pressure drainfield: _______
❑ Drip field: _______
❑ Spray field: _______
❑ Outfalls: _______

Form 1-1 (continued)**. System description (SD).**

System ref. #:____________________

D. No system documentation available

Complete the remaining information if it is not available in the permit or as-built drawings.

Facility details

1. Number of bedrooms: ______________
2. Square footage of facility: ___________sq ft
3. Number of current occupants: ______________
4. Design flow: ____________gpd
5. Design strength: ___________ BOD (mg/L) ____________TSS (mg/L) ___________ FOG (mg/L)
6. Water supply:
   - ❑ Private water supply
   - ❑ Public water supply
7. Water source (if private supply): Lateral distance to water supply
   - ❑ Groundwater well: _____________ft
   - ❑ Spring: _____________ft
   - ❑ Surface water (e.g. creek, lake, etc.): _____________ft
8. Garbage disposal present. Yes_____No_____
9. Are any water softener or water treatment chemicals used. Yes_____No_____
   - ❑ Softener backwash drains to system: Yes_____No_____
   - ❑ Softener backwash does not drain to system: Yes_____No_____
10. Has facility been remodeled since original construction. Yes_____No_____

System Details

1. Site

a. Landscape position: ____

b. Drainage: ❑ Surface/gravity ❑ Subsurface/gravity ❑ Subsurface/pump

c. Monitoring well present. Yes_____No_____

2. Pretreatment components - Tanks

a. Holding tank

1) Capacity: ____________gal

2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic ❑ Other

i) Manufacturer:____

3) Access to surface. Yes_____No_____

4) Location (GIS): ________/_______

b. Septic tank /trash tank

1) Capacity (total): ____________gal

i) Compartmented. Yes____No______

ii) Capacities for compartmented system: 1)____gal 2)___gal

2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic ❑ Other

i) Manufacturer:____

3) Access to surface. Yes_____No_____

4) Location (GIS): ________/_______

5) Effluent screen. Yes_____No_____

i) Manufacturer:______________________________ Model: ____________________

Form 1-1 (continued). **System description (SD).**

System ref. #:________________

c. Flow equalization tank (surge, etc.)
1) Capacity: __________gal/in
2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
3) Access to surface. Yes____No_____
4) Location (GIS): ________/_______
5) Pump tank: ___________N.A.
i) Manufacturer:____
6) Pump: ___________N.A.
i) Manufacturer:______________________ Model:____________ HP:_____
7) Pump operating condition
i) Discharge Rate: _________gal/min
ii) Operating pressure: ______________ft
8) Control method
i) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
ii) Description:____
9) Pump dose settings
i) Frequency _________doses/day
ii) Interval _________ sec/dose
iii) Volume __________ gal/dose
10) Control panel
i) Manufacturer:______________________ Model:________________
11) Electrical
i) Separate circuits (pump, alarm). Yes____No_____
ii) Breaker size: _______________
12) Alarm
i) Manufacturer: ____
ii) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
iii) Description:____

d. Dosing tank
1) Capacity: __________gal/in
2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
3) Access to surface. Yes____No_____
4) Location (GIS): ________/_______
5) Dosing tank: ___________N.A.
i) Manufacturer:____
6) Pump: ___________N.A.
i) Manufacturer:______________________ Model:____________ HP:_____
7) Pump operating condition
i) Discharge Rate: _________gal/min
ii) Operating pressure: ______________ft
8) Control method
i) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
ii) Description:____
9) Pump dose settings
i) Frequency: ________doses/day
ii) Interval: _________ sec/dose
iii) Volume: __________gal/dose
10) Panel for sensors
i) Manufacturer:______________________ Model:________________
11) Electrical
i) Separate circuits (pump, alarm). Yes____No_____
ii) Breaker size: _______________

Form 1-1 (continued)**. System description (SD).**

System ref. #: ________________

12) Alarm
   i) Manufacturer: ________________
   ii) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
   iii) Description: ________________

3. Pretreatment components - advanced

a. Aerobic treatment unit (ATU)
   1) Treatment method:
      ❑ Suspended growth ❑ Attached growth ❑ Rotating Biological Contactor
      ❑ Combination attached/suspended growth ❑ Sequencing Batch Reactor
      ❑ Other: ________________
   2) Capacity: ________gpd
   3) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
      i) Manufacturer: ________________ Model #: ________________
      ii) Product serial #: ________________
   4) Access to surface. Yes____No_____
   5) Location (GIS): ________/_______
   6) Effluent screen / Tertiary filter ________N.A.
      i) Manufacturer: ________________
   7) Air supply
      i) Air supply method: ❑ Aspirator ❑ Compressor ❑ Blower ❑ Free Air
      ii) Manufacturer: ________________ Model #: ________________
   8) Sludge return method: ________________

b. Single pass filter
   1) Media: ❑ Sand ❑ Glass ❑ Foam ❑ Peat ❑ Other: ________________
      i) Media depth: ________in
      ii) Liner material: ________________
   2) Filter size: ________sq ft
      i) Dimensions: ______ft x ____ft
      ii) Accessibility: ❑ Buried ❑ Free Access ❑ Covered
      iii) Cover material: ________________
      iv) Lid insulated. Yes____No_____
   3) Distribution method: ❑ Pressure ❑ Gravity
      i) Pipe diameter: ________in
      ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ________________
         Orifice orientation: ________________
      iii) Flow control diameter: ________in
      iv) Number of flow controls (orifices, nozzles, etc.): ________
      v) Squirt height/Operating pressure: ________in
      vi) Clean outs/Inspection ports: Number________Yes____No_____
      vii) Clean out access to surface. Yes____No_____
   4) Filtrate collection system: ________

c. Recirculating Filter
   1) Media: ❑ Sand ❑ Gravel ❑ Bottom Ash ❑ Foam ❑ Other: ________________
      ❑ Polystyrene ❑ Textile
      i) Media depth: ________in
      ii) Liner material: ________
      iii) Recirculation method: ________

Form 1-1 (continued). **System description (SD)**

System ref. #: __________

2) Filter size: __________sq ft
   i) Dimensions: _____ft x ____ft
   ii) Accessibility: ❑ Buried ❑ Free access
   iii) Cover material:______________________
   iv) Lid insulated. Yes____No_____
3) Distribution method
   i) Pipe diameter: ____________in
   ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________
   Orifice position: ______________________
   iii) Flow control diameter: ____________in
   iv) Number of flow controls (orifices, nozzles, etc.): ____________
   v) Squirt height/Operating pressure: ____________in
   vi) Clean outs/Inspection ports: Number________Yes____No_____
   vii) Clean out access to surface. Yes____No_____
4) Filtrate collection system: ____________
5) Forced aeration: __________N.A.
   i) Description:______________________

d. Trickling filter
1) Media: ❑ Gravel ❑ Foam ❑ Textile ❑ Plastic ❑ Other:____________
   i) Media depth: ____________in
   ii) Liner material: ____________
2) Filter size: ______________________sq ft
   i) Dimensions: _____ft x ____ft
3) Distribution method
   i) Pipe diameter: ____________in
   ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________
   Orifice position: ______________________
   iii) Flow control diameter: ____________in
   iv) Number of flow controls (orifices, nozzles, etc.): ____________
   v) Squirt height/Operating pressure: ____________in
   vi) Clean outs/Inspection ports: Number________Yes____No_____
   vii) Clean out access to surface. Yes____No_____
4) Filtrate collection system: ____________
5) Forced aeration : __________N.A.
   i) Description: ______________________

e. Constructed wetland
1) Bed media: ❑ None ❑ Gravel ❑ Other:______________________
   i) Number of cells: ____________
   ii) Media depth: ____________in
   iii) Water depth: ____________in
   iv) Liner material: ____________
   v) Border material: ____________
2) Size: __________sq ft
   i) Dimensions: _____ft x ____ft
   ii) Length to width ratio: ________:______

Form 1-1 (continued)**. System description (SD).**

System ref. #: __________

3) Distribution method
   i) Pipe diameter: ______________in
   ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________________
   Orifice position: ________________________________
   iii) Flow control diameter: ______________in
   iv) Number of flow controls (orifices, nozzles, etc.): ______________
   v) Squirt height/Operating pressure: ______________in
   vi) Clean outs/Inspection ports: Number________Yes____No_____
   vii) Clean out access to surface. Yes____No_____
4) Surface loading rate: _______gpd/sq ft
5) Filtrate collection system: ______________
6) Monitoring location: ______________
7) Vegetation: ___________N.A.
   i) Description:________________________________
8) Water level control: ___________N.A.
   i) Description:________________________________

f. Lagoon system
1) Type: ❑ Aerobic ❑ Facultative ❑ Partial-mixed aerated ❑ Anaerobic
   i) Water depth: ______________ft
   ii) Liner material: ______________
2) Lagoon size: ____________sq ft
   i) Dimensions: ______ft x ____ft
   ii) Length to width ratio: ________:______
3) Inlet to lagoon
   i) Pipe description:________________________________
   ii) Pipe diameter: ______________in
   iii) Clean outs. Yes____No_____
4) Surface loading rate: _______gpd/sq ft
5) Monitoring location: ______________
6) Vegetation: ___________N.A.
   i) Description:________________________________
7) Water level control: ___________N.A.
   i) Description:________________________________

g. Disinfection unit
1) Chlorine – tablet
   i) Manufacturer:______________________ Model:____________________
2) Chorine – liquid
   i) Manufacturer:______________________ Model:____________________
3) Ultraviolet light
   i) Manufacturer:______________________ Model:____________________
4) Ozone
   i) Manufacturer:______________________ Model:____________________
5) Other:____
6) Disinfection monitoring location:________________________________
7) Dechlorination
   i) Type: ________________________________
   ii) Manufacturer:______________________ Model:____________________
8) Dechlorination monitoring location: ________________________________

Form 1-1 (continued). **System description (SD).**

System ref. #: ___________

4. Final treatment and dispersal

a. Gravity distribution

1) Type: ❑ Trench ❑ Bed ❑ ET bed

i) If lined ET bed, describe liner material:______________________

2) Distribution method: ❑ Gravity-to-gravity ❑ Pressure-dosed gravity ❑ Siphon-to-gravity

3) Configuration: ❑ Parallel ❑ Serial ❑ Sequential

4) Distribution approach: ❑ Distribution box ❑ Solid header pipe ❑ Drop box ❑ Stepdown

5) Distribution media

i) Material: ❑ Gravelless ❑ Multi-pipe ❑ Chamber
❑ Washed rock ❑ Polystyrene ❑ Other:______________________

b. Pressure

1) Low-pressure distribution

i) Level. Yes_____No______

ii) Number of zones: ________________

a) Switching method: ❑ Hydraulic valves ❑ Separate pumps
❑ Other:______________________

iii) Distribution method

a) Pipe diameter: ______________in

b) Orifice diameter: ______________in

c) Orifice orientation: ________________

d) Number of orifices: ________________

e) Squirt height/Operating pressure: ______________in

f) Clean outs/Inspection ports: Number_________Yes_____No______

g) Clean out access to surface. Yes_____No______

iv) Number of trenches/beds: ________________

v) Dimensions of trenches/beds: ______ft x ____ft

Pressure mound distribution

i) Distribution method: ❑ Trench ❑ Bed ❑ Other:______________________

a) Pipe diameter: ______________in

b) Orifice diameter: ______________in

c) Number of orifices: ________________

d) Squirt height/Operating head: ______________in

e) Clean outs/Inspection ports: Number_________Yes_____No______

f) Clean out access to surface. Yes_____No______

ii) Number of trenches/beds: ________________

iii) Dimensions of trenches/beds: ______ft x _____ft

2) Drip field

i) Distribution field: ❑ Surface ❑ Subsurface

ii) Drip tubing manufacturer:____________________ Model:______________________

iii) Filtration: ❑ Screen ❑ Disk ❑ Sand
Manufacturer:______________________________ Model:______________________

iv) Filter cleaning: ❑ Automated ❑ Manual/Continuous flush

v) Number of zones: ________________

a) If multiple, switching device: ________________

b) Zone area(s): ______sq ft ________ sq ft ___________sq ft

vi) Field flushing: ❑ Automated ❑ Continuous ❑ Manual

vii) Air release/Vacuum breaker: ____________N.A.

a) Manufacturer:______________________ Model:______________________

viii) Inspection ports. Yes_____No______

a) Locations:____

Form 1-1 (continued). **System description (SD).**

System ref. #: __________

4) Spray field
   i) Number of zones: ______________
      a) If multiple, switching device: ______________
   ii) Distribution heads per zone: ______________
      a) Manufacturer: ______________ Model(s): ______________
      b) Pattern(s): ______________
   iii) In-line filtration: ❑ None ❑ Screen ❑ Disk ❑ Sand
      a) Manufacturer: ______________ Model: ______________
   iv) Total area of spray distribution fields: ___________sq ft
   v) Gauging Device: ______________
5) Outfalls
   i) Permit number: ______________
   ii) Permit requirements: ______________
   iii) Location: ______________
   iv) Monitoring location: ______________

Form 1-1 (continued). **System description (SD).**

System ref. #:___________________

E. Sketch of system

Scale 1 in = ________ ft

Form 1-2. System evaluation (SE).

(This form is used for identification of the system design flow and to gather the operational checklists needed for conducting an O&M service visit.)

A. Client contact information

Name of owner:______________________________ System ref. #:______________

Site address/county:____

____

Date of last service:____________________

B. System documentation *(See Form 1.1 System Description (SD) for complete documentation)*

Design flow: ____________Gal per day

C. Operational checklists *(from Form 1.1 System Description (SD) Section C)*

Form 4-1. Site assessment on File. ❑ Yes ❑ No

Tanks and advanced treatment component operational checklists (Chapters 5, 6 and 7):

❑ Pump: Demand-Dosed system: ____________
❑ Pump: Timer-Dosed system: ____________
❑ Holding tank: ____________
❑ Septic/Trash/Processing (tank): ____________
❑ Pump tank(s): ____________
❑ Media filter: ____________
❑ Aerobic treatment unit:____________
❑ Constructed wetland: ____________
❑ Lagoon: ____________
❑ Disinfection unit -Chlorine: ____________
❑ Disinfection unit -Ultraviolet light: ______
❑ Disinfection unit -Ozone: ____________

Final treatment and dispersal component operational checklists (Chapter 8):

❑ Gravity distribution: ______
❑ Evapotranspiration bed: ______
❑ Mound system: ______
❑ Bottomless sand filter: ______
❑ Bottomless peat filter: ______
❑ Low-pressure drainfield: ______
❑ Drip field: ______
❑ Spray field: ______
❑ Outfalls: ______

D. System Evaluation

1. O&M service provided on: Date:____________________ Time:________________

2. Observation and assessment of the site (on lot and in neighborhood)
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
      i) Source of odor, if present: ______________________________
   b. Any surfacing or breakouts. Yes ___ No____
   c. Any construction, utility work, or changes in drainage patterns. Yes ___ No____
   d. Are all components present and not modified. Yes ___ No____
   e. Are all lids at grade or on risers present and secure. Yes ___ No____
   f. Traffic on onsite wastewater system. Yes ___ No____

Form 1-2. (continued)**. System evaluation (SE).**

System ref. #:__________________

3. Estimated system flow: ___________ gallons per day
   Indicate method used for estimate:
   - ❑ House water meter reading:

     This time: __________(gal) - Last time: ___________(gal) = Result: _____ gal

     Result: ___________(gal) / ____________________days = ___________GPD

   - ❑ Dosing tank control meter readings (indicate form used): PDD: _________ PTD: _________
   - ❑ Discharge line meter
   - ❑ Estimate based on number of occupants: ______People

4. Complete operational checklists for pretreatment components, pumps, pump tanks and controls (Chapters 5, 6 and 7).

5. Complete operational checklists for final treatment and dispersal components (Chapter 8).

6. Updates required on **Form 1-1. System description:**

   ____

   ____

   ____

   ____

7. Site status at conclusion of O&M service visit:
   - ❑ Verify that controls are set on the appropriate mode.
   - ❑ Power is on to all components.
   - ❑ Revisit all components to verify lids are secure.
   - ❑ Gather all tools for removal from the site.
   - ❑ Verify that no sewage is on the ground surface.
   - ❑ Service notification.

8. Comments:

   ____

   ____

   ____

9. Overall system condition:

   ❑ Acceptable ❑ Maintenance needed
   ❑ Unacceptable ❑ Maintenance performed
   ❑ Mitigation required

Company name: ____

Agreement period from: ________________________ to ________________________

This report indicates the condition of the above onsite wastewater treatment system at the time of the O&M service visit. It does not guarantee that it will continue to function satisfactorily.

Signature of service provider: ________________________________Date:__________________

Introduction to wastewater

Wastewater treatment is achieved by processing effluent in various treatment steps to remove contaminants. Several wastewater treatment processing methods fall into one of two main categories based upon their oxygen state: aerobic and anaerobic. Oxygen is needed for aerobic treatment to take place, and aerobic bacteria need oxygen to grow and live. Anaerobic bacteria grow and live in the absence of oxygen. (NOTE: Another category of bacteria which can be supported in aerobic or anaerobic conditions is referred to as facultative. Facultative processes will not be covered.) The processing methods necessary for wastewater treatment depend on the constituents present in the effluent and the level of treatment desired.

Wastewater treatment processes are categorized as:

- Physical
- Chemical
- Biological

Physical processes include filtration, dispersion, settling, and dilution. Physical filtration works by moving wastewater through pore spaces in various media. Physical treatment processes can remove large particles, pathogens, and suspended solids. The smaller the pore space size, the smaller the size particle or microorganism that can be physically trapped. **Settling** is the process by which solids settle out of the wastewater. Dispersion dilutes the remaining contaminants but does not remove them.

The three chemical processes that can treat wastewater include cation exchange, adsorption, and precipitation. Cation exchange and adsorption allow contaminants in wastewater to bond with media particles to slow the rate of movement through the media and to allow uptake of nutrients by plants and microorganisms in the media. Precipitation happens when constituents in wastewater or in the media combine together to make a new compound and become heavy enough to physically settle from the effluent. Precipitation processes are important for phosphorus removal.

Biological processes for treatment take many different forms. 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, removes pathogens, and works best under aerobic conditions. Mineralization transforms organic nitrogen into other inorganic forms of nitrogen that can become part of yet other biologically driven treatment processes.

Wastewater can be tested to determine the strength (or concentration) of its constituents. The following is a list of contaminants that wastewater can be tested for:

- Solids analysis
- Turbidity
- Biochemical oxygen demand (BOD)
- Chemical oxygen demand (COD)
- Dissolved oxygen (DO)
- Fecal coliform (FC)
- pH
- Alkalinity
- Total kjeldahl nitrogen (TKN)
- Total phosphorus (TP)

Solids analysis measures the amount of solids present in wastewater. Typical analyses include total suspended solids (TSS), total dissolved solids (TDS), or total solids.

Turbidity is the physical clarity of the water and is an indicator of the presence of suspended matter in wastewater.

Biochemical Oxygen Demand (BOD) is the amount of oxygen consumed by microbes during the decomposition of organic matter. It is an indicator of the overall strength of the wastewater.

Chemical Oxygen Demand (COD*)* is a measure of the amount of organic matter oxidized by a strong chemical oxidant.

Dissolved Oxygen (DO) is the concentration of oxygen dissolved in an effluent.

Fecal coliform (FC) is an indicator microorganism that can be cultured in standard tests to indicate contamination. Fecal coliform originates in the digestive system of humans and animals.

pH measures the acid or base quality of wastewater. It is measured on a scale from 1 to 14, with 1 being the most acidic, 14 the most basic, and 7 neutral.

Alkalinity refers to a wastewater's relative ability to neutralize acids.

Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen and ammonia in a water body.

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

Evaluation of onsite wastewater treatment system components

An onsite wastewater treatment system can be divided into four functional components. Typically, a system includes:

- Wastewater source
- Collection and storage
- Pretreatment components
- Final treatment and dispersal components

Each of these components must be evaluated to determine overall system performance.

Wastewater source

Three broad categories of wastewater are domestic/residential, commercial, and industrial.

- **Domestic/wastewater** is normally discharged from plumbing fixtures, appliances, and devices such as toilets, bath, laundry, and dishwashers coming from a residence.
- **Commercial wastewater** includes wastes resulting from office buildings, restaurants, or food processing and production enterprises.
- **Industrial wastewater** is the water or liquid-carried waste from an industrial or manufacturing process.

The focus of these service provider materials is domestic wastewater generated by single-family residences. This wastewater is composed primarily (99.9 percent) of water. Although the constituents and strength of domestic wastewater can vary from residence to residence or even day to day, there are certain constituents that are generally present. These include the following:

- Organics
- Inorganics
- Solids
- Pathogenic organisms
- Nutrients
- Metals
- Persistent organic compounds
- Fats, oils, and grease (FOG)
- Other

Organic materials are carbon-based constituents that come from plant or animal sources, and may be solid or liquid. Organics can be broken down and consumed by microbes.

Organics can be living or dead. Biochemical oxygen demand (BOD) is the typical measurement used to gauge the organic content of a wastewater.

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.

Solids in wastewater may be organic or inorganic, and removing them is one of the major goals of wastewater treatment. Solids in residential wastewater may be ***dissolved*** in the liquid or ***suspended***. Some of the suspended solids may settle out before leaving the septic tank. These are called ***settleable*** solids.

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

Nutrients are elements essential for the growth of living organisms. However, humans do not utilize all of the nutrients that we consume, and residual nutrients become a potential contaminant. Of particular concern are nitrogen and phosphorous.

Nitrogen is found in several forms in wastewater. ***Organic nitrogen*** is found in cells of all living organisms as proteins and amino acids, and 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^-)).

Ammonium nitrogen 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 soil particles. Under aerobic soil conditions ammonium will be converted to nitrate.

Nitrate nitrogen is a negatively charged ion that is not strongly held by the soil and can be leached into the groundwater. Nitrate may be converted to **nitrogen gas** (N_2) under anaerobic conditions through the biological denitrification process.

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 absorption areas is dependent upon sorption and precipitation reactions. It can also move in surface water or in groundwater, during erosion episodes, or under anaerobic soil conditions.

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 wastewater when strong chemicals and/or vitamins are used in the home. While some metals are essential for animal and plant nutrition, at higher levels they may be toxic. In soils, metals generally become more soluble as the pH decreases.

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 can be found in household solvents, cleansers, paint, and medical products.

Fats, oils, and grease (**FOG**) in domestic wastewater generally originate in the kitchen or bathroom. Kitchen FOG usually comes from disposing of animal- or vegetable-based food scraps down the sink and into the system. Households using garbage disposals typically have 30 to 40 percent more FOG than households not using garbage disposals. Bath oils, sun tan lotions, and moisturizing creams are bathroom sources of FOG that enter the wastewater stream.

Others, 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.

Collection and storage components

Collection components of residential systems are generally limited to a solid, rigid pipe that collects wastewater from plumbing fixtures and appliances. This pipe, laid on a 1 to 2 percent downward slope (1/8- to 1/4-inch per foot), exits the structure, and extends to the pretreatment component. A cleanout should be located in the pipe before the first pretreatment component. Depending on sampling needs and requirements, adequate sampling basins should be located between components. Some sites may have elaborate collection systems. These systems may have pump tanks collecting the waste and subsequent transmission lines for transporting it to the pretreatment components. Holding tanks can be considered storage devices because they essentially store wastewater until it is collected and transported to a different site for treatment and dispersal.

One collection option, where permitted by local regulation, is to split wastewater before any treatment occurs. Wastewater consists of blackwater (wastewater from toilets and food preparation areas) and graywater (wastewater from all other plumbing fixtures). Blackwater contains higher concentrations of nitrogen and human pathogens, and decomposes more slowly than graywater. Traditionally, systems have combined blackwater and graywater for treatment, but occasionally they are treated separately. Although residential graywater has fewer large solids than blackwater, graywater still contains pathogens and needs treatment. Graywater can be reused for irrigation, toilet flushing, or other uses where potable water treatment is not necessary in some jurisdictions. The elimination of graywater reduces hydraulic and organic loading.

There are two main types of non-discharging toilets that treat non-water-carried toilet waste: incinerating and composting. An incinerating toilet is a toilet that reduces human excreta and urine to a sterile ash and vapor by incineration. It is a self-contained waterless system that is powered by electricity or fueled by natural or propane gas. Exhaust gases must be properly vented, and residual ash must be removed every other incineration cycle. The toilet can be used 40 to 60 times between incineration cycles, which take about 4.5 hours.

A composting toilet is a toilet that receives non-water-carried wastes, such as human excreta, urine, and some organic kitchen wastes, and transmits it to a composting chamber. The waste undergoes drying and varying degrees of decomposition. The toilet can contain mechanical agitators, thermostats, humidistats, heaters, and fans to ensure that proper moisture content and temperatures are maintained. Direct homeowner involvement is required to monitor moisture and temperature levels. The key maintenance activity is periodic removal of the composted waste.

Pretreatment components

Pretreatment components remove many of the contaminants from the wastewater to prepare the effluent for final treatment and dispersal into the environment. Many options exist for treatment prior to release into the receiving environment. The level of treatment is selected to match the receiving environment and the intended use. The most commonly used pretreatment component is the septic tank and this is discussed in Chapter 5. Advanced pretreatment components are discussed in Chapter 7.

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 meeting the treatment and dispersal requirements; these options are covered in Chapter 8 of this manual.

Chapter 2

Safety

Learning objectives

Upon completion of this chapter, you should be able to:

1. Recognize the hazards associated with wastewater and wastewater systems, and demonstrate safe work habits.
2. Identify safety equipment required to prevent injuries during O&M service visits.
3. List the immunizations recommended for professionals working around wastewater.
4. Explain the meaning of safety management.
5. Describe the causes of accidents, and give examples of each.
6. List practices that demonstrate good personal hygiene.

Introduction

This chapter will discuss a few key points on **safety management.** It will then focus on exposures specific to the O&M profession and wrap up with a few tips on first aid.

Management of safety

An effective safety culture is created in a company through clear commitment to safety by top management. Company leaders must commit themselves to safety guidelines and follow them. A safety-oriented culture includes providing adequate resources (money, training, and people) that ensure safety is of the highest importance. A company's safety, health, and environmental (SH&E) management is based on identification of hazards and control of risks by both staff and management. Responsibility for SH&E management in any company involves everyone. Throughout the organization, employees must know what their level of responsibility is, what they control, and what they don't control. In larger companies, there may be someone who is directly responsible for development and management of SH&E issues. Because the majority of companies in the onsite wastewater treatment industry are small businesses with fewer than 10 employees, safety programs typically require more involvement by all personnel.

All safety topics are equally important. Components of a safety plan include:

- Observation of sound engineering and maintenance standards.
- Development of comprehensive SH&E procedures and operating instructions.
- Clear documentation of expectations/objectives for managers and employees.

- Use of programs to help employees anticipate potential injuries and incidents.
- Encouragement of personnel to minimize risky behaviors.

How accidents happen

Few accidents occur randomly, especially in the workplace. Generally, the root cause of accidents can be placed into one of four categories:

1. **Rushing** – Hurrying to get the job done for any reason.
2. **Eyes not on path** – Often the cause of most slips, trips, and falls.
3. **Eyes not on task** – Contributes to most impact, penetration, or splash injuries.
4. **Line of fire** – Wrong place, wrong time. May be in combination with 1-3 above.

Many people consider the process of safety management a burden. However, people make hundreds of safety decisions every hour of every day. Here are a few examples:

- When you use the blender or garbage disposal, are you careful not to put your fingers in the unit?
- When you start your car in the morning, do you look behind as you back out of the driveway?
- When you drive to work, do you wear your seatbelt?
- Do you signal before you change lanes in traffic?
- Do you slow down when driving in heavy rain?
- Do you turn your headlights on at dusk?
- Do you wash your hands before you prepare food?

How can a company that performs onsite wastewater treatment O&M translate these examples into actions that encourage work-safety?

Creating an SH&E policy is the first step

A company's commitment to SH&E management comes from its vision and values. Each company should create and adopt a safety policy that is unique. A policy of "no injuries to anyone, ever" has its basis in the belief that accidents can be controlled and injuries prevented. The SH&E policy expresses the company's commitment to this principle (see Example 2-1). The SH&E policy is supported by company standards and procedures that allow management of the safety process. Other elements include various operating instructions or procedures, hazard-specific training, and keeping records of pertinent events. Developing and maintaining compliance with regulatory requirements and the company's management system are further supported through a series of reviews.

Setting the standards

The following list is an example of standards for a SH&E program and includes steps that a company should take to establish its SH&E policy.

1. SH&E commitment
A company's SH&E policy applies throughout its operations. The company identifies policies and standards necessary to comply with local laws and with the company's SH&E program. The company's SH&E policy and standards are put in place, and resources needed for implementation are established. The conduct and accountability expected from employees for SH&E performance are defined.

2. Management and resources
Management leads the implementation of the company's SH&E policy and establishes

Example 2-1. Sample SH&E Policy.

Safety, Health, and Environment Policy

We believe that all work-related injuries, illnesses, and environmental incidents are preventable.

We will manage all our activities with concern for people and the environment and will conduct our business without compromising these values and vision.

In particular, we will:

- Strive to ensure our facilities operate to the highest standards to protect our employees, contractors, neighbors, and the environment.
- Sell only those products or services that can be completed, transported, stored, used, and disposed of safely.
- Provide appropriate information and/or training on the safe use and disposal of our products to our customers and consumers.
- Require every employee and contractor working for us to comply with relevant legislation and with this policy, and provide them with the necessary training.
- Communicate openly about our activities and report progress on our safety, health, and environmental performance

We make this commitment to our employees, contractors, customers, and the community as we work towards our vision of

"No Injuries to Anyone, Ever"

and monitors programs aimed at the continuous improvement of performance toward defined goals. The responsibility and authority of personnel charged with implementation of these standards are described.

3. Communication

Relevant information is provided to employees, contractors, customers, suppliers, and the public concerning the potential effects of the company's materials, products, and activities on the safety and health of people and the environment.

4. Training

Competence and expertise in SH&E protection are considered in selecting and placing employees. Training needs are identified and satisfied to ensure that all employees have the necessary skills and proper regard for the safety and health of themselves and others as

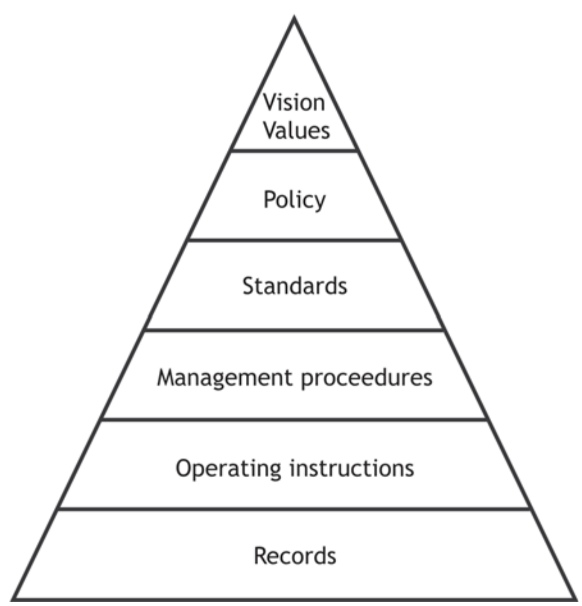


Figure 2-1. Program development pyramid: Building a solid foundation.

well as for environmental protection. Training and validation are regularly reviewed.

5. Material hazards
A complete and current inventory is available of all materials and products present in the workplace. Their associated hazards are identified, and risks to people and the environment assessed. Appropriate information is maintained to properly handle, store, transport, use, and dispose of materials. Appropriate limits for workplace and environmental exposure to all relevant materials and physical agents are established, and that information is disseminated. Personal protective equipment (PPE) required while in contact with the material is identified, provided, and used.

6. SH&E quality assurance
All facilities are equipped and maintained to ensure continued safe operation, the health of people, and minimum adverse impact to the environment. There are periodic reviews of hazards to identify opportunities for reduction or elimination. There are also routine inspections of worksites, equipment, and PPE.

7. Work procedures
Work procedures are written and maintained to ensure the safety and health of people and the protection of the environment. Hazards are eliminated or consequent risks reduced as far as is reasonably practicable. Control measures are implemented, and monitoring programs are arranged to demonstrate safe and healthy working conditions, safe behavior, and effective protection of the environment and assets.

8. Emergency plans
The nature and scale of all reasonably foreseeable emergencies (including transport emergencies) are identified. Adequate arrangements are established to deal with these emergencies. The arrangements are made in association with public emergency services. Plans are communicated and reviewed.

9. Contractors and suppliers
The SH&E implications of all aspects of work carried out by others on behalf of the company are considered. Competent contractors are selected and monitored. The contractor is required to provide sufficient information to ensure that the safety and health of company employees or others are not put at risk and that company environmental standards are not compromised by the contractor's activities.

10. Soil and groundwater protection
Arrangements are made to prevent contamination of land and groundwater arising from company activities.

11. SH&E performance and reporting
SH&E performance and records are maintained as required.

Implementing the standards

Each company is a little different but all build their safety program by choosing from the standards listed. Some require minimum effort to implement. Others may require more effort, depending on the activities of the company. Generally, most of the standards can be organized into one of three areas:

- Attitude
- Skills
- Knowledge

Attitude

A person's attitude during the workday is not static and is based in some behavioral aspects of what he or she does. The previous list of safety decisions is really a list of safe behaviors that we choose to exhibit. An important part of understanding behaviors is understanding the different perspectives associated with attitudes toward risk.

Employee attitude is important when you consider his or her perception of risk and determine how (or if) it should be managed or modified. So let's look at the previous examples from a different perspective:

- When you use the garbage disposal, are you careful not to put your fingers in the unit? *When you use a tool other than your fingers to clear a jammed garbage disposal, you avoid the* ***line of fire****.*

- When you start your car in the morning, do you look behind as you back out of the driveway? *It is easier to keep your* ***eyes on the path*** *if the car is backed into the driveway and you have a clear view of the street ahead of you.*

- When you drive to work, do you wear your seatbelt? *Failing to wear a seatbelt is commonly a* ***rushing*** *issue.*

- Do you signal before you change lanes in traffic? *Accidents often occur when drivers fail to signal; because they are* ***rushing****, they are distracted and don't have their* ***eyes on the path****, or they are not driving defensively to avoid the* ***line of fire****.*

- Do you slow down when it is raining hard? *The choice not to* ***rush*** *helps drivers stay safe in the rain.*

- Do you turn your lights on at dusk? *Turning your lights on at dusk enables you to keep your* ***eyes on the path****.*

This last discussion was designed to help understand the motivations for behavior. Behaviors are changed by a conditioned response that works both positively and negatively.

If your phone rings and you answer it, and no one is on the line, you will hang up. If this continues you may become less likely to answer the phone each time.

If you eat your lunch without washing your hands and don't get sick, you tend to not wash your hands when running late from one job to the next.

If you scrape your knuckles on a concrete lid and don't get sick shortly after being exposed to raw sewage through the wound, you are not motivated to wear your gloves.

However, if you hurt your back by lifting a heavy concrete tank lid and that causes you to be off work for two weeks and lose pay or customers, you start lifting in a way that protects your back.

Key safety point:
Your feedback from positive and negative behaviors should be the same if nothing happens. Don't gamble with your health and ability to work.

Skills and knowledge

Some people come to the workplace with a skill set based on prior experience or work history. Others are new to the industry or workplace and may have a common skill that is easily transferred to similar work tasks or work environment.

It is important to understand each individual's skills and evaluate them relative to their new workplace environment. This is the **employer's** responsibility.

A company's safety or integrated work procedure is developed to assist people in controlling risks in the workplace. Therefore a high degree of compliance is required. Procedures are divided into two main categories to assist in prioritizing the standards to meet local requirements and company policy: critical and regular.

Critical procedures are those that carry significant risk, involve a number of people, and/or require a high degree of attention to ensure the required level of compliance is maintained. Widespread training is required and in-depth procedures are needed to ensure that compliance continues.

Regular procedures are those that involve few people, normal risks, and require lower levels of attention. Training is limited to those people who are directly affected.

Safety hazards

In this section, we will review:

- Specific safety hazards
- Points of entry and mitigation
- Engineering controls to minimize risk of exposure by use of PPE

O&M professionals working on onsite wastewater treatment systems must understand the possible safety hazards they may encounter. They must also practice good personal hygiene, avoid personal injury, know the basics of first aid, and understand proper safety procedures for working in confined spaces. Additionally, the service provider must also plan to properly deal with any surface discharge of effluent. Common safety hazards associated with onsite wastewater treatment systems include pathogens, poisonous or explosive gases, electrical hazards, and others.

Biological (pathogens)

Working with onsite wastewater treatment systems creates the possibility that homeowners and O&M service providers may come into contact with **pathogenic bacteria and viruses** in sewage effluent. Pathogenic bacteria have the potential to cause diseases such as salmonella, shigellosis, typhoid fever, cholera, paratyphoid, bacillary dysentery, and anthrax. Viruses can cause polio and infectious hepatitis. Internal parasites can cause amoebic dysentery, ascaris (giant ringworm), and giardiasis.

Point of entry: (Line of fire exposure)

This exposure is the most common through direct contact with raw sewage or partially treated effluent in any portion of the wastewater stream. Exposure can occur through the skin, eyes, or mouth; through open cuts or scrapes; or with contact from splashing or back splashing of liquid from any of the open elements of a tank or treatment component. This can occur during procedures from initial inspection to testing of system pressure and volume flows (squirt heights).

Personal protective equipment

- **Hands/arms**
  A good quality latex or rubber glove is a critical piece of PPE for minimizing this type of exposure. Ensure that the type of glove used is suitable for protection against exposure to raw sewage or effluent. Gauntleted over-gloves provide additional protection. Ensure that when taking this equipment off and on, careful procedures are used to ensure that no cross-contamination of clothing or equipment occurs.

  If there is a possibility that cross-contamination has occurred, wipe down affected surfaces (steering wheels, gearshifts, door handles, or hand tools) with a disinfectant.

- **Eyes/mouth**
  Eye protection such as glasses (with side shields) or goggles should be worn. Safety glasses designed for protection from flying debris and penetrating objects may not be necessary, but a face shield or facemask may be worn for an additional level of splash protection.

Good personal hygiene

Practicing good personal hygiene is important for the operator because all wastewater must be assumed to be infectious. O&M professionals should observe the following practices to avoid infection:

- Keep hands and fingers away from eyes, ears, nose, and mouth.
- Wear rubber gloves that have been evaluated and deemed "fit for use."
- Wash hands before eating or smoking.
- Do not store or wash personal clothes with work clothes.
- Give cuts and scratches first aid immediately.
- Take a shower after work.
- Receive appropriate immunizations against illness including but not limited to Typhoid fever, tetanus, paratyphoid, polio, and hepatitis A and B. It is recommended that you consult with your local physician and/or health care professionals for appropriate immunizations.
- Provide and use waterless hand cleaners, and ensure that they are effective against viruses.

Key safety point:
If your safety gloves have ANY holes or minute perforations, contamination is a real possibility. For comparison, a virus moving through a pinhole in a glove is like a garden snake swimming through a 3-foot culvert. Gloves should be hospital quality and fit for use. You may not be able to tell if there is a minute hole or tear, so gloves should be changed after each job or more frequently if the barrier protection is compromised.

Underground system components, confined spaces

There are hazards associated with underground or confined spaces. The definition of a confined space is that it has limited entry and exit; it contains known or potential hazards; it has poor natural ventilation; and it is not designed for continuous human occupancy. There are two categories of confined spaces: open-top enclosures with depths that restrict the flow of air, and enclosures with extremely small openings for entry and exit. All O&M professionals should have designated training and equipment regarding confined spaces. Seek Occupational Safety and Health Administration (OSHA) guidance and applicable certifications.

The nature of confined spaces makes them dangerous. If one does not know the dangers involved and is not properly trained in rescue procedures, death can occur. One-half of fatalities in confined spaces occur among rescuers who are improperly trained and who succumb to danger, because they are emotionally involved. Training should include:

- Safe entry and exit procedures
- Use of respiratory equipment
- Knowledge of first aid techniques
- Isolation techniques: blanking and blocking
- Procedures for monitoring the atmosphere
- Lockout/tagout
- Safe practices
- Confined space rescue

Ventilation is often a problem in confined or underground spaces. Use meters to test air quality for presence of dangerous gases. A clean air supply should be provided, and the space should be ventilated if any of the following are present:

- Sources of combustible vapors or gases
- Toxins and other contaminants above permissible levels
- Oxygen levels of concern*
- Potential hazards of flammability
- Toxic gases or vapors
- Disturbed particulate matter

* Normal oxygen level is 20.9 percent, deficient is less than 19.5 percent, and excess (which can lead to explosion) is more than 23 percent. The normal oxygen level in septic tanks is 19 percent, so care should be taken when accessing a septic tank.

Poisonous and explosive gases

Another hazard associated with onsite systems is the potential for the build up of **poisonous or**

explosive gases. To prevent problems with the accumulation of hazardous gases, check for oxygen levels and toxic gases with the appropriate equipment, and use appropriate gas masks or air packs.

Point of entry: Inhalation (line of fire exposure) and personal protective equipment

This exposure may also be associated with confined space entry. Tanks containing sewage or partially treated wastewater are confined spaces. Entry of such spaces is an OSHA regulated activity. Commercial air quality testers are available for testing the space for oxygen and various types of contaminants. PPE for this exposure ranges from partial facemasks with specialized canisters that capture and remove the poison gas to air-supplied breathing apparatuses. **Do not enter tanks unless trained and equipped to do so.**

Engineering controls

Another means of controlling this hazardous environment is through the use of engineering controls. Written procedures, task-specific training, testing equipment, and confined space entry procedures are among these controls. The space may be flooded with a volume of fresh air to purge any poisonous gases, but continual air quality testing is required by a trained person.

Key safety point:
Some gases are poisonous; others are poisonous AND explosive. Air testing devices that test for explosive environments typically test ONLY for the percentage (level) of oxygen that renders it explosive/flammable. The equipment may or may not indicate if it is poisonous. Make sure the device is capable of testing what is needed (fit for use).

- **Hydrogen sulfide**
  One such hazardous gas is **hydrogen sulfide** (H_2S), which is formed during anaerobic decomposition in the septic tank. Hydrogen sulfide smells like rotten eggs at low concentrations, erodes concrete and metals, discolors and removes paint, and can paralyze the human respiratory system. When mixed with oxygen it forms **sulfuric acid** (H_2SO_4). It causes dizziness, irritation, and headache at as low as 50 ppm, and is toxic or fatal at 600 ppm. It also causes olfactory fatigue, and, after a few minutes, the smell is no longer noticeable.

- **Chlorine gas**
  Chlorine (Cl_2) is another gas that can accumulate in the tank. Chlorine gas is heavier than air, is irritating to the nose and mouth, and forms **hydrochloric acid** (HCl) in the lungs. In addition, because chlorine displaces air, it can cause suffocation. Most gas masks are useless against chlorine, so air packs are needed for protection. The safety limit for chlorine gas is 1 ppm. Chlorine products are used in disinfection of wastewater. Generally chlorine gas is not used in small systems. However, chlorine tablets and liquid chlorine bleach may release chlorine.

- **CO(x) gases**
  Carbon dioxide (CO_2) and **carbon monoxide** (CO) are other gases that pose hazards to O&M service providers. Carbon dioxide is an odorless, tasteless gas that is produced by gas-forming bacteria that digest organic substances in pretreatment components of onsite wastewater treatment systems. The exposure limit for carbon dioxide is 5000 ppm. Carbon monoxide can become a problem when there is a lack of oxygen. Carbon monoxide is colorless, odorless, explosive, and causes suffocation. The exposure limit for carbon monoxide is 50 ppm.

- **Methane**
  Methane (CH_4), which is produced by gas-forming bacteria that digest organics in septic tanks, is odorless and is explosive when mixed with air.

Lockouts and tagouts

Be aware of lockouts and tagouts. Safe work practices should always be used and be consistent with the nature and extent of the associated hazard. Live parts that have been de-energized but not locked out must be treated as energized, and de-energized circuits should be locked out and tagged. Written procedures shall be kept and made available for inspection. A copy of paragraph (b) of General Industry Standards of Occupational Safety and Health, set by the U.S. Department of Labor, 1910.353, fulfills the requirement for written procedures. This can be found at: **http://www.osha.gov.**

Lockout and tagout procedures state that the locks and tags must be in place before equipment may be de-energized. Live parts must be disconnected from all electrical sources, and stored electrical energy must be released. This may also include the pressurization of the system. The general provisions for lockout and tagout are that live parts must be de-energized unless it is impossible to do so and if safe work practices for working on live parts are mandated.

Locks and tags must be placed together unless the lock cannot be applied. If only a tag is used, an additional safety measure must be used as well. A lock may only be used without a tag if only one item is de-energized, if the lockout period does not extend past the shift, *and* if exposed employees are familiar with the procedures. A qualified person shall check to see if the equipment is de-energized (if it is over 600 volts), and verify that equipment is safe to energize. Only the person placing the lock shall remove it unless that person is not in the work place and the employer takes certain precautions. Only qualified persons are allowed to work on live, exposed parts.

Electrical shock

Electrical shock is another potential hazard to onsite wastewater treatment system O&M professionals. Because electrical shock can cause serious injury or death, O&M professionals should not attempt to repair electrical equipment unless they are experienced with electrical systems. In all states, O&M professionals must be qualified and authorized to work on electrical equipment before attempting to make any repairs or troubleshoot. Ordinary 120-volt electricity can be fatal; 12 volts may also cause injury. Depending on the systems, service providers may also see 240-volt systems.

Point of entry: Direct contact with energy to ground (line of fire exposure) and personal protective equipment

This exposure may also be associated with a confined space entry and in some cases can be the cause of the resulting reaction of flammable/explosive gasses. Depending on the task at hand, the best control is use of lockout/tagout procedures with which everyone on the project site is familiar. "Hot wiring" is generally not a recommended practice on live electrical components but is allowed in some cases. The electrical license holder may need an additional certification to do this.

Engineering controls

Another means of controlling this hazardous environment is through the use of engineering controls. Engineering controls are those measures that help control the working environment by some physical means. Written procedures, task-specific training, and following proper lockout/tagout procedures will ensure safety. These procedures must be documented, and specific training must be provided for employees exposed to electrical hazards.

> **Key safety point:**
> Use the right tool for the job. Hand tools and some specialized tools are designed specifically for use in electrical environments. If you are using a lockout/tagout procedure, check to make sure you are following a permit-to-work procedure as well. This is occasionally used as another level of engineering control.

Any electrical system should be considered dangerous unless the service provider knows that it is de-energized. Remember these basic safety rules when working around electrical equipment:

- Keep your mind on the potential hazard at all times.
- Don't use metal ladders.
- Never override any electrical safety device.
- Inspect extension cords for abrasion and insulation failure.
- Use only grounded or insulated (Underwriter Laboratory (UL) approved) electrical equipment.
- Take care not to ground yourself when in contact with electrical equipment or wiring.

Only trained and qualified individuals should be allowed to service, repair, or troubleshoot electrical equipment and systems.

Utility lines

Utility lines are a potential hazard located on every property. The O&M professional should identify the location of utility lines when entering the property. Overhead utility lines are well within the reach of a liquid vacuum tank or backhoe. Look up and around you when you scope the site for other dangers.

Underground utility lines are also a danger when digging on a site. Before digging at a site, locate underground utility lines. A free service available to everyone in the United States is the Underground Service Alert (USA). The number to call is: **1(800) 227-2600.** Please remember that some electrical and gas lines may not be marked by the locator service because they are local lines. These local lines may be going to the onsite wastewater treatment system or other units requiring electricity on the property. Always exhibit care when digging with a backhoe or hand tools around an onsite wastewater treatment system.

Other hazards

Other hazards for the O&M professional include the following (NOTE: This list is not complete. Every region has specific hazards that service providers should be aware of.):

- **Stinging insects**
  - Scorpions
  - Wasps
  - Bees
- **Biting insects**
  - Black widow spiders
  - Brown recluse spiders
  - Mosquitoes
  - Biting flies
  - Fire ants
- **Dogs**
- **Water moccasin snakes**
- **Poisonous and rough vegetation**
  - Poison ivy
  - Rose bushes
  - Berry bushes/ Thistle/Devils club, etc.
  - Poison oak
- **Open excavations**
  - Slopes, ditches, and shore-up sides
  - Holes
  - Open access ports

> **Key safety point:**
> Use the buddy system. Working alone is always a great risk itself.

Lifting injury prevention

O&M professionals should be aware of activities that could cause injury. Particular care should be followed when lifting heavy or awkward items. The following steps should be practiced to avoid personal injury:

- Do not lift more than can be handled comfortably.
- Establish a solid footing and good balance before lifting.
- Get as close to the load as possible when lifting or carrying.
- Make sure both feet are pointing at the load.
- Keep the back straight, while gripping the object firmly and using the legs to provide lift.
- Never carry a load that is too large to see over or around.

Surface discharge of sewage and effluent

In addition to personal safety, the operator should have an emergency plan for dealing with sanitation problems as a result of surface discharges of effluent or sludge. Because any discharge of effluent should be considered infectious, physically block off any area where discharge occurs, and then treat it with lime if necessary. Fence in tank areas, and put lockable lids on tanks to prevent children from gaining access. Removal of residuals (pumping) should be performed by an authorized handler, and sludge should be transported to an authorized facility. Any bypasses must be reported to an appropriate state agency in a timely manner.

First aid

Because of the possibility of accidents, injury, and exposure to hazardous material, always keep a well-stocked first aid kit on hand, preferably in the vehicle or tool box from which you are working. Clean water for handwashing should be available, but at a minimum, waterless hand cleaner and towels should be available at the job site. Knowledge of CPR is mandated in some jurisdictions depending on the crew size. With the use of cell phones and two-way remotes, it is unlikely that you will need to make other arrangements, but if you are in an area without service, contingency plans should be developed.

For more complete information about first aid, contact the American Red Cross (www.redcross.org) for training information and publications.

Emergency numbers to keep on hand:

- 911 for EMS units or fire trucks
- Telephone number of the nearest hospital or medical treatment facility
- Directions on how to get there

Conclusion

Whether we are aware of it or not, we make decisions about safety continuously. It defines our risk tolerance and determines the choices we make as we go forward. We hope that this discussion has raised your awareness of key safety issues for O&M service providers. If you are going to take risks, do it with full knowledge of the potential consequences. Then you can make reasonable choices based on your experience and knowledge as to how much and what level of protection you require.

You can get additional information on safety and safety management through various sources including the local regulatory agency responsible for worker and workplace safety in your state.

Chapter 3

Business and Industry Ethics

Learning objectives

Upon completion of this chapter, you should be able to:

1. Describe the differences among ethics, law, and regulatory code.
2. Understand the importance of ethics in the O&M service provider industry.
3. Describe how the O&M checklists can be used to establish standards of practice.
4. Identify the characteristics that contribute to credibility.

Introduction

The O&M Service Provider Program develops a relationship between you as the service provider and your clientele. This discussion is designed to assist you in developing your philosophy for conducting O&M on onsite wastewater treatment systems. In your business, you will be faced with questions of ethics and have the opportunity to build credibility, respect, and admiration.

Business and industry ethics

Credibility, personal respect, and admiration from others are highly valued in today's society. The avenue to these three values is **ethics**.

Ethics address the moral duties and obligations that we have within our society. Acceptable behavior—what is right and wrong—is defined within ethics with the goal of achieving maximum good for all people.

Ethical questions affect our daily lives. We make ethical or unethical decisions every day that build or weaken our credibility, personal respect, and admiration from others.

Definitions of ethics: A comparison of ethics and law

Generally, ethical questions that are the most important evolve into laws. These laws include punishments for offenders as part of the judicial process.

The area of personal ethics usually does not include an objective review of one's actions or a structured punishment procedure. Instead, the "rules" are much less specific and are handed down by word and example more so than by written documentation. This is because many of these stated or unstated norms are based on emotion, religious beliefs, and subjective personal perceptions.

Thus, the differences between ethics and laws include structure, formality, and objectivity.

Even though ethics are much more vague,

they influence our lives as much or perhaps more than any law.

How one builds or loses *credibility* through ethical questions

Credibility that is built up within the mind of our peers and customers includes believability and dependability.

When one demonstrates a level of integrity, honesty, and consistency in one's dealings with others, society acknowledges the pattern. When people with credibility speak, their words carry weight in the minds of listeners. Their words are believed to be true, simply because of who spoke them.

The second element of credibility has to do with being dependable. People in positions of leadership have developed a history of being believable. Their peers believe what they say and have come to depend upon their input before making decisions. People accept the information being presented by an authority figure, because he or she is dependable. As a service provider, people will accept what you say because of your dependability.

Thus, the value of **credibility** becomes clear.

How one builds or loses personal *respect* through ethical questions

Respect is given to people in either a **position** of respect or to those who have earned **personal** respect.

Positional respect is a result of the position itself, rather than the character of the person holding that position. For example, a police officer guiding traffic in an intersection holds positional respect. You, as a driver approaching the corner, have never met the police office. Yet, you carefully follow instructions because of the police officer's position of respect.

This type of respect is necessary for the proper and efficient functioning of our society, but it is not the valued type of respect we are speaking of today.

Personal respect, rather than positional, is the goal of an ethical person. The significant difference between the two is that personal respect must be demonstrated and earned. Our peers are keeping mental notes of our actions, noticing either breeches of ethics or advances that we demonstrate every day.

Because personal respect must be earned and is an individual trait arising from our personal relationships, it is far more valuable than positional respect.

For example, regulatory inspectors in our industry have an automatic positional respect. But, like all of us, they also seek and value personal respect. They must be willing to make ethical decisions in order to earn it.

How one builds or loses personal *admiration* through ethical questions

The final aspect of ethics that we will address deals with the responsibility we have as professionals to guide and influence the onsite wastewater treatment industry. Part of being a professional is active membership in local, state, and national professional associations. Participating in these organizations provides the opportunity to both gain (information, continuing education units, etc.) and give back to the industry.

Giving back also involves developing admiration from our peers through ethical conduct that allows us to guide the industry toward betterment for all. Like personal respect, this benefit from living an ethical life is difficult and time consuming to build but is easily destroyed.

Gaining this admiration is not for the benefit of our personal egos. It is instead our responsibility to provide the necessary leadership for the entire industry.

Ethics from a viewpoint of personal, public, and peer group perceptions

Service providers need to function as professionals. This includes knowing the applicable local, state/provincial and national statutes, codes, laws, and regulations applicable to the industry. If facility owners receive multiple answers to the same question from service providers, they will become suspicious of the whole industry. You as a professional must know the correct answer to general questions, or you and the industry will lose credibility.

Service providers should compete honestly and lawfully, building their businesses through their own skills and merits. How can this be implemented? Use straight forward contracts showing what services you will provide. This will educate homeowners so they can compare bids and also ask competitors appropriate questions.

O&M service providers should also avoid any act that might promote their individual interests at the expense of the integrity of the industry and avoid conduct that might discredit the industry. We must look at the betterment of the industry. If the onsite wastewater treatment industry gets a “black eye,” then it is harder to maintain this industry in the eye of the public.

Instead, service providers should seek to enhance the reputation of the industry with others by the way they communicate and interact.

You are the representative of the industry to the client, and this will reflect on the industry as a whole.

Summary

We should be aware of ethics at all times. Doing so allows each of us to gain personal respect, credibility among our peers, and even admiration from those whom we influence.

Chapter 4

Site Assessment

Learning objectives

Upon completion of this chapter, you should be able to:

1. Describe the influence of topography and landscape position with regard to onsite wastewater treatment system function.
2. Describe the causes and effects of erosion around onsite components and in the drainfield.
3. Identify proper grading and subsurface water management procedures for an onsite system.
4. Explain the importance of keeping encroachments and sources of stormwater away from system components.
5. Describe the purpose of vegetation over the drainfield.
6. Explain the significance of dead vegetation, excessive vegetation, large trees, and roots in the drainfield.
7. Identify the four elements that must be present when a groundwater monitoring well is required.
8. Understand and be able to accurately complete Operational checklist 4-1. Site assessment.
9. Recognize changes in site conditions that indicate the need to complete Operational checklist 4-1. Site assessment again.

Overview

The site is essentially a system "component" that must be managed as much as any other individual component. By careful initial assessment of the site, the service provider can track any changes that may occur over time as a result of system location in the landscape as well as from human activities.

Operation and maintenance

Assessment of the site helps identify surface and subsurface features used to manage water on the site and can be accomplished by using Form 4-1 Site assessment (SA). This form should be filled out when a service provider first secures an agreement to provide O&M for a system. This should be kept in the system file for reference. During each subsequent visit to the site, this form is needed only if Item 2 in Section D on Form 1-2. System Evaluation (SD) (page 20) indicates that changes have been made to the site.

Certain tools and equipment are helpful for O&M service providers. A list of suggested tools is included in "Appendix C."

For some of the activities, the service provider will determine whether certain critical points are in acceptable or unacceptable condition. Unacceptable conditions indicate the need for maintenance, upgrade, repair, or further investigation.

1. Surface water management: Topography and landscape position are the connection between the hydrologic cycle and onsite 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 low elevation, 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 onto or near the site, there are serious implications for system performance during wet seasons.

Surface water should be diverted away from tanks, drainfields, and any other system components. Diversion berms and swales will collect surface water moving across the site and channel it around the system. If required, these should be intact and operating effectively. Stormwater running off buildings or other structures can infiltrate into the components of onsite wastewater treatment systems. Rainfall coming off a roof, driveway, or patio should be diverted around the system with the use of gutters, drainage trenches, and/or berms.

Proper grade over tanks, drainfields, and other system components is essential to good surface water management. Final grade should be relatively even and sloped to allow surface water to drain away from system components. However, excessively steep slopes will encourage erosion. Side slopes of mounded soil absorption areas are prone to erosion if they are excessively steep.

Sewage odors and/or surfacing effluent could indicate 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. This settling can result from compaction of material placed around systems, loss of soil into onsite wastewater treatment components, or structural failure of components. 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 failure 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.

Erosion around system components can occur as a result of settling, improper grading, or inadequate/improper vegetation. The system area should remain free of any eroded areas or any excavations.

2. Subsurface water management: Subsurface water management can be maintained by use of interceptor drains to collect water moving onto the site and divert the water around and away from the 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 will 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 check lists for the drainage pump tank, pump, and controls must be completed. Ensure that the sump pump is working, and that there is an outlet for the sump pump discharge.

3. Encroachments: Placing manmade structures too close to system components will affect performance and is probably regulated by local code. Driveways and utility easements should not compromise the system. Patios, decks, or other structures should not be located on top of any system component because 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 system components should be discouraged. Make a note if any such activities are occurring over or near system components.

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 the neighbors have done anything that might affect flow or damage the system. Ideally, the system should be protected from traffic either by being in an inaccessible location or by the erection of barriers.

If a reserve area is designated for the system, this should also be free of system encroachment. Any activities that would encourage compaction or erosion should be avoided. Vegetable gardening, however, would be considered an appropriate use of this area.

4. 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 will also stabilize 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 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 dry regions, dead vegetation over a tank or lateral may simply be due to insufficient moisture to maintain vegetation during dry periods. Excessive vegetation adjacent to dead vegetation (bullseye 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.

Testing of soil fertility and salinity can help identify and solve problems with vegetation.

5. Groundwater monitoring wells: 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 EPA guidelines if no local codes exist. Indicate if any testing is done and any recommendations are made as a result. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from the laboratory to complete the system file. Report the information to the proper entities.

6. Additional comments and photographs: Photos of initial site conditions serve as a good baseline for identifying changes in site conditions. Any other site conditions that could affect system performance should be noted (e.g., recent tree removal, flooding, filling in of holes, or grading).

Form 4-1. Operational checklist: Site Assessment (SA)

(This form is to be filled out one time at the initial site assessment and used as a reference for all other O&M service visits.)

Service provided on: Date:_________ Time:___________ Reference #:______________________

Service provided by: Company:__________________________ Employee: ______________________

Date of last service: ____________________ by: ❑ You ❑ Other:____________________________

1. Surface water management
   - a. Is surface water effectively managed/diverted away from the site. Yes ____ No____
   - b. Is surface water effectively diverted away from system and components. Yes ____ No____
   - c. Evaluate the presence of odor within 10 ft of perimeter of the system:
     ❑ None ❑ Mild ❑ Strong ❑ Sour ❑ Chemical
   - d. Source of odor, if present: ______________________________
   - e. Are the system components free from settling or erosion. Yes ____ No____
2. Subsurface water management
   - a. Type: ❑ Gravity ❑ Pump ❑ Not present
   - b. Outlet open to drainage. Yes ____ No____
   - c. Rodent guard on outlet. Yes ____ No____
   - d. Sump pump working. Yes ____ No____
   - e. Outlet for sump pump discharge. Yes ____ No____
3. System encroachment
   - a. Is the system free from encroachment. Yes ____ No____
     ❑ Driveways ❑ Utility easements ❑ Patios ❑ Decks ❑ Livestock
     ❑ Gardening ❑ Vehicular traffic ❑ Construction ❑ Pets ❑ Other:_______
   - b. Is the reserve area free from encroachment. Yes_____ No____
     ❑ Driveways ❑ Utility easements ❑ Patios ❑ Decks ❑ Livestock
     ❑ Gardening ❑ Vehicular traffic ❑ Construction ❑ Pets ❑ Other:_______
4. Vegetation and soils
   - a. Trees in distribution field. Yes ____ No____
     Type(s): ______________________________
     Location(s): ______________________________
   - b. Excessive vegetation. Yes ____ No____
     Location(s): ______________________________
   - c. Uneven vegetation. Yes ____ No____
     Location(s): ______________________________
   - d. Poor vegetation. Yes ____ No____
     Location(s): ______________________________

   Soil fertility and salinity sampling (if required). Yes ____ No____
5. Groundwater monitoring wells (if applicable)
   - a. Present. Yes ____ No____
   - b. Wells accessible. Yes ____ No____
   - c. Wells intact. Yes ____ No____
   - d. Wells properly protected. Yes ____ No____
   - e. Labels and tags in place. Yes ____ No____

   Groundwater sampling (if required). Yes ____ No____
6. Additional comments:______________________________

____

Attach any photographs of the site to this form.

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable

Chapter 5

Pretreatment Components–Tanks

Learning objectives

Upon completion of this chapter, you should be able to:

1. Describe, compare, and contrast holding tanks, septic tanks, trash tanks, and processing tanks.
2. Describe the treatment processes that occur in tanks.
3. Explain the operational significance of a tank that is above or below normal operating level.
4. Describe the function of an effluent screen in a tank.
5. Describe the use of a sludge judge and/or other measuring device to determine the depth of sludge and scum in a tank.
6. Describe the conditions that indicate a tank should be serviced.
7. Understand and be able to accurately complete Operational Checklists:
    a. 5-1. Holding tanks (HT)
    b. 5-2. Septic, trash, and processing tanks (STPT)

Introduction

Pretreatment components prepare wastewater for final treatment and dispersal. The quantity of contaminants is reduced to a level the soil can accept and treat. Wastewater pretreatment components include septic tanks, aerobic treatment units, media filters, and constructed wetlands. This chapter will discuss holding tanks, septic tanks, trash tanks, and processing tanks.

Holding tanks

Overview

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 residence (Figure 5-1). Holding tanks are often prohibited except under extenuating circumstances and their use is often temporary while other options are being explored.

Treatment

Holding tanks are generally considered a collection and storage device with treatment actually provided at a different location. Settling of the solids may occur during storage. However, all material in the holding tank is removed during pumping.

Operation and maintenance

Holding tank O&M includes the following activities (**Form 5-1. Holding tanks** (HT)):

1. Check for odors near the tank. There should be no strong odors near the tank if the house vent stack is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports, damaged lids/risers, or surfacing effluent. Also check the roof vent location, prevailing winds, and atmospheric pressure. Note whether the odor is strong, mild, septic (rotten eggs), chemical, or sour in nature.

2. Record the material used to construct the tank. Tanks may be made of concrete, plastic or fiberglass. Any flex detected in non-concrete tanks should be noted, because their strength is dependent upon the integrity of their shape. With the availability of newer materials, metal tanks are uncommon. Metal tanks typically have significant problems with watertightness as a result of corrosion. Determine the size of the tank. Information on tank capacity should be included on the permit. If it is not available, it can be obtained by first calculating the volume and then using a conversion factor to convert cubic feet to gallons. These calculations are discussed in Appendix A.

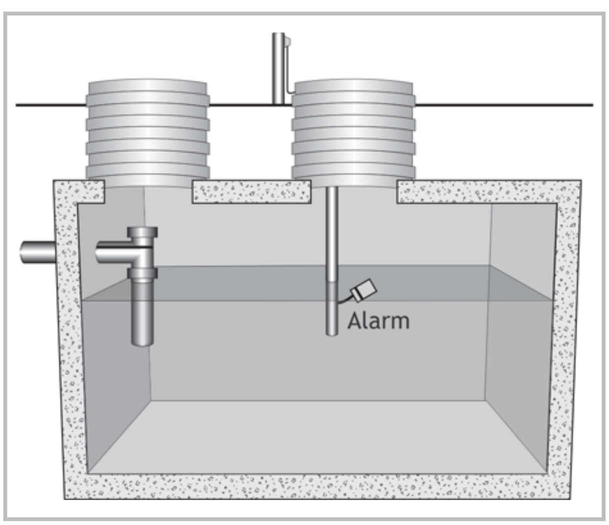


Figure 5-1. Holding tank with the water level in alarm status.

3. Note where the access is located on the tank (inlet/center). If the tank access is farther than 6 to 7 feet from any tank wall, it may limit maintenance in those areas, especially during pumpout services.

   Tank access must be adequate for inspecting contents and servicing the tank. If there is a riser on the tank, it should be in good condition and properly sealed to prevent infiltration. Check the riser/tank seam for stains that would indicate infiltration of groundwater or surface water. Ideally, the riser should come to grade so that no digging is required to reach it. Some jurisdictions may not require access to grade, so some digging may be required. If it is buried, note how much cover is on the tank.

   The lid on the tank or riser should be securely fastened with safety screws (screws that require a non-standard tool) or other means. The lids must be readily removable by the service provider but child-proof. If a concrete lid is used, weight of the lid will limit unauthorized access. The lids must be operable as designed, and there should be no obstacle placed near or on top that makes them inoperable. The lids must not be so heavy as to make them inoperable. If the tank was uncovered by the owner, note that on the checklist.

4. Note whether the alarms are present and if they are audible or visual. Test to make sure they are fully operational.

   Check what kind of monitoring is available (remote telemetry or electronic monitoring), and test the systems manually to see if they are operational.

5. The maximum liquid level for a holding tank is measured from the bottom of the tank to the invert of the inlet pipe. Measure the current level in the tank with respect to the inlet. Measure the alarm activation level from the invert of the inlet pipe. Use of multiple sensors increases accuracy of water levels. Some systems have three alarm sensors set at 50, 75, and 100 percent capacity. Other systems have sensors set at 75 percent and 90 percent capacity. The alarm level is set on the basis of how fast a pumper can respond to a service call. Note whether levels have exceeded the maximum or if the level has dropped without the tank being pumped out (an indication of a leak).

   Check the inlet to evaluate effluent flow into the tank. Normally, the flow will start and stop due to use in the home. Continuous flow may indicate a plumbing leak.

   Make a note of the date of the last pumping of the tank.

6. When the tank is pumped, evaluate structural conditions inside the tank. Check the integrity of the tank top, sides, and bottom. The inside of the tank should show no signs of structural failure such as exposed rebar or rust stains from the rebar in a concrete tank. Spalling (physical degradation of a concrete structure that exposes aggregate and/or structural reinforcement materials) is an indication of possible structural failure and should be noted. A plastic tank that has deformed has also lost a significant amount of its structural integrity.

   Because the tank lid is above the liquid level, it is particularly prone to corrosion. Inspect the inside of the tank (particularly at the riser/tank seam) to make sure there is no root intrusion that would indicate a chance of leakage or infiltration.

   If no one in the home is using water, listen for leaks or running water into the tank. Notify the homeowner to correct any plumbing leaks or drips.

7. Check pumping frequency. Local regulations may dictate the pumping frequency required, but holding tanks generally require pumping before they reach capacity.

8. If the tank was pumped, note the name of the contractor, the amount removed, and the date the service was performed.

Form 5-1. Operational checklist: Holding tank (HT)

Reference #:____________________

Service provided on: Date:________ Time:____________
Service provided by: Company: ________________________ Employee:______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________

Date of last inspection: ______________________________

1. Conditions at the tank
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
2. Tank description
   a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   b. Capacity: ____________gal
3. Tank access
   a. Access location: ❑ Inlet ❑ Center
   b. Located at grade. Yes____No_____
   c. If 'No', how deep is lid buried. ____________
   d. Risers on tank. Yes____No_____
   e. Evidence of infiltration in risers. Yes____No_____
   f. Lids securely fastened. Yes____No_____
   g. Lid in operable condition. Yes____No_____
4. Alarm(s)
   a. Alarm(s) present. Yes____No_____
   b. Audio alarm operational. N.A.____Yes____No_____
   c. Visual alarm operational. N.A.____Yes____No_____
   d. Remote telemetry operational. N.A.____Yes____No_____
   e. Electronic monitoring operational. N.A.____Yes____No_____
5. Current tank operating conditions
   a. Liquid level relative to inlet: ___________in
      At ❑ Above ❑ Below
   b. Maximum liquid level of tank (invert of inlet pipe):___________in
   c. Height at which alarm is activated as measured from invert of inlet: ____________in
   d. Evidence liquid level has been higher. Yes____No_____
   e. Evidence liquid level dropped without pumping. Yes____No_____
   f. Evidence of continuous inflow. Yes____No_____
   g. Date of last pumpout:______________________________
6. Tank structural condition (evaluate if tank pumped): N.A.__________
   a. Appears to be watertight (no visual leaks). Yes____No_____
   b. Rebar exposed. Yes____No_____
   c. Corrosion present. Yes____No_____
   d. Spalling present. Yes____No_____
   e. Cracks present. Yes____No_____
   f. Root intrusion. Yes____No_____
   g. Deflection noted. N.A.____Yes____No_____
7. Holding tank pumping recommended. Yes____No_____
8. Contractor responsible for pumping: ____________
   a. Gal removed:________________Date:____________________

Notes

1. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Septic tanks, trash tanks, and processing tanks

Overview

This section describes tanks that are used to separate, decompose, and store solids that are part of the stream of wastewater. Please take note that when septic tanks in general are referred to in the text, it means septic tanks, trash tanks, and processing tanks as a group.

A septic tank, trash tank, or a processing tank is an enclosed watertight container made of concrete, polyethylene, or fiberglass that collects and provides primary treatment by separating solids from wastewater (Figure 5-2). Because the liquid level in the tank remains relatively constant, incoming flow is forced to slow down. This allows the settleable solids to fall to the bottom of the tank as sludge, while floatable solids (fats, oils and grease or FOG) rise to the top as 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 septic tank is critical for allowing physical separation of solids. Detention time is a measure of the time effluent remains in a tank and is calculated by dividing the tank volume by the daily flow (calculation covered in Appendix A). Inclusion and configuration of inlet devices and compartment walls result in a less direct flow path for the effluent which allows for better separation in the tank.

All tanks must be watertight to prevent water from entering as well as leaving the system.

Inflow/infiltration

Inflow (extraneous water directly entering a component, such as via a sump pump, foundation drain, or condensate line) or infiltration (entry of surface water through a leaking pipe, pipe penetration or access riser/tank seam) increases flows beyond design capacity and reduces detention time. This results in solids carrying over that clog the distribution pipes, and excess effluent that can saturate the soil absorption area and cause the system to fail.

Exfiltration

Effluent leaking from the tank can contaminate groundwater. If the tank contains a pump, the lower operating depth of the tank increases the chance of scum being drawn by the pump and passed on to other components of the system.

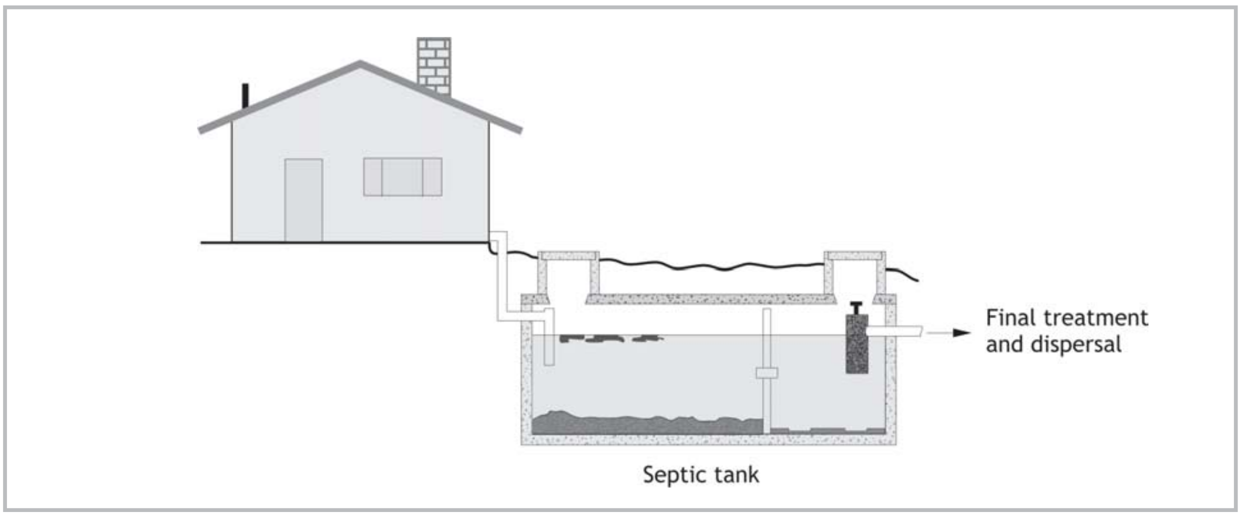


Figure 5-2. Two compartment septic tank system (profile view).

Effluent screen

An effluent screen should be placed in the outlet of the septic tank for additional filtration of the wastewater (Figure 5-3). Effluent screens remove solids that could instead be carried out of the tank and potentially clog downstream treatment devices. Processing tanks usually have an effluent screen within their pump vaults.

Trash tanks

A trash tank is generally used before advanced treatment units. These tanks can be as small as one-half of the daily design flow volume. The size is generally specified by the manufacturer of the advanced treatment unit. Trash tanks can serve as an anaerobic/facultative treatment device but mainly serve to remove plastic and other non-degradable items from the wastewater stream. Trash tanks are not designed for recirculation.

Processing tank

This is a special use of an anaerobic treatment tank used to increase nitrogen removal. Processing tanks are used in conjunction with some advanced treatment units that will be covered in Chapter 7. The processing tank is a combination septic tank, surge stank, pump tank, and recirculating tank. As illustrated in Figure 5-5, anaerobic effluent from the processing tank is pumped to an advanced treatment unit where NH4 is converted to NO3 by the aerobic processes that occur there. The effluent is then recirculated to the processing tank where anaerobic bacteria convert the NO3 to nitrogen gas (N2) through a process called dentrification. The anaerobic conditions in the processing tank are ideal for these organisms.

If there is too much recirculation, the processing tank can turn aerobic, thus inhibiting the conversion of nitrate to nitrogen gas. If not enough recirculation takes place, the amount of ammonium that is converted to nitrate might not be sufficient, and the effluent treatment in terms of BOD_5 and TSS removal might be compromised. The O&M for this component is similar to the other anaerobic treatment tank with the additional step of setting and adjusting the recirculation ratio. This is discussed in the media filter section in Chapter 7.

Treatment

Used properly, the septic tank provides primary treatment of wastewater. The fundamental function of the septic tank is to remove solids from raw wastewater, which is called primary treatment. Primary treatment generally re-

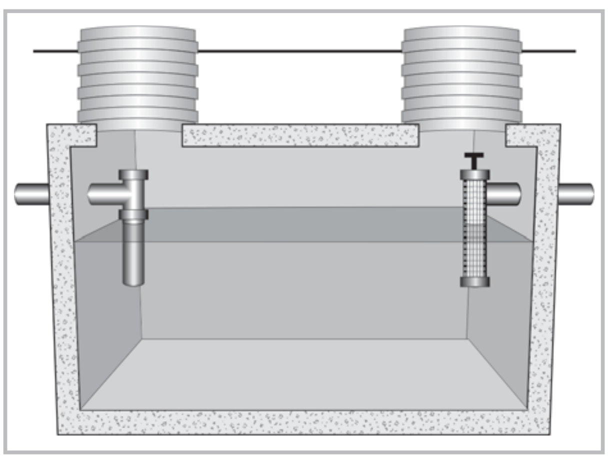


Figure 5-3. Effluent screen on the outlet of a tank (profile view).

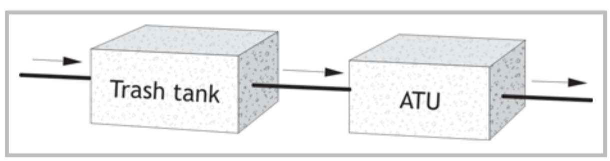


Figure 5-4. An example of where a trash tank can be placed in a treatment train.

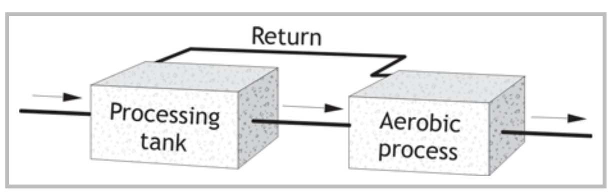


Figure 5-6. General schematic of effluent circulating from the aerobic process tank to the anaerobic processing tank to increase treatment.

fers to allowing solids to settle to the bottom, and oils, grease, and other floatables to migrate to the surface. Primary treatment reduces two commonly used measures of contaminant concentration: biochemical oxygen demand (BOD_5) which is reduced by 31 to 54 percent or more, and total suspended solids (TSS) which is reduced by 60 to 80 percent. Oil and grease are typically reduced by 79 percent.

Of the solids removed from the wastewater, some are digested and some are stored in the tank. Up to 50 percent of the solids retained in the tank decompose; the rest accumulate as sludge and scum and must be removed periodically. Pumping the tank is performed by a professional, as residual solids (septage) must be handled and disposed of according to accepted practices and regulatory parameters.

The septic tank by definition is a facultative or anaerobic treatment system. An anaerobic system does not have free oxygen and the microbes breaking down the waste must be able to live on the organic material in the septic tank. They are thus referred to as anaerobic microbes. Facultative microbes can thrive with or without free oxygen and are also present in septic tanks.

Anaerobic bacteria do not thrive in environments with free oxygen. Wastewater entering the septic tank has dissolved free oxygen, and this is quickly removed because of the oxygen requirements of the wastewater treatment processes. As the system matures, the anaerobic bacteria become more efficient, because the oxygen demand in the system rapidly removes free oxygen entering with the influent and maintains the anaerobic environment. Greater removal rates of BOD_5 and TSS are achieved under this fully anaerobic environment.

Operation and maintenance

Septic tank, trash tank, and processing tank O&M include the following evaluations (**Form 5-2. Septic, trash and processing tanks (STPT)**):

1. Note the type of tank being evaluated: a septic tank, trash tank, or processing tank. Also note whether a pump vault is present within the tank.

2. There should be no strong odors near the tank if the house vent stack is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports, damaged lids/risers, or surfacing effluent. Also check the roof vent location, prevailing winds, and atmospheric pressure. Note whether the odor is strong, mild, septic (rotten eggs), chemical, or sour in nature.

3. Record the material used to construct the tank. Tanks may be made of concrete, plastic or fiberglass. Any flex detected in non-concrete tanks should be noted, because their strength is dependent upon the integrity of their shape. With the availability of newer materials, metal tanks are uncommon. Metal tanks typically have significant problems with watertightness as a result of corrosion.

Determine the size of the tank. Information on tank capacity should be included on the permit. If it is not available, it can be obtained by first calculating the volume and then using a conversion factor to convert cubic feet to gallons. These calculations are discussed in Appendix A.

Note whether the tank is compartmented, the number of compartments in the tank, and if available, the capacity in gallons of each compartment.

4. Make note of where the access is located on the tank (inlet/outlet/center). If the tank access is farther than 6 to 7 feet from any tank wall, it may limit maintenance in those areas, especially during pumpout services.

Tank access must be adequate for inspecting contents and servicing the tank. If there is a riser on the tank it should be in good condition and properly sealed to prevent infiltration. Check the riser/tank seam for stains that would indicate infiltration of groundwater or surface water. Ideally, the riser should come to grade so that no digging is required to reach it. Some jurisdictions may not require access to grade, so some digging may be required. If it is buried, note how much cover is on the tank.

The lid on the tank or riser should be securely fastened with safety screws (screws that require a non-standard tool) or other means. The lids must be readily removable by the service provider but child-proof. If a concrete lid, weight limits unauthorized access. The lids must be operable as designed, and there should be no obstacle placed near or on top that makes them inoperable. The lids must not be so heavy as to make them inoperable. If the tank was uncovered by the owner, note that on the checklist.

5. Note whether the alarms are present and if they are audible or visual. Test to make sure they are fully operational.

   Check what kind of monitoring is available (remote telemetry or electronic monitoring), and test the systems manually to see if they are operational.

6. The liquid level in the septic tank should be at the invert of the outlet of the tank. If the level is below the outlet, the tank may not be watertight. If it is higher than the outlet, the effluent screen may need cleaning. If the screen is not the problem, there may be problems in a downstream component such as ponding in the soil adsorption area. Evaluate the liquid level markings on the sides of the tank to see if the level has changed over time. Debris hanging over the baffles would also indicate that the level has been above normal.

   The maximum liquid level for a tank is measured from the bottom of the tank to the invert of the outlet pipe. Note whether levels have exceeded the maximum or if the level has dropped without the tank being pumped out (an indication of a leak). Measure the current level in the tank with respect to the outlet. Measure the alarm activation level from the invert of the outlet pipe.

   Check the inlet to evaluate flow into the tank. Normally, the flow will start and stop due to use in the home. Continuous flow may indicate a plumbing leak.

   A properly functioning septic tank will have three distinct layers: scum, clarified effluent (a clear zone), and sludge (Figure 5-6). Check for the presence of these three layers by using a sludge judge or similar device. Heavy flocculation in the clear zone is an indicator of a need for pumping. Absence of any one of the layers should lead to further evaluation. Common causes of this would be the use of septic tank additives, the excessive use of antibiotics or toxic cleaning chemicals. Any of these will affect bacterial activity and some will affect how solids separate in the tank. The depth of sludge/scum accumulation should be measured with respect to the bottom of the outlet baffle.

Make a note of the date of the last pumping of the tank.

7. Local regulations may dictate pumping frequency or maximum sludge/scum accumulation before pumping is required. The depth of sludge/scum accumulation can be measured with respect to the depth of the outlet baffle. The scum layer should be at least 3 inches above the bottom of the outlet baffle, and the sludge should be at least 12 inches below the bottom of baffle. The clear zone should be about 67 to 75 percent of the operating tank volume or liquid depth. In other words, the combined depth of the scum and sludge should not exceed 25 to 33 percent of the total liquid depth.

8. An outlet baffle or tee should be present in the outlet of the tank. This baffle draws effluent from the clear zone and protects the soil treatment area. In some cases there may be a baffle on the inlet and a compartment baffle as well. Baffles may be concrete (cast with a concrete tank) or PVC (a sanitary tee). The baffle(s) should be in place and (if concrete) not corroded.

An effluent screen may be located in the tank outlet. It should be secured in place, and a note should be made whether the water level has been above the screen as described in Number 6 (page 54). The presence of an effluent screen will result in a higher operating level in the tank as the screen plugs. The plugging effluent screen serves as a flow restrictor, causing the water level in the tank to fluctuate. This water level rise increases as a greater percentage of the screen becomes

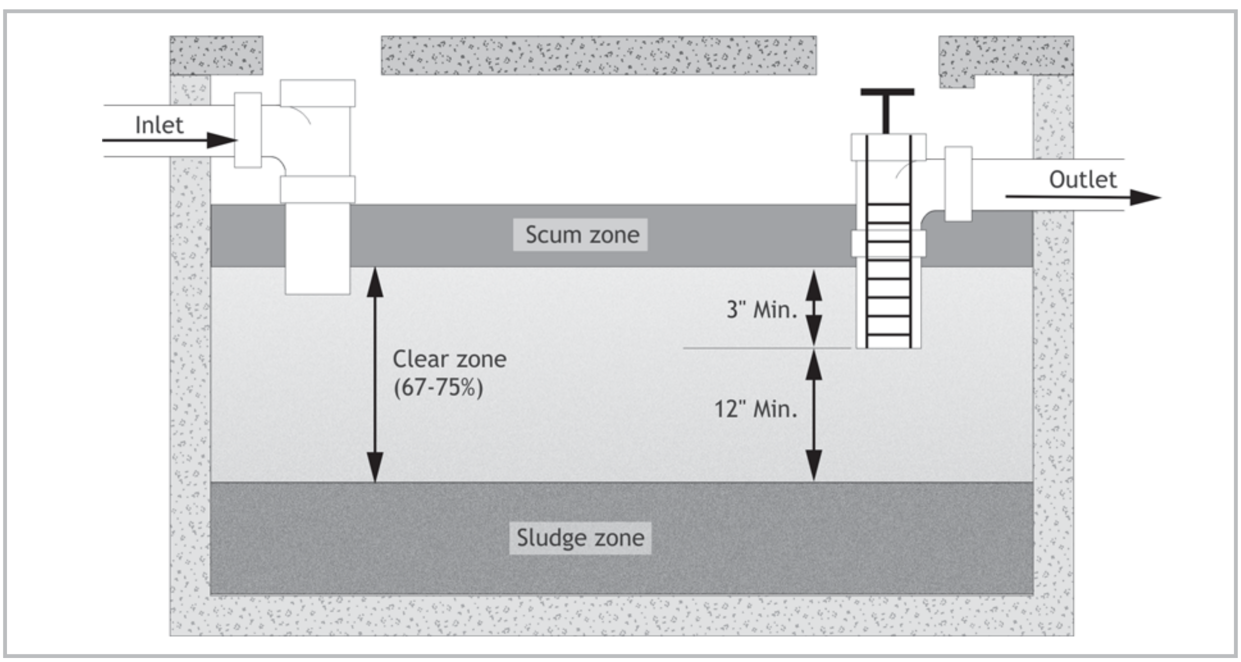


Figure 5-6. Guidelines for pumping tanks (profile view).

plugged. There should be no signs of bypass around the screen. If bypass has occurred, the filter should be cleaned or replaced. Upon removal of the screen for cleaning, extra effluent can surge into the next component of the treatment system. To avoid this surge, consider pumping out the tank just prior to removing the screen. A clogged screen could be an indicator that the tank may need pumping anyway.

To service the screen, remove it from the case, inspect and note the extent of screen blockage. Using proper personal protective equipment, spray the screen off over the inlet opening of the tank and re-insert it into the housing. Alternately replace it with a new unit and place the old one in a bag for proper disposal or off-site cleaning.

9. When the tank is pumped, evaluate structural conditions inside the tank. Check the integrity of the tank top, sides, and bottom. The inside of the tank should show no signs of structural failure such as exposed rebar or rust stains from the rebar in a concrete tank. Spalling (physical degradation of a concrete structure that exposes aggregate and/or structural reinforcement materials) is an indication of possible structural failure and should be noted. A plastic tank that has deformed has also lost a significant amount of its structural integrity.

Because the tank lid is above the liquid level, it is prone to corrosion. Inspect the inside of the tank (particularly at the riser/tank seam) to make sure there is no root intrusion that would indicate a chance of leakage or infiltration. If no one in the home is using water, listen for leaks or running water into the tank. Notify the homeowner if any plumbing leaks or drips are detected.

10. If the tank was pumped, note the name of the contractor, the amount removed, and the date the service was performed.

11. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record the chain of custody (COC) information, and deliver the sample to an authorized laboratory. Retain a signed COC from the testing laboratory to complete the system file. Report the information to the proper entities.

Form 5-2. Operational checklist: Septic, trash, and processing tanks (STPT).

Service provided on: Date:_________ Time:______________ Reference #:______________________
Service provided by: Company: ______________________ Employee:______________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Type:
   ❑ Septic tank ❑ Trash tank
   ❑ Processing tank ❑ Pump vault present
2. Conditions at the tank
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
3. Tank description
   a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   b. Capacity: ____________gal
   c. Compartmented? Yes ____No_____
   d. Capacities for compartmented system: 1)______ gal 2) ______ gal
4. Tank access
   a. Access location: ❑ Inlet ❑ Outlet ❑ Center
   b. Located at grade. Yes_____No_____
   c. If 'No', how deep is lid buried. ____________
   d. Risers on tank. Yes_____No_____
   e. Evidence of infiltration in risers. Yes_____No_____
   f. Lids securely fastened. Yes_____No_____
   g. Lid in operable condition. Yes_____No_____
5. Alarm(s)
   a. Alarm(s) present. Yes_____No_____
   b. Audio alarm operational. N.A.____Yes_____No_____
   c. Visual alarm operational. N.A.____Yes_____No_____
   d. Remote telemetry operational. N.A.____Yes_____No_____
   e. Electronic monitoring operational. N.A.____Yes_____No_____
6. Current tank operating conditions
   a. Liquid level relative to outlet: ____________in
      ❑ At ❑ Above ❑ Below
   b. Maximum liquid level of tank (invert of outlet pipe):__________in
   c. Height at which alarm is activated as measured from invert of outlet: ____________in
   d. Evidence liquid level has been higher. Yes_____No_____
   e. Evidence liquid level dropped without pumping. Yes_____No_____
   f. Evidence of continuous inflow. Yes_____No_____
   g. Date of last pumpout:______________________________
   h. Presence of flocculant in clear zone. Yes_____No____
   i. Evaluation of layers in tank:

Compartment Number	Scum (in)		Clear Zone (in)		Sludge (in)		Odor	Other
	Depth	Color*	Depth	Color	Depth	Color		
1								
2								

*Color Choices: ❑ Clear ❑ Flocced ❑ Milky ❑ Muddy ❑ Grainy
❑ Black ❑ Brown ❑ Mustard ❑ Gray ❑ White

7. Tank pumping recommended. Yes_____No_____

NOTES

2. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

5. ❑ Acceptable ❑ Unacceptable

6. ❑ Acceptable ❑ Unacceptable

Form 5-2 (continued). **Operational checklist: Septic, trash, and processing tanks (STPT)**

Reference #:______________________

8. Baffles currently structurally sound. Yes_____No_____
    a. Inlet baffle in place. Yes_____No_____
    b. Outlet baffle in place. Yes_____No_____
    c. Compartment baffle in place. N.A. _______ Yes_____No_____
    d. Effluent screen. N.A. _______ Yes_____No_____
        Manufacturer:____________________Model:_______________
    e. Is screen accessible from ground surface. N.A. __ Yes_____No_____
    f. If screened, percent plugged: _______________%
    g. Was screen cleaned. Yes_____No_____
9. Tank structural condition (evaluate if tank pumped): N.A.___________
    a. Appears to be watertight (no visual leaks). Yes_____No_____
    b. Rebar exposed. Yes_____No_____
    c. Corrosion present. Yes_____No_____
    d. Spalling present. Yes_____No_____
    e. Cracks present. Yes_____No_____
    f. Root intrusion. Yes_____No_____
    g. Deflection noted. N.A. _______ Yes_____No_____
10. Contractor responsible for pumping: _______________
    a. Gal removed:_______________ Date:____________________
11. Lab samples collected for monitoring. Yes_____No_____
    Types of analysis:____
    ____
    ____

8. ❑ Acceptable
   ❑ Unacceptable

9. ❑ Acceptable
   ❑ Unacceptable

Chapter 6

Dosing Systems and Controls

Learning objectives

Upon completion of this chapter, you should be able to:

1. Describe the components of an onsite wastewater system that includes a pump tank.
2. Identify various types of pumps and their applications.
3. Understand the purpose and O&M requirements for siphons.
4. Understand the different functions of surge tanks, pump tanks, recirculation tanks, and internal pump basins.
5. Understand the purpose and O&M requirements of the following components in the pump tank:
    a. Air release valve
    b. Check valve
    c. Quick disconnect
    d. Anti-siphon device
    e. Isolation valve
6. Understand settings for demand and time-dosed control panels.
7. Understanding math calculations for:
    a. Gallons per inch
    b. Doses per day
    c. Volume per dose
    d. Gallons per day
    e. Gallons per minute and
    f. Cycle counters-elapsed time meters
8. Understand and be able to accurately complete Operational Checklists:
    a. 6-1. Dosing tank (DT),
    b. 6-2. Pump: Demand-dosed (PDD)
    c. 6-3. Pump: Time-dosed (PTD)

Overview

Dosing systems are used in many ways in onsite wastewater treatment systems. For example, they may be used to deliver effluent to:

- A soil treatment area at a higher elevation than the wastewater source (pressure-dosed gravity) (Figure 6-1)
- Low-pressure distribution (Figure 6-2)

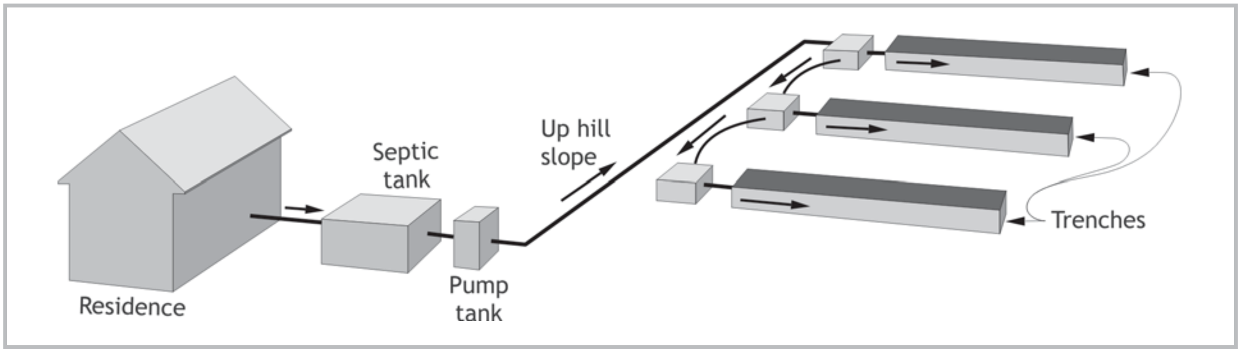


Figure 6-1. Diagram illustrating use of a pump tank for dosing effluent to upslope trenches with sequential distribution.

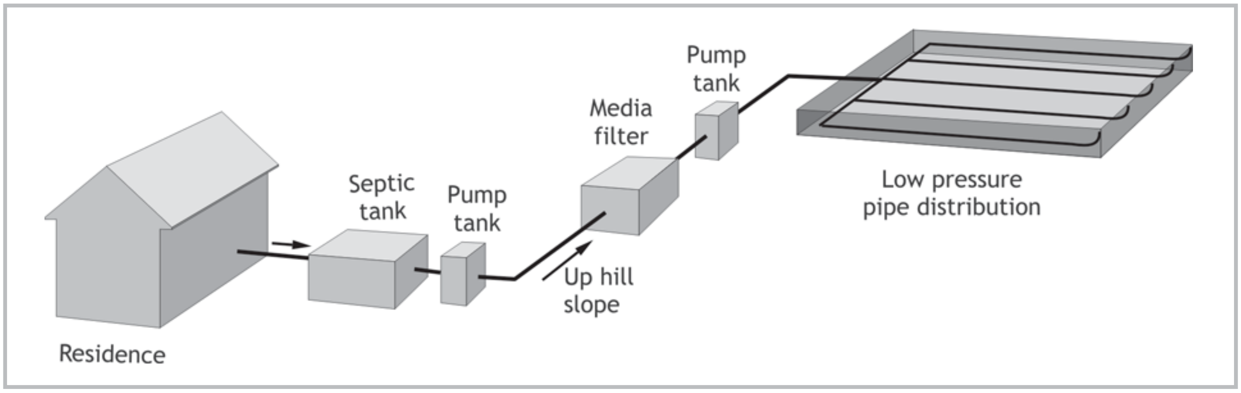


Figure 6-2. Diagram illustrating use of a pump tank for dosing effluent to upslope trenches with low pressure distribution.

- Subsurface drip distribution
- Spray distribution

Pump tanks may also be used to deliver wastewater to an advanced pretreatment component such as an aerobic treatment unit (ATU) or a media filter. In these applications, the tank may serve as a flow equalization tank, processing tank, recirculation tank, or sump.

The dosing system consists of a tank, pump or siphon, discharge assembly, controls, and associated electrical components (Figure 6-3). The particular design of the system is dictated by the nature of the downstream components.

Pump tanks

The pump tank is typically a concrete, fiberglass, or polyethylene container that collects and stores septic tank effluent. A pump 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 unit or final treatment and dispersal area is designed to be dosed.

A pump 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 2,000 gallons, which would be sent to the next component without activating any alarm system. During power outages,

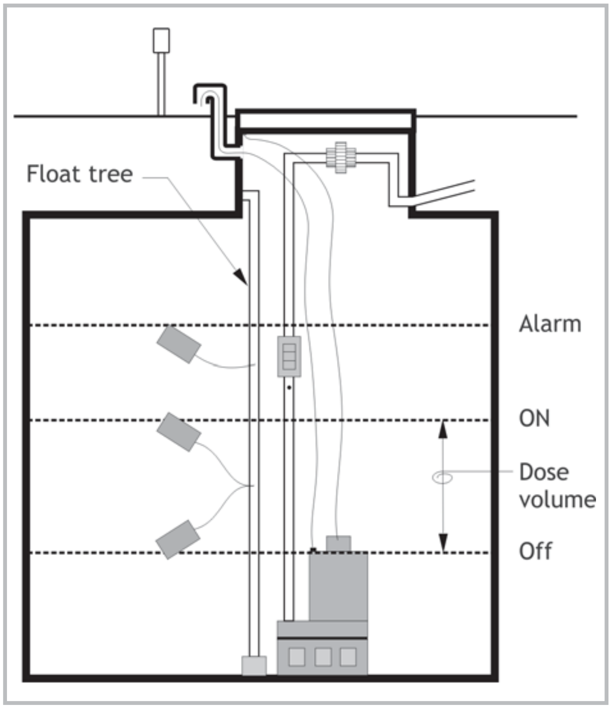


Figure 6-3. Diagram illustrating components of a pump system (profile view).

pump tanks at residences served by a community water system accumulate effluent which will discharge in one dose once power is restored. This has caused many onsite wastewater treatment systems to fail.

Surge or flow equalization tanks are typically designed to hold twice the normal daily flow of the home. The flow from a surge or flow equalization tank is controlled by a timer that distributes wastewater to the next component in fixed amounts with fixed off or rest periods. The effluent is typically delivered intermittently over a 24-hour period using a repeat-cycle timer in the pump control panel. In the scenario where power is restored after an outage, an alarm will sound, but the timer does not allow the 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. This technology also provides an early warning system when a low-head pump is used instead of a high-head pump, and the orifices begin to plug as discussed in the section on pumps (below).

Solids management in pump tanks varies according to design considerations and solid-handling capability of pumps. The pump may be installed on the bottom of the tank (Figure 6-4) or slightly above the bottom with the addition of a block or other device. The operation of a low-head pump tends to stir the contents of the tank and solids can thus be resuspended and discharged. This can be minimized by placing a shield around the pump forcing the effluent to be drawn from a higher elevation (Figure 6-5). Another option is to install the pump within a vault as shown in Figure 6-6. The vault has openings around its mid-section through which effluent is drawn from the clear zone. The vault may also include an effluent screen to provide further solids removal.

Pumps

Pumps are an important component of many onsite wastewater treatment systems. Pump selection is influenced by solids-handling capability and flow and pressure relationships. The two main types of pumps for sewage purposes are solids-handling and effluent pumps. Clean 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.

Effluent pumps are positioned after septic tank and require that the wastewater be relatively

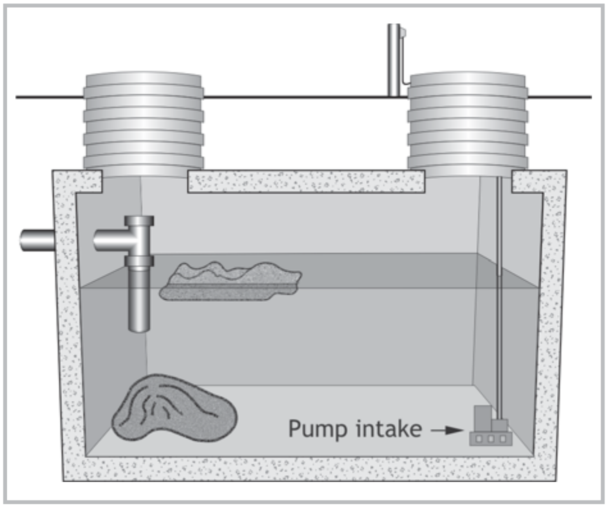


Figure 6-4. Pump tank with the pump located on the bottom of the tank (profile view).

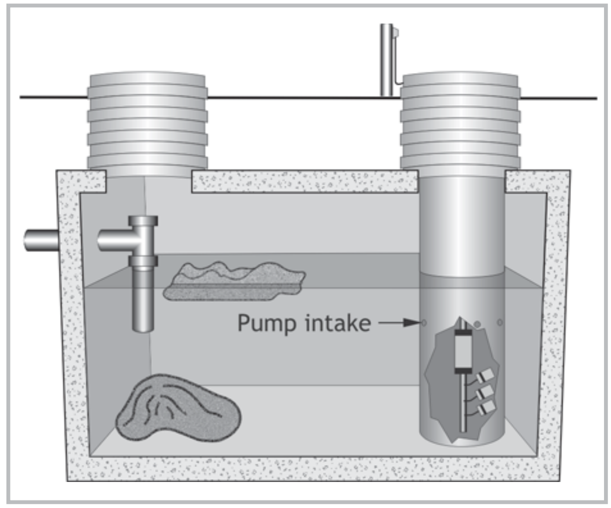


Figure 6-6. Pump tank with a pump vault (profile view).

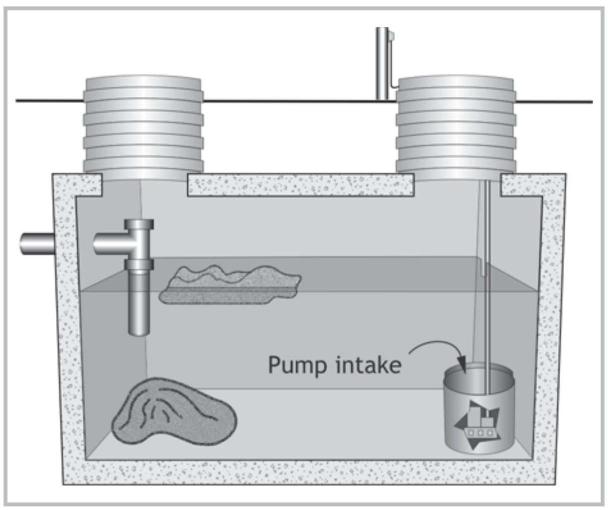


Figure 6-5. Pump tank with a shield around the pump (profile view).

free of solids. 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. Note that turbine pumps are more sensitive to the amount and size of solids in the effluent.

Both high-head and low-head pumps are centrifugal pumps (Figure 6-7). 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 motor rotates the impeller at a lower speed. 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-well motor pump) consists of a motor below a rotating shaft. The motor rotates a series of impellers (usually called stages) mounted on the shaft (Figure 6-8). 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 relative to pressure generated from a single stage pump.

This difference is apparent when viewing the pump or performance curves for comparable examples of the two pump types. The high-head pump will usually deliver liquid at less flow but at a higher head than a low-head pump

(Figure 6-9). Thus, the slope of the curve for a given high-head pump is steeper than for a comparable low-head pump. In performance, this means that a minor change in flow (plugging of orifices) will result in a significant increase in pressure with a high-head pump. This pressure increase will push water out of other orifices without giving any indication of plugging problems to the service provider. A low-head pump will show signs of a problem to the service provider by increasing the pump run time. A low-head pump will usually handle larger solids better than a high-head pump will. Table 6-1 shows performance tradeoffs of high-head and low-head pumps. Pump manufacturers are now making low-head pumps with steeper curves to enhance performance.

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.

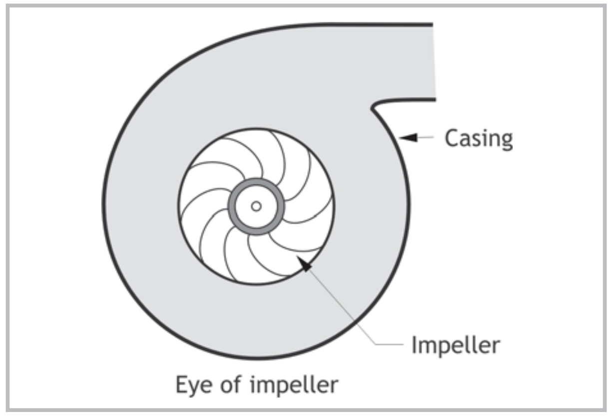


Figure 6-7. Centrifugal pump (view from bottom).

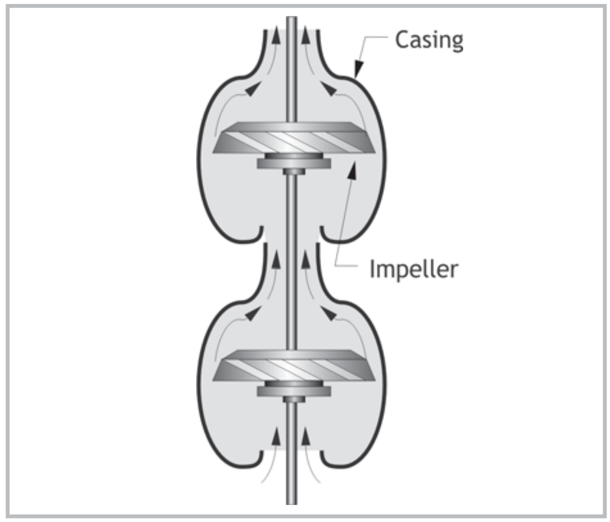


Figure 6-8. Submersible turbine pump (profile view).

Pump discharge assembly

The discharge assembly is made up of all the piping and components from the pump discharge point to the point at which the supply line leaves the tank (Figure 6-10). The assembly should be accessible and reachable from the surface. The pump discharge assembly should have a union or other quick-disconnect coupler to facilitate removal of the pump without having to cut the discharge pipe. A length of nylon rope, stainless steel cable, or other non-corrodible material should be attached to the pump to facilitate removal during maintenance activities. An isolation valve should be located on the field side of the quick disconnect to prevent backflow during maintenance.

The assembly may include a check valve in the vertical portion of the

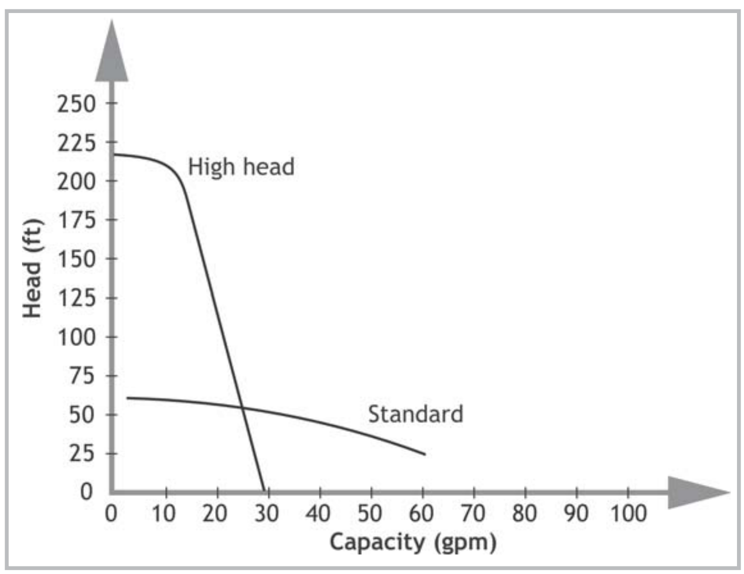


Figure 6-9. Example of a high-head vs. low-head pump curve (for comparison only).

Table 6-1. 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 space in the tank, reducing the volume or working capacity of the tank.	• Flow intake is lower in the tank, allowing for a larger volume or working capacity in the tank.
• Capable of maintaining a constant gallons per minute (GPM) with 80 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 a 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.
• Pumps relatively less gallons per minute.	• Pumps relatively more gallons per minute.
• Smaller orifices required in distribution networks and are typically placed in a 12 o'clock position to achieve equal loading; orifices of small size and in this position will plug as the lines are continually flooded.	• A higher horse-power/low-head pump may be needed in some applications.
• Requires scheduling to cool pump.	• Need not be sleeved to promote heat exchange to the surrounding liquid.

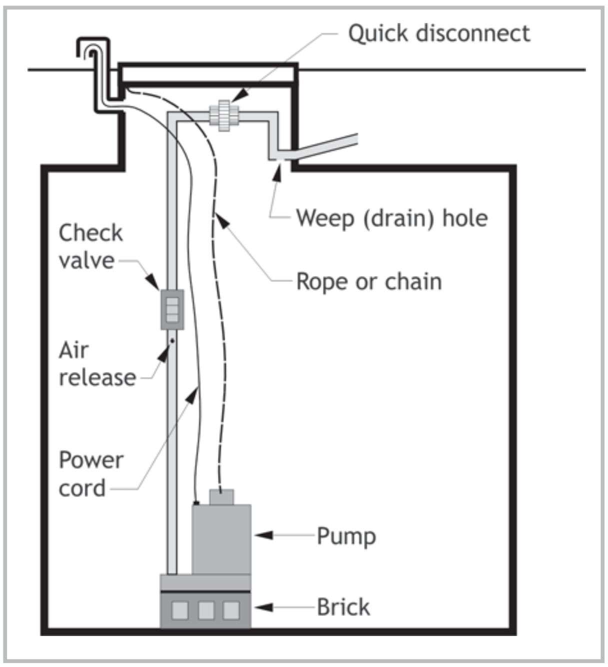


Figure 6-10. Pump discharge assembly (profile view).

supply line to prevent drainback of effluent after a dosing event. However, if freezing is a possibility, the entire supply line must drain back to the tank. If a check valve is used, a vent hole (air release) must be provided between the pump and the check valve to prevent air-lock of the pump.

If the discharge point is at an elevation lower than the pump-off elevation, an anti-siphon device must be provided. In this case, the weep hole (if present) can also serve as an anti-siphon device. Other configurations can also be used as anti-siphon devices. A spit tube installed at the highest elevation in the discharge pipe directs some of the flow back into the tank. When the pump turns off, air flow through the tube breaks the siphon. Another method is to install a check valve in a reversed orientation at the highest point in the discharge pipe. When the pump is on, the valve closes, sending all the flow to the next component. When the pump turns off, the valve opens, breaking the siphon.

If the system design is such that the supply line from the tank moves first uphill and then downhill to the next component, air may become trapped in the line during rest periods. In this situation, an air release valve should be placed at the highest elevation of the pipe. The valve should be housed in a vault that comes to grade to allow for inspection and maintenance.

Controls

Pump systems 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 water level sensors or floats in the tank. The components then perform a variety of basic functions:

- Automatically turning the pump on and off with a manual override.
- Sounding an alarm to indicate problems.
- Providing a means of monitoring the system (meters/counters).

A pump system can be dosed either when a set volume is collected (demand-dosed system) or by using pump capacity (gpm) and time (timer-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 the variations in the water usage patterns of the facility. This is the simplest form of dosing but results in variable delivery of effluent.

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. If the system has only piggyback controls, an upgrade to a control panel should be strongly recommended to collect system data.

Timer-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, timer-dosing eliminates variations or peaks in wastewater flow by dosing the dispersal component more evenly throughout the day or night. Timer controllers are more commonly found on pretreatment devices or systems requiring flow equalization.

In all cases, electrical components must be properly protected from the elements and from the corrosive environment of the pump tank. Ideally, this is achieved through use of a National Electrical Manufacturers Association (NEMA) 4X enclosure with properly sealed connections.

The control-floats or water-level sensors used with pump tanks are adjustable and each is set to operate specific components in the tank. In a demand-dosed configuration, a designated volume of effluent is pumped based upon the float elevations (Figure 6-11).

In a single-float system, the on/off function may be provided by a single wide-angle or differential float control. Some jurisdictions limit the dose volume to 10-25% of the design flow. If very small or very large doses are required, a two-float system should be used since a single float has limited lower and upper operating ranges.

In a two-float configuration, the pump turns on when the effluent rises to the on-float

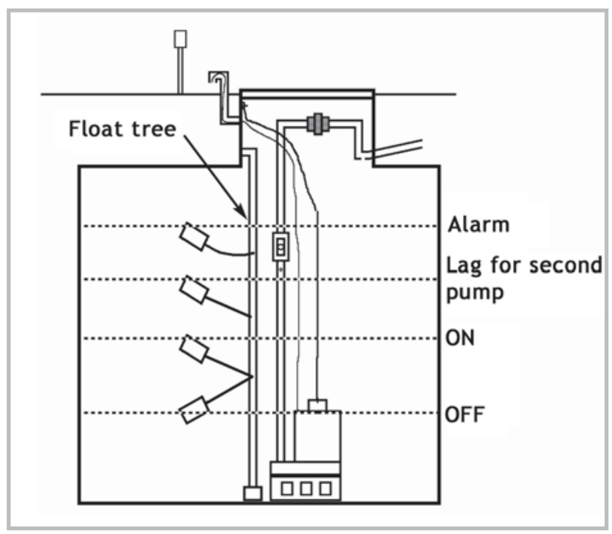


Figure 6-11. Float tree in pump tank with attached floats (three-float configuration) (profile view).

elevation, pumps effluent down to the off-float elevation, and then turns off.

In duplex systems, two pumps are alternately turned on. In this case, a lag switch or sensor is either included above (or combined with) the alarm float. If one pump fails or if flows are excessive, the effluent level rises to activate this switch and turn on the resting pump. A cycle counter should be included in the control panel to track these events.

In a timer-dosed configuration, the on/off float enables the timer to operate only after the effluent level has risen to a specific elevation in the tank. The timer activates the pump for a specified amount of time and delivers a specified dose volume based upon the actual pump delivery rate. The timer then turns the pump off for a specified rest period.

There may also be other floats or sensors in timer-dosed systems that perform various functions. Figure 6-12 illustrates configurations with a timer- override float (these are not recommended because they can defeat the purpose of the timer system) or a peak-enable float. If used, these floats are installed between the usual timer on (enable) float and the high-water alarm float so that they activate the pump during periods of higher than normal flow.

The floats in Figure 6-12 each function in slightly different ways. A timer override float is a differential switch that delivers a different volume to the next component. It essentially (and temporarily) changes the function of the timer-dosed system to a demand-dose regime until the effluent in the tank is reduced to a normal operating level. It is critical that a counter is used to track how often a timer override float is used. This counter tells you the system has been overloaded. Ideally, an alarm float should activate only an alarm to warn that excessive flows are occurring.

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 that 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. Again, a counter on this float is recommended for recording performance.

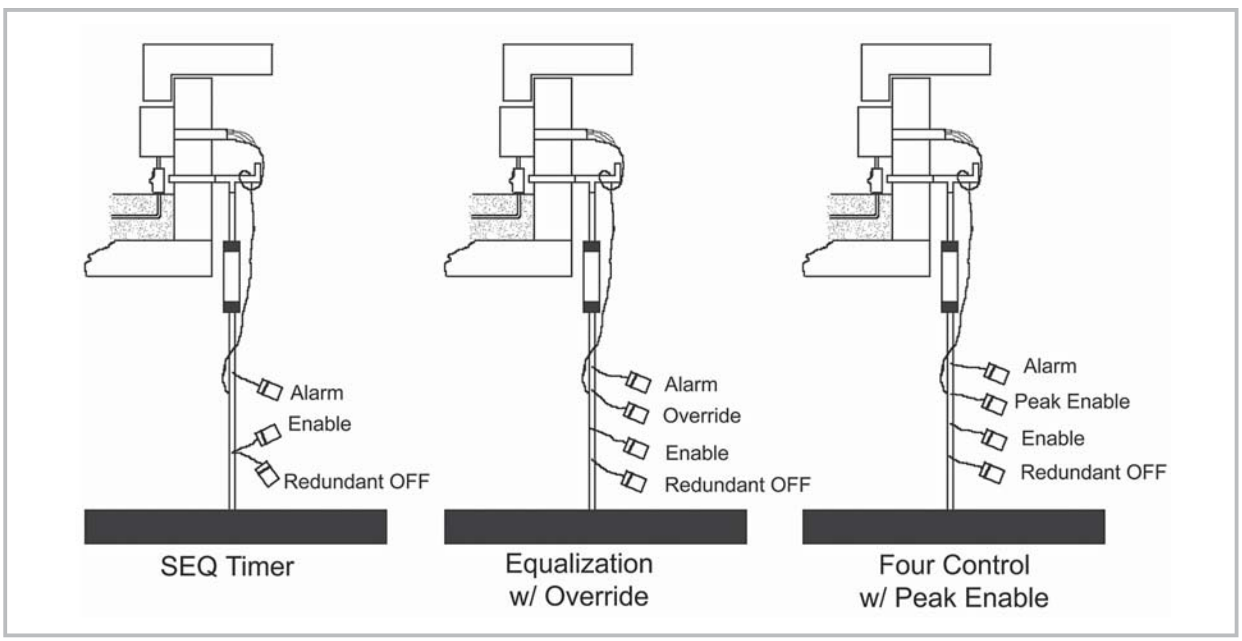


Figure 6-12. Float configurations for timer controlled operations. (profile view)
Source: American Manufacturing, Inc.

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 should be wired on an electrical circuit separate from the pump. Without a separate circuit, the pump can overload the circuit, and the alarm will not operate.

Siphons

A siphon is a passive dosing device that discharges a set dose when liquid levels in the siphon tank displace the air in the trap of the device. The device will only function if the pretreatment or dispersal component receiving the dosed-flow distribution is at a lower elevation than the siphon discharge by at least several feet (4). Siphons do not use floats to operate. Instead, the size of the siphon bell and the height of the siphon trap determine the dose volume that is delivered during each cycle.

Siphons do not require a discharge assembly like that included with pump systems. Instead, the discharge pipe delivers the dose to the soil adsorption area at a lower elevation.
Siphons have discharge rates ranging from 25 gpm up to 3,000 gpm. Siphons used in residential applications generally operate at the lower end of this range. Digital and mechanical cycle counters are available (and strongly recommended) for use with siphons to monitor flow. A high-water alarm may or may not be present on siphon systems, but they are recommended.

When liquid enters the dosing tank, the liquid levels rise in the tank and siphon bell at the same rate (Figure 6-13 (a)). The siphon is vented to the atmosphere through vent piping. This rising action continues until the level of the liquid reaches the open end of the outside vent pipe (Figure 6-13(b)).

Once the liquid reaches the outside vent pipe, it creates an air seal. As the level of liquid continues to rise in the tank, the liquid level in the bell continues to rise but at a much slower rate (Figure 6-13(c)). At the same time, the head of water in the tank exerts pressure on the air trapped in the top of the bell and the long leg of the trap. The air in the long leg of the trap is forced toward the invert of the trap (Figure 6-13(d)).

As the liquid in the tank approaches the high-water line, the liquid in the bell increases to a level just short of the top of the trap, and the air in the long leg of the trap descends to the invert of the trap.

As the liquid in the tank reaches the high-water line, a volume of air is forced around the invert of the trap and out through the discharge leg of the siphon. The escaping air relieves the back pressure within the siphon, and the liquid inside the bell rushes up and fills the siphon trap, thereby starting the siphon action (Figure 6-13(e)).

The liquid is drawn out of the tank (Figure 6-13(f)) until the liquid in the tank reaches the bottom of the bell. Then the siphon draws air, and the siphon action is stopped (Figure 6-13(g)).

Siphons require regular inspections to ensure that they are operating properly. One of the most common problems with siphons occurs when a siphon is described as "losing its prime." This means that the siphon has lost the air pressure under the bell (Figure 6-14). Insufficient air volume trapped under the bell creates a situation where the liquid level will not achieve the necessary head or pressure to drive the effluent into the distribution system. This condition causes liquid to dribble or trickle through the siphon, which prevents the wastewater from being distributed properly. The following conditions can cause this problem:

- An air leak typically occurs where the vent pipe screws into the top for the bell.
- During periods of rapid flow into the dosing chamber, air entrained in the flow can carry air bubbles under the siphon bell, which causes the siphon to "burp" well before the high-water line is reached.

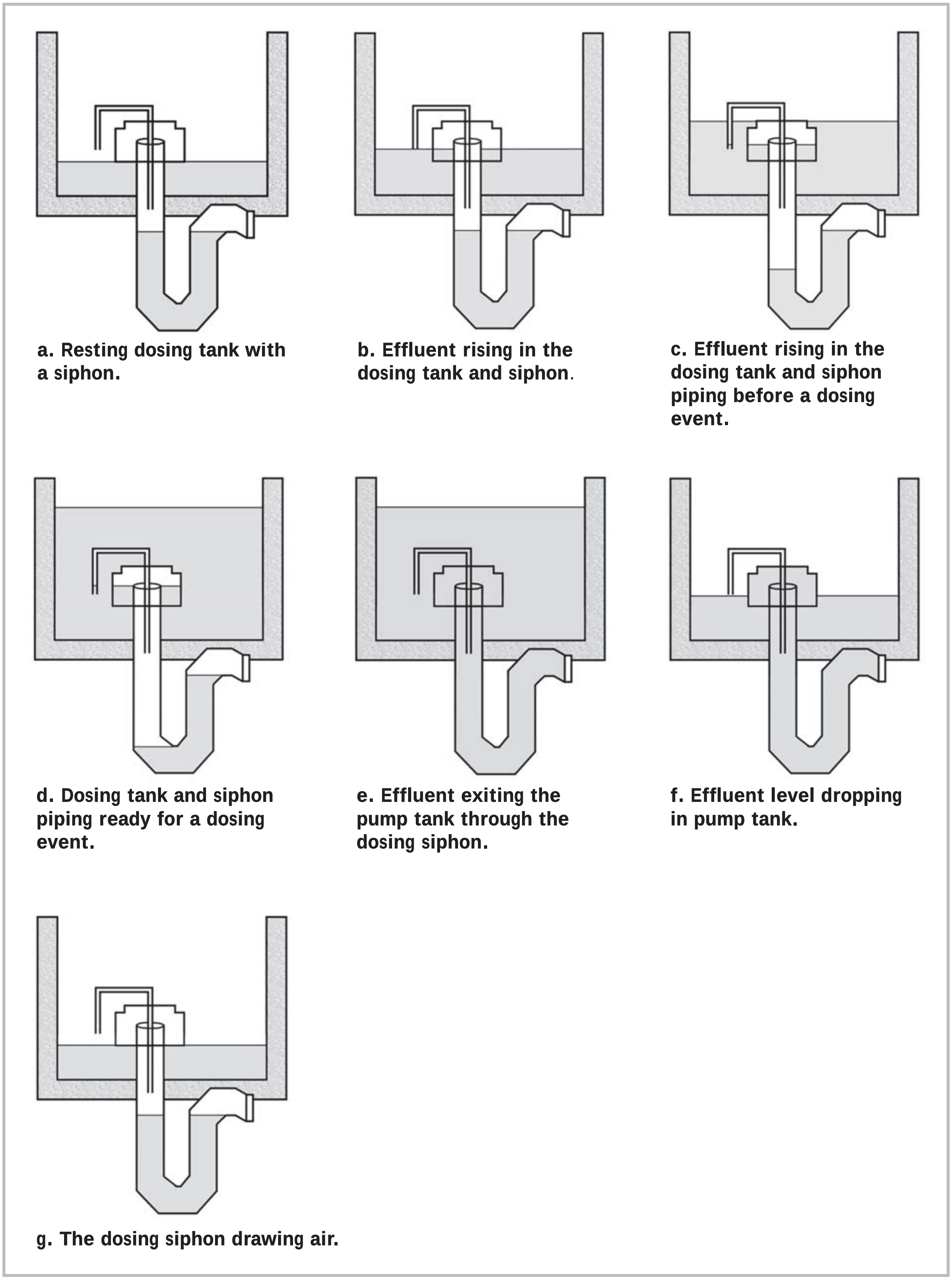


Figure 6-13. Siphons.

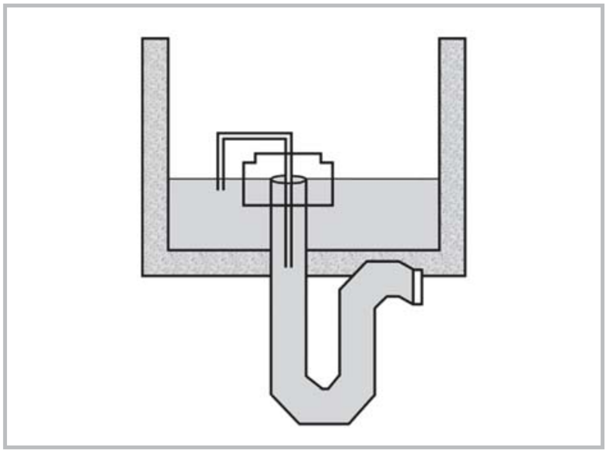


Figure 6-14. Siphon with a loss of prime.

The air pressure or prime is lost in the burp. The flow into the dosing chamber should be redirected and/or baffled to prevent this.

- Poorly designed siphons (frequently home-made siphons) often do not get a large enough air bubble across the invert of the siphon to start the siphon. If the dosing chamber is filled rapidly, the siphon works properly, but when rates in the dosing chamber are slow, the poorly designed siphon burps but does not start.

- Vacation homes can be a problem. If the occupants vacate the house for a period of several weeks and happen to leave while the water level in the dosing chamber is somewhat close to the high-water level (and therefore the air pressure under the bell is high), the air under the bell can be diffused or absorbed into the water, thereby reducing the air volume that is trapped under the bell.

There are two ways to restart a siphon that has lost its prime:

- Drain the dosing tank until the water level is below the open end of the outside vent pipe.
- Blow air under the siphon bell.

Operation and maintenance

The service provider must perform certain tasks and make observations to make sure that pump tanks, pumps, siphons, and control panels continue to function correctly. Forms 6-1, 6-2, and 6-3 are operational checklists used to monitor the function of these components.

The proper care of the pump tank can be accomplished through the following evaluations (**Form 6-1. Dosing tank** (DT)):

1. Determine and note the primary use of the pump tank. Note: This form is also used for processing tanks that include a pump. Record the pump intake depth.

2. There should be no strong odors near the tank if the house vent stack is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports, damaged lids/risers, or surfacing effluent. Also check the roof vent location, prevailing winds, and atmospheric pressure. Note whether the odor is strong, mild, septic (rotten eggs), chemical, or sour in nature.

3. Record the material used to construct the tank. Tanks are typically made of concrete, but plastic and fiberglass are becoming more common with improved construction practices. Any flex detected in non-concrete tanks should be noted, because their strength is dependent upon the integrity of their shape. With the availability of newer materials, metal tanks are uncommon. Metal tanks typically have significant problems with watertightness as a result of corrosion.

   Determine the size of the tank. Information on tank capacity should be included on the permit. If it is not available, it can be obtained by first calculating the volume and then using a conversion factor to convert cubic feet to gallons. These calculations are discussed in Appendix A.

4. Make note of where the access is located on the tank (inlet/outlet/center). If the tank access is farther than 6 to 7 feet from any tank wall, it may limit maintenance in those areas, especially during pumpout services.

   Tank access must be adequate for inspecting contents and servicing the tank. If there is a riser on the tank it should be in good condition and properly sealed to prevent infiltration. Check the riser/tank seam for stains that would indicate infiltration of groundwater or surface water. Ideally, the riser should come to grade so that no digging is required to reach it. Some jurisdictions may not require access to grade, so some digging may be required. If it is buried, note how much cover is on the tank.

   The lid on the tank or riser should be securely fastened with safety screws (screws that require a non-standard tool) or other means. The lids must be readily removable by the service provider but child-proof. If a concrete lid is used, the weight of the lid will limit unauthorized access. The lids must be operable as designed, and there may be no obstacle placed near or on top that makes them inoperable. The lids must not be so heavy as to make them inoperable. If the tank was uncovered by the owner, note that on the checklist.

5. The maximum liquid level for a tank is measured from the bottom of the tank to the invert of the inlet pipe. Note whether levels have exceeded the maximum or if the level has dropped without the tank being pumped out (an indication of a leak). Measure the current level in the tank with respect to the inlet. Measure the alarm activation level from the invert of the inlet pipe.

   Check the inlet to evaluate flow into the tank. Normally, the flow will start and stop due to use in the home. Continuous flow may indicate a plumbing leak.

   Make note of the date of the last tank pumping.

6. The pump or siphon should be located under the access riser for ease of access. Pull chains/ropes are not used with siphons, but if the system uses a pump, a non-corrodible pull-chain or rope should be attached to allow easy removal when needed.

7. Siphon systems do not include a discharge assembly, but pump systems do. If applicable, check the discharge assembly for the presence or absence of the following devices:

   a. An anti-siphon or air release device should be present, depending upon system design. If an anti-siphon hole is used, it should be located below the check valve.
   b. A drain back device should be present in colder climates.
   c. A quick-disconnect should be present. In order to facilitate pump removal, a quick-disconnect in the discharge assembly allows easy access.
   d. An isolation valve should be present on the field side of the assembly to prevent backflow from the field or

unit upon disconnection.

e. Inline filters can also be added in the pump assembly before the supply line. These filters will protect the pressure distribution system from solids and plugging.

8. Electrical connections for the pump and floats contained in the pump tank can be made either internally or externally to the pump tank. Because of the combination of moisture and gases, the tank is extremely corrosive to electrical components. All electrical connections should be in a watertight, accessible enclosure. Some codes may allow connections within the tank access riser, but these should be installed in NEMA 4 or 4X (watertight, airtight, and explosion-proof) enclosures. In either case, gas flow prevention should be included through proper use of duct seal, gas seal-offs, grommets, or cord grips in all electrical connections entering and exiting the tank. Watertight wire nuts are another device to minimize corrosion problems.

9. When the tank is pumped, evaluate structural conditions inside the tank. Check the integrity of the tank top, sides, and bottom. The inside of the tank should show no signs of structural failure. A concrete tank is failing if the rebar is visible or signs of rust from the rebar are evident. Referred to as spalling, chipping and flaking of the concrete is a start towards structural failure and should be noted. If it is excessive, the tank is nearing collapse. A plastic tank that has deformed has also lost a significant amount of its structural integrity.

   Because the tank lid is above the liquid level, it is prone to corrosion. Inspect the inside of the tank (particularly at the riser/tank seam) to make sure there is no root intrusion that would indicate a chance of leakage or infiltration.

   If no one in the home is using water, listen for leaks or running water into the tank. Notify the homeowner to correct any plumbing leaks or drips.

10. Sludge will accumulate in the bottom of the pump tank. Sludge accumulation must be managed at a level below the pump intake to make sure the solids are not sent into the next component. An excessive amount of pump tank solids may indicate inadequate septic tank capacity, high flow, high peak flows, or even abuse or lack of service. Record the amount (in inches) of sludge and solids accumulation. The odor and color of the solids should also be noted.

11. Note whether the tank is in need of pumping based upon sludge measurements. A good guideline is to pump when less than 70 percent of the tank below the intake is operable, or when there is an increase in the rate of accumulation. It depends on where the pump inlet is located. This may be dictated by state or local regulation. When required, solids must be removed and properly disposed of by certified professionals.

12. If the tank was pumped, note the name of the contractor, the amount removed, and the date removed.

13. A pump vault or basket filter may be present in the pump tank to passively remove solids from the water migrating toward the pump inlet. These devices are essentially effluent screens and require periodic cleaning. In-line filters (located

after the pump) should be checked and cleaned as well.

14. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record the chain of custody (COC) information and deliver the sample to an authorized laboratory. Retain a signed COC from the testing laboratory to complete the system file. Report the information to the proper entities.

Calculating flow

In order to calculate the flow, some simple calculations need to take place. The cycle counters, pump dose volumes, elapsed time meters, and pump capacity for both the pretreatment and final dispersal need to be documented. If the entire treatment and distribution system is gravity flow, then a water meter at the source of the wastewater is necessary to determine forward flow.

The pump dose volume is related to either the float settings (dose volume) or the timer settings of that site. In a timer-dosed system, the pump flow (gpm) multiplied by the pump run time (min) gives the total volume that the pump delivers to the supply line. Care should be exercised in this calculation, because the volume delivered to the supply line may not be the same volume delivered to the pretreatment unit (or final treatment and dispersal). The return volume (drainback) coming back to the pump vault (or chamber) when the transport pipe drains needs to be subtracted from the volume delivered to the supply line. This is the volume of effluent actually delivered to the pretreatment unit (or the final treatment and dispersal components).

When using a demand-dosed system, the dose volume is used for flow measurement. The volume is the number of events counted by the cycle counter multiplied by the volume in the dose. The current cycle counter reading is subtracted from the previous pump cycle counter reading. This is the number of times the pump has been on.

If an ETM is used with a demand-dosed system, the elapsed time can be multiplied by the pump delivery rate to calculate forward flow.

Pump: Demand-dosed (PDD)

Overview

In a demand-dosed configuration, the pump is turned on whenever a prescribed volume of effluent flows into the pump tank and activates the floats or sensors. The dose to the next component is subject to the variations in water usage from the source. This is the simplest form of dosing but results in the most variable delivery of effluent.

This design measures the water level in the tank with sensors from the bottom of the tank. The system then interprets the data from the sensors from the top of the tank. The system is dosed as needed.

Operation and maintenance

The demand-dosed system control panel O&M can include the following evaluations (**Form 6-2. Pump: Demand-dosed system (PDD)**):

1. Note which type of control is used. If a piggyback control is used, determine if it is functional. If a control panel is used, it should be watertight with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm test switch. The presence of a control (HAND-OFF-AUTO) switch allows the service provider to check pump function without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions, it should be in the AUTO position. If the

Form 6-1. Operational checklist: Dosing tank (DT).

Service provided on: Date:_________ Time:______________ Reference #:_______________________
Service provided by: Company: _______________________ Employee:_______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _______________________________

1. Type:
   ❑ Pump tank ❑ Siphon tank ❑ Surge/Flow equalization tank
   ❑ Processing tank ❑ Recirculation tank ❑ Internal pump basin sump
   a. Pump intake depth: ______________
2. Conditions at the pump tank
   a. Evaluate presence of odor within 10 feet of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ________________________________
3. Tank description
   a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   b. Capacity: ____________gal
   c. Surface area: ___________sq ft
   d. Operational depth: ____________in
   e. Gallons per inch (GPI): __________gal/in
4. Tank access
   a. Access location: ❑ Inlet ❑ Outlet ❑ Center
   b. Located at grade. Yes_____No_____
   c. If 'No', how deep is lid buried. ______________
   d. Risers on tank. Yes_____No_____
   e. Evidence of infiltration in risers. Yes_____No_____
   f. Lids securely fastened. Yes_____No_____
   g. Lid in operable condition. Yes_____No_____
5. Current tank operating conditions
   a. Liquid level relative to inlet: ____________in
      ❑ At ❑ Above ❑ Below
   b. Maximum liquid level of tank (invert of inlet pipe):___________in.
   c. Height at which alarm is activated as measured from top of maximum liquid level: ____________in
   d. Evidence liquid level has been higher. Yes_____No_____
   e. Evidence liquid level dropped without pumping. Yes_____No_____
   f. Evidence of continuous inflow. Yes_____No_____
   g. Date of last pumpout: ________________________________
6. Pump/Siphon
   a. Pump/Siphon under access. Yes_____No_____
   b. Pull chain or rope present. N.A.___ Yes_____No_____
7. Discharge assembly: N.A. ___________
   a. Anti siphon/air release device. Yes_____No_____
   b. Backflow prevention (check valve) present. Yes_____No_____
   c. Air release located below check valve. Yes_____No_____
   d. Drain back device present. Yes_____No_____
   e. Quick disconnect present. Yes_____No_____
   f. Isolation valve present. Yes_____No_____
   g. Inline filters present. Yes_____No_____
8. Electrical components sealed and watertight. N.A.____Yes_____No_____

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable
8. ❑ Acceptable ❑ Unacceptable

Form 6-1 (continued). **Operational checklist: Dosing tank (DT).**

Reference #:____________________

9. Tank structural condition (evaluate if tank pumped): N.A.___________
   a. Appears to be watertight (no visual leaks). Yes____No_____
   b. Rebar exposed. Yes____No_____
   c. Corrosion present. Yes____No_____
   d. Spalling present. Yes____No_____
   e. Cracks present. Yes____No_____
   f. Root intrusion. Yes____No_____

9. ❑ Acceptable ❑ Unacceptable

10. Solids accumulation:

Scum (in)	Sludge (in)	Odor	Color	Other

11. Tank pumping recommended. Yes____No_____
12. Contractor responsible for pumping: ______________
    a. Gal removed:__________________Date:__________________
13. Screen(s)
    a. Type of screen: ❑ Vault with basket ❑ Vault with filter ❑ In-line screen
    b. Was screen cleaned. Yes____No_____
14. Lab samples collected for monitoring. Yes____No_____
    Types of analysis:____

panel has a cycle counter and/or an hour meter (elapsed time meter), record the present and last readings. If there are no meters, they are strongly recommended as an upgrade to facilitate O&M activities.

Siphon systems often include battery-operated cycle counters as the only metering component. This is critical to determine that the siphon is operating properly. If one is present, record the cycle reading, and calculate the total number of cycles and average cycles per day.

If the system uses a telemetry system, check to make sure it is operational, and note the type of system used.

2. If the system uses a siphon, note whether it is operating properly by running water into the tank until it activates. Be careful to direct the hose spray against the tank wall to avoid introducing air bubbles that may cause the siphon to 'burp.' (NOTE: Measure the ON and OFF elevations and the time it takes to deliver the dose during this operational test. Then skip to the calculations in numbers 5 through 8 in this section to complete the O&M service for this component.)

   If the system uses a pump, note whether the pump operated properly with the HAND-OFF-AUTO switch in the panel or with the piggyback control. Indicate whether the pump is high-head (multi-stage) or low-head (single-stage), and measure the operating amps and voltage. Manually check that the pump turns on and off.

3. Note what types of water level sensors are used in the tank: floats, ultrasonic,

or pressure transducers. These should be operated manually to ensure proper function of the pump and alarms.

4. Starting with the float or sensor setting nearest the bottom of the tank, measure from the bottom of the tank lid (or other noted reference point) in inches to determine the elevations of the following:
   - Pump OFF elevation
   - Pump ON elevation
   - Alarm ON elevation
   - Lag pump ON elevation (typically in larger systems)

   Indicate what function each float has in the system and whether it is operational. Also note whether the float is secured in its position in the pump tank.

5. The dose volume (DV) can be calculated by multiplying gallons/inch (GPI) (Form 6-1 item 3.e by the number of inches of separation between the pump-on and pump-off floats noted in Number 4 (Figure 6-16). (NOTE: Using inches of separation here is valid only if float tether lengths are equal.)

   Inches pumped =
   Pump off (in) – Pump on (in)

   DV (Gal) = GPI x Inches pumped (dose)

6. The pump delivery rate (PDR) in GPM can be calculated by running the pump for a specified period of time and measuring the elevation of the effluent at the pump OFF and pump ON points. (NOTE: The specified time should allow for full pressurization of the system. A pressure gage can be used to verify that this has been accomplished. Generally, a runtime of four or five minutes is sufficient.) Using the measurements, PDR in GPM is calculated thus:

   PDR (GPM) =
   DV (gal) ÷ Verified pump run time (min)

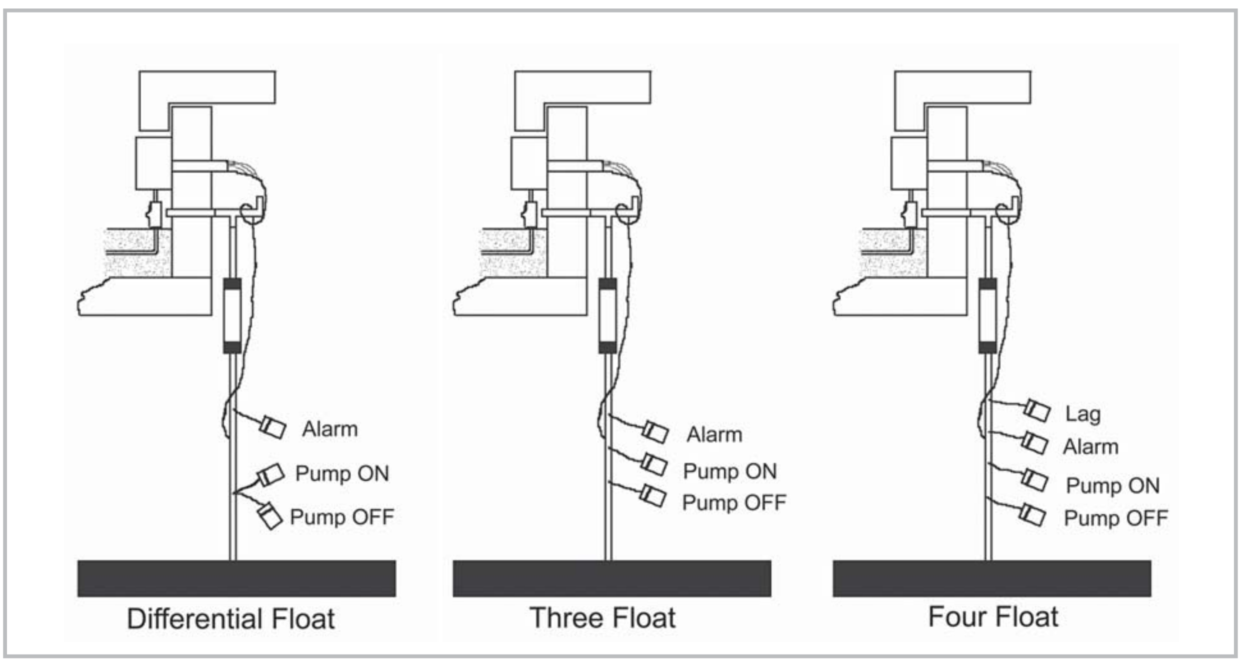


Figure 6-15. Float configurations for pumping systems. (profile view)
Source: American Manufacturing, Inc.

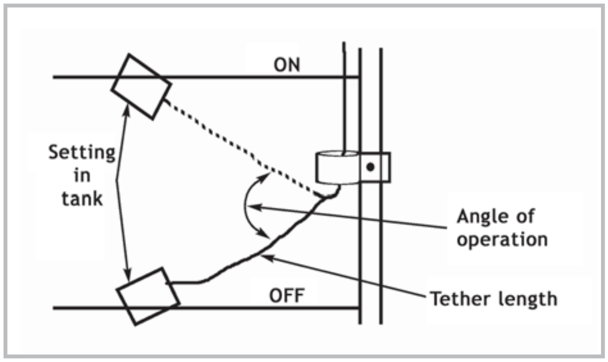


Figure 6-16. Float separation evaluation for estimating dose volume.

7. The total gallons pumped since the last inspection can be calculated using cycle counter readings or elapsed time meter readings. Using cycle readings, calculate the total number of cycles and multiply by the dose volume (DV) calculated in Number 5:

Total gal = (PCR – LCR) x DV (gal)

Using elapsed time meter readings, calculate the total run time *in minutes* and multiply by GPM as calculated in Number 6:

Total gal = (PTR – LTR) x GPM

Make a note of how the pump was activated, either by adding water or by lifting the float.

8. The average gallons per day (GPD) can be calculated using the figures from Number 7. Take the total gallons from either equation above and divide by the number of days of operation since the last inspection:

Gal/day (GPD) =
Total gal ÷ Number of days

Form 6-2. Operational checklist: Pump: Demand-dosed system (PDD) (including siphons).

Service provided on: Date:_________ Time:______________ Reference #:_______________________
Service provided by: Company: _________________________ Employee:_______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ______________________________

System type: ❑ Pump ❑ Siphon

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable

1. Controls
   a. Type: ❑ Piggy back ❑ Control panel
   b. Controls operating properly. Yes _____ No______
   c. Is enclosure watertight. Yes ______No______
   d. Alarm test switch working properly. Yes ______No______
   e. At time of inspection, control switch (HAND-OFF-AUTO) was set at:
      "Hand/Manual"_____________
      "Auto"________________
      "Off"_________________
   f. Electrical meter readings:

		Reading (this)	Reading (last)	Difference	N.A.
i)	ETM			min	
ii)	Cycles/events			Events (NC)	

Calculate cycles/day: _____ [NC] / [Days] = _______ [CPD]

   g. Telemetry operational. N.A.: _______Yes ______ No_____
      Type:_______________________

2. Pump/Siphon
   a. Siphon operating properly. N.A.: ________Yes ______ No_____
   b. Pump operating properly. Yes ______ No_____
   c. Type of pump: ❑ Multi-stage ❑ Single-stage
   d. Amps measured: ______________amps
   e. Voltage measured: _______________volts
   f. Pump turns on/turns off. Yes _____No______
3. Water level sensors
   a. Type of water level sensor: ❑ Floats ❑ Pressure transducers ❑ Ultrasonic ❑ Other: _____________
   b. Pump floats/sensors functioning properly. Yes _____No______
   c. Alarm float/sensor operating both audible and visible. Yes _____ No______
4. Sensor settings:

Sensor Number*	Function	Operational	Set At**		Secured
			Inches	Datum	
1		Yes___ No___			Yes___ No___
2		Yes___ No___			Yes___ No___
3		Yes___ No___			Yes___ No___
4		Yes___ No___			Yes___ No___
5		Yes___ No___			Yes___ No___

**(Designate starting from bottom of tank)*
*** (Measurements are taken from a fixed point ("Datum") near the surface or bottom of float tree in inches)*

5. Dose volume (DV)
   a. Pump Off – Pump On = ________in pumped (dose)
   b. GPI: _______ (Form 6.1 – Item 3.e)
      _______dose (in) x _______________GPI =____________ DV(gal)

Form 6-2 (continued). **Operational checklist: Pump: Demand-dosed system (PDD) (including siphons).**

Reference #:____________________

6. Pump delivery rate (PDR)
   a. Dose volume (from Item 5): __________ gal
   b. Verified pump run time "On": __________ min
   ____________ gal pumped ÷ __________ min = ________________ GPM
7. Total gallons
   a. Method to activate pump: ❑ Water added ❑ Lifted float
   b. Total gallons (from elapsed time meter)
   [_____(PTR) - _____(LTR)] x _____(GPM) = _______Total Gal
   OR Total gallons (from event/cycle counter)
   [_____(PCR) - _____(LCR)] x _____(DV) = _______Total Gal
8. Gallons per day (GPD)
   a. _____Total gal ÷ _____No. of days = ________Gal/day (GPD)

CPD: cycles per day
DV: dose volume
ETM: elapsed time meter
GPI: gallons per inch
GPM: gallons per minute
GPD: gallons per day
HAND-OFF-AUTO: Hand-off-auto switch
LCR: last cycle reading
LTR: last time reading
PCR: present cycle reading
PDR: pump delivery rate
PTR: present time reading

Pump: Timer-dosed (PTD)

Overview

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

Operation and maintenance

The timer-dosed system control panel operation and maintenance can include the following evaluations (**Form 6-3. Pump: Time-dosed system** (PTD)):

1. A control panel used for timer-dosed systems should be NEMA 4 or 4x with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm by operating the test switch. It is important to record the timer setting and the mode setting (hours, minutes, or seconds). Note the position of the control (HAND-OFF-AUTO) switch, keeping in mind that under normal operation it should be in the AUTO position. If the timer settings are changed during the inspection, record the new settings. If the panel has a cycle counter and/or an hour meter (elapsed time meter), record the present and last readings. If the system uses a telemetry system, check to make sure it is operational, and note the type of system used.
2. Note whether the pump operated properly using the HAND-OFF-AUTO switch in the

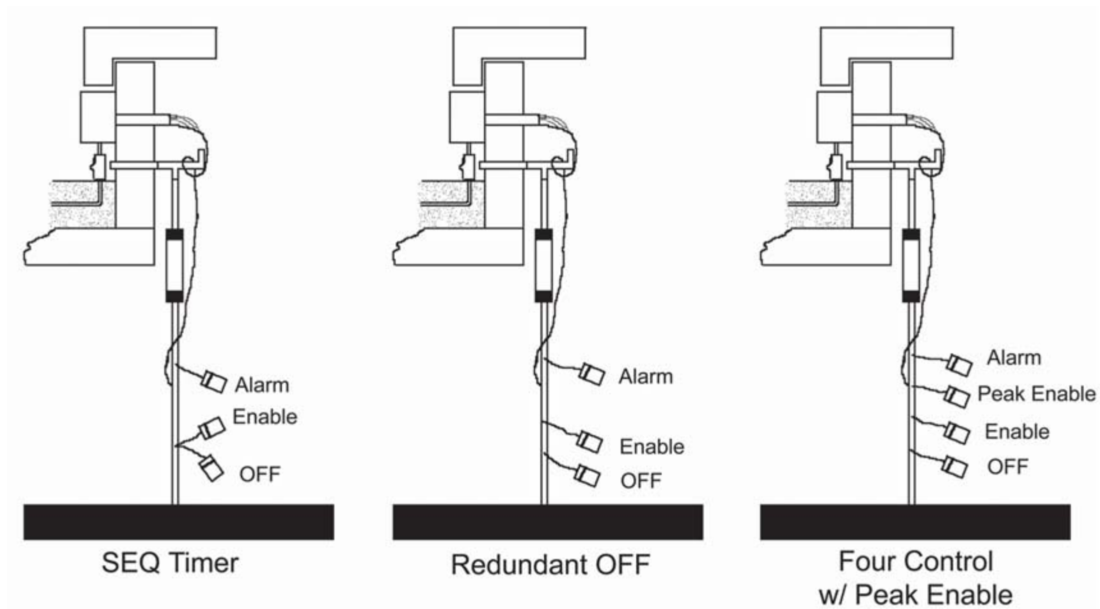


Figure 6-17. Timer-dosed float configurations (profile view). Source: American Manufacturing, Inc.

panel. Indicate whether the pump is turbine (multi-head) or low-head (singe-stage), and measure the amps and voltage. Manually check that the pump turns on and off.

3. Note what types of water level sensors are used in the tank: floats or different types of transducers. These should be operated manually to ensure proper function of the timer, pump, and alarms.

4. Starting with the float nearest the bottom of the tank, measure from the bottom of the tank lid in inches to determine the elevations of the controls. There are several different float configurations a service provider might see for timer control systems; thus, it is important to identify the function of each float carefully.

   Indicate what function each float performs in the system and whether it is operational. Also note whether the float is secured in its position in the pump tank.

5. Measure and record the number of minutes or seconds the pump actually runs during a timer cycle. The function of a repeat cycle timer can be checked by adjusting the settings to lower increments (e.g., a pump run time of 30 seconds, pump off time of 30 seconds). With multiplex pump systems, the pump sequencer function can also be tested this way. (NOTE: Remember to always return the timer to the original or specified settings.)

   The PDR should be close to the design delivery rate; it should deliver a certain number of GPM at the specified total dynamic head (TDH) from the system design. Calculate GPM by running the pump for a specified period of time (or for one cycle), and measure the elevation of the effluent before and after the test. (NOTE: The specified time should allow for full pressurization of the system. A pressure gage can be used to verify that this has been accomplished. Generally, a runtime of four or five minutes is sufficient.) Using the measurements, GPM is calculated thus:

Inches pumped =
Pump OFF (in) – Pump ON (in)

Gal pumped = Inches pumped x Gal / in

GPM = Gal pumped ÷ Min

6. Using the GPM calculated in Number 5, calculate the Dose Volume (DV) by multiplying the actual pump "on" time by GPM. Pump "on" time was recorded under Number 5 on the form.

DV (gal) =Min / cycle x GPM

7. The total gallons pumped since the last inspection can be calculated using cycle counter readings or elapsed time meter readings. Using cycle readings, calculate the total number of cycles and multiply by the DV calculated in Number 6 on the form:

Total gal = (PCR – LCR) x DV (gal)

Using elapsed time meter readings, calculate the total run time ***in minutes*** and multiply by the GPM calculated in Number 5:

Total gal = (PTR – LTR) x GPM

8. The gallons pumped per day (GPD) can be calculated using the figures calculated in number 8. Simply take the total gallons from either equation above and divide by the number of days since the last inspection.

_____Total gal ÷ _____No. of days =
_______GPD

Form 6-3. Operational checklist: Pump: Time-dosed system (PTD)

Service provided on: Date:_________ Time:_______________ Reference #:________________________
Service provided by: Company: __________________________ Employee:___________________________
Date of last service: ______________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _________________________________

Notes

1. Controls Timer manufacturer:___________________
   a. Is enclosure watertight. Yes_____No_____
   b. Alarm test switch working properly. Yes_____No_____
   c. At time of inspection, timer was set at: "On"____ Mode setting____
      "Off"____ Mode setting____
   d. At time of inspection, control switch (HAND-OFF-AUTO) was set at:
      "Hand/Manual"_______
      "Off" ________
      "Auto" ________
   e. If timer was changed from above, new setting is: "On"____ Mode setting____
      "Off"____ Mode setting____
   f. Electrical meter readings:

		Reading (this)	Reading (last)	Difference	N.A.
i)	ETM			min	
ii)	Cycles/events			Events (NC)	

Calculate cycles/day: _____ [NC] / [Days] = _______ [CPD]

   g. Telemetry operational. N.A._______Yes ____ No _____
      Type: _____________________

2. Pump
   a. Pump operating properly. Yes_____No_____
   b. Type of pump: ❑ Multi-stage ❑ Single-stage
   c. Amps measured: ___________amps
   d. Voltage measured: ___________volts
   e. Pump turns on/turns off. Yes_____No_____
3. Water level sensors
   a. Type of water level sensor: ❑ Floats ❑ Pressure transducers
      ❑ Ultrasonic ❑ Other:________________
   b. Pump sensors functioning properly. Yes_____No_____
   c. Alarm sensor operating audible and visible alarms. Yes_____No_____

Notes:
1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable

4. Sensor settings:

Sensor Number*	Function	Operational	Set At:		Secured
			Inches**	Datum	
1		Yes___ No___			Yes___ No___
2		Yes___ No___			Yes___ No___
3		Yes___ No___			Yes___ No___
4		Yes___ No___			Yes___ No___
5		Yes___ No___			Yes___ No___

(Designate starting from bottom of tank)
*** Measurements are taken from a fixed point ("Datum") near the surface or bottom of float tree in inches)*

5. Pump delivery rate (PDR) (measured)
   a. Pump Off_____________ - Pump On _______________ = ________in
   b. GPI: _______ (*From* Form 6.1 – Item 3 e)
   c. Verified pump run time: _____________min

(____________In x ________________________GPI) ÷ Pump run time (min) =_______(GPM)

Form 6-3. (continued). **Operational checklist: Pump: Time-dosed system (PTD)**

Reference #:______________________

6. Dose volume (DV) (from timer setting)
   a. Pump delivery rate: ________________ GPM (from Item 5)
   b. Verified pump run time: ________min
   _________ GPM x _________ min/cycle =____________(DV[Gal/ cycle])
7. Total gallons (from elapsed time meter)
   a. [_______(PTR) - _____(LTR)] x _____(GPM) = _______Total Gal
   OR Total gallons (from event/cycle counter)
   [_______(PCR) - ____ (LCR)] x _____(DV) = _______Total Gal
8. Gallons per day (GPD)
   _____Total gal ÷ _____No of days = _____Gal./Day (GPD)

CPD: cycles per day
DV: dose volume
ETM: elapsed time meter
GPD: gallons per day
GPI: gallons per inch
GPM: gallons per minute
HAND-OFF-AUTO: Hand-Off-Auto Switch
LCR: last cycle reading
LTR: last time reading
PCR: present cycle reading
PDR: pump delivery rate
PTR: present time reading

Chapter 7

Pretreatment Components–Advanced

Learning objectives

Upon completion of this chapter, you should be able to:

Media Filter

1. List the types of and differences between the media used in media filters, and explain how media filters treat wastewater.
2. Explain the relationship between effluent detention time and wastewater treatment efficiency in media filters.
3. Understand the difference between single-pass and recirculating media filter treatment processes and treatment trains.
4. Understand trickling filter treatment trains, and identify treatment processes.
5. Understand and explain the difference between media filters and trickling filters.
6. Understand and be able to accurately complete Operational checklist 7-1. Media filters (MF).
7. Understand what distal pressure is and how it may indicate a need for servicing.
8. Describe the methods used to clean distribution laterals in media filters.
9. Understand what recirculation ratio is and how it may indicate the need for service on a media filter.

Aerobic Treatment Units

10. Describe the components of an aerobic treatment unit.
11. Understand the difference between suspended growth and attached growth treatment processes.
12. Name the treatment process and stages occurring in a sequencing batch reactor.
13. Identify the different methods to introduce air into an aeration chamber.
14. Understand the purposes of and O&M requirements for the following components in an aerobic treatment unit:
    a. Air supply vent
    b. Schrader valve
    c. Aspirator
    d. Clarifier
15. Understand the effect of hydraulic loading on the clarifier and organic loading on the aeration chamber.
16. Understand and be able to accurately complete Operational checklist 7-2. Aerobic treatment unit (ATU).

Constructed Wetlands

17. Understand the treatment processes in constructed wetlands.
18. Understand the relationship between hydraulic detention time and the quality of the effluent.
19. Understand and be able to accurately complete Operational checklist 7-3. Constructed wetlands (CW).

Lagoons

20. Understand the main treatment processes occurring in lagoon systems.
21. Understand and be able to accurately complete Operational checklist 7-4. Lagoon maintenance (LM).

Disinfection

22. Understand the types of disinfection systems.
23. Understand and be able to accurately complete Operational checklists 7-5. Disinfection unit-chlorine (DUC), 7-6. Disinfection unit-ultraviolet light (DUUL), 7-7. Disinfection unit-ozone (DUO).

Overview

Advanced pretreatment components typically follow primary treatment from septic tanks and decrease the constituents of concern in wastewater before they reach the final treatment and dispersal component. Advanced pretreatment components are used when a site has a high risk to public or environmental health and primary treatment is not protective enough. Advanced pretreatment components include:

- Media filters
- Aerobic treatment units (ATUs)
- Constructed wetlands
- Lagoons
- Disinfection units

Distal head

Several advanced wastewater treatment systems and soil treatment area (STA) options incorporate pressure distribution to achieve uniform wastewater loading. Assessing uniform application of wastewater is usually done by determining distal head on the individual laterals conveying wastewater. The distal head is the pressure at the end of the laterals of some pretreatment units or final treatment and dispersal units (if equipped with pressure laterals). Uniform distal head on each lateral means that uniform application of wastewater is likely occurring. The distal head pressure is typically measured with a clear calibrated PVC pipe that is attached to the end of the lateral and held vertically. When the pump is activated, the effluent rises in the clear pipe, and the height is recorded (Figure 7-1).

Distal head is also loosely referred to as "squirt height"—the height that wastewater will squirt in free air. Generally, the height that wastewater rises in a PVC pipe is somewhat higher than the "squirt height."

Some manufacturers and/or regulatory programs set minimum and/or maximum distal head for different types of pretreatment and final treatment and dispersal units. The service provider is encouraged to contact the manufacturer or the regulatory jurisdiction for specifics.

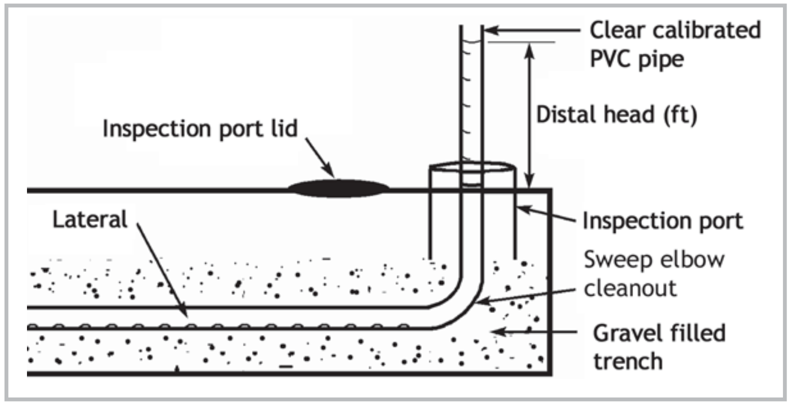


Figure 7-1. Distal head pressure (profile view).

The distal head should be first recorded at system start up, and this value should correspond to the design distal head. This start-up value will be the baseline value to which future measurements will be compared. If the distal head reading increases in the future, it is an indication that some orifices are clogged. Some manufacturers establish that the laterals should be cleaned and flushed if the distal head pressure increases by more than 20 to 40 percent of the initial value. (NOTE: The laterals should be cleaned if non-uniform distribution of effluent is observed, regardless of distal head increases.)

For residential systems, the general practice is that the laterals are flushed, snaked, and flushed without measuring the squirt height. The time required to flush, snake, and flush is equivalent to the time required for measuring the distal head, thus saving the service provider valuable time and ensuring treatment goals for the system.

The process of snaking the laterals involves either a bottlebrush attached to the end of an electrician's or plumber's snake, or a small diameter pressure washer nozzle and hose. Initial flushing of the laterals removes the inevitable collection of biosolids at the lateral end. Once the laterals are snaked, they should be flushed again to remove any solids that may have been dislodged. Laterals may also be vacuumed out with a pump truck if the orifices are well protected.

The distal head should be checked after snaking and flushing the laterals. After cleaning the lateral, the distal head should be equivalent to the initial baseline value recorded during system start-up. A decrease over time in the distal head might be an indication of pump wear-out, clogging or malfunction, or a leak in the distribution system.

Air release valves

Air release valves allow the air in lines to purge, speeding up the pressurization of the distribution network. After the pump cycles off, the air release valves open automatically to allow air to enter the piping. Air release valves may be needed on some systems and, when needed, are placed at the highest point in the system. They must be protected from damage and freezing. Valve boxes are generally placed around the valve to protect it and to create a void space for air exchange.

Media filters

Overview

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, recirculation tank, or processing tank, effluent is evenly distributed over the media surface. 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 either a soil absorption area or the soil surface for final treatment, or sent back to a recirculation/processing tank or a recirculation compartment for additional processing. The filter bed is never saturated with effluent, and the presence of air promotes establishment of aerobic microorganisms. The only exception to this aerobic conditions rule is with upflow anaerobic filters where saturated conditions are maintained. Bottomless media filters will not be covered in this chapter (see Chapter 8 for details on bottomless filters).

Treatment

Media filters treat wastewater through four main processes: filtration, chemical and physical sorption, assimilation, and decomposition of organic material. Filtration removes solid materials by physically straining or screening out particles in the wastewater moving through the bed. Chemical and physical sorption removes materials from the effluent through adsorption to the media surfaces and to the biological growth that adheres to the media surface. Assimilation is the process by which the microbiological communities living on the media surfaces transform the material that has been filtered or adsorbed into another chemical state. Decomposition is the process by which organic wastes breakdown into simpler compounds.

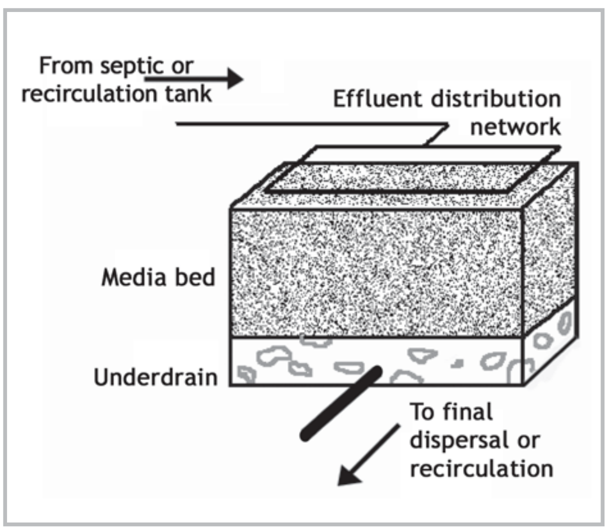


Figure 7-2. General schematic of a media filter.

Types of Media Filters

- Single-pass Media Filters
  - Granular (sand, glass, other)
  - Foam or plastic
  - Peat

- Recirculating Media Filters
  - Granular (sand, gravel, bottom ash, other)
  - Foam or plastic
  - Textile

Most single-pass sand filters are designed as buried filters, covered with 6 to 10 inches of breathable top soil and planted to grass. Other single-pass or recirculating media filters are “free access,” meaning that their surface is either in direct contact with free air or is accessible via a hinged lid or risers that come to finish grade.

Understanding media types

Several different types of media have been used in media filters. Media types can be generally categorized as solid granular or absorbent. In the solid granular media category, there are three materials that have been used—sand or gravel, bottom ash, and crushed glass.

Media less than 2 millimeters in diameter is sand, and anything larger is referred to as gravel. Sand and gravel have been used in media filters for decades. Sand, through which wastewater flows relatively slowly, is typically used for single-pass filters. Gravel is typically used for recirculating filters, which can accept larger amounts of wastewater than can single-pass sand filters. Nationwide, more sand filters have been used to treat water and wastewater than probably any other advanced treatment technology.

Regionally, other solid granular media such as crushed glass and bottom ash have been used. Also called "slag," bottom ash is a byproduct of coal-fired power plants. Bottom ash is still used in some Appalachian Mountain states where coal-fired power plants are common. The use of glass media has been isolated to the northwestern United States and western Canada and is used on a relatively limited basis today. Other types of media material, such as tire chips, have been experimented with on a limited basis. The service provider is encouraged to check with local and state regulatory programs, as localized use of other solid type media may also exist.

Absorbent medias have been substituted for the nonabsorbent granular types mentioned above to help encourage more efficient movement of wastewater and gases in the filter bed. This can allow a reduction in the system footprint. The absorbent media filters used in a single-pass mode currently include peat and open-cell foam (stated in order of their industry debut). Textile and open-cell foam media are also used in recirculating filters.

Single-pass media filters

Overview

In single-pass systems, wastewater applied to the filter surface percolates through the media bed and collects at the filter base. As the name implies, wastewater flows though the filter bed only once and then flows to the next treatment and/or dispersal step. Treated filter bed effluent is usually pressure-dosed to the drainfield for final treatment and/or other dispersal. A limited number of media filters may employ gravity flow to feed both the media bed and the drainfield distribution trenches. Several different types of single-pass filters have been used; the oldest type being the sand filter, which has long served as the industry standard. Fairly recently, absorbent media (peat and foam) have been substituted for sand media to help encourage more efficient movement of wastewater and gases within the filter.

Treatment

Single-pass media filters are designed to treat wastewater by physical filtration of solids; chemical adsorption, assimilation or transformation; and decomposition of organic wastes. They are usually quite effective in removing BOD_5 and TSS. Single-pass media filters are not generally known for their nitrogen removal abilities. They are, however, considered good nitrification zones (conversion of organic and ammonium forms of nitrogen to the nitrate-nitrogen form), and some filters can remove appreciable numbers of pathogenic organisms. Single-pass sand filters, for example, are capable of achieving three to four orders of magnitude reduction in fecal coliform bacteria. Effective treatment depends upon the hydraulic and organic loading rates to the filter. The service provider is encouraged to check local and state regulations for approved loading rates. Treatment train options are discussed below.

Please note that in the field, actual treatment trains may differ from those shown in Figures 7-3 and 7-4. In a particular system, actual pump locations could possibly be a combination of both internal and external configurations. Although pump locations may differ among regulatory jurisdictions, it is important that the service provider recognize where major treatment components are located and what their function or purpose is. In so doing, the service provider will determine if the overall treatment train is correctly configured in a logical and generally accepted manner.

In Figure 7-3, effluent leaves the house and enters a septic tank containing a screened pump vault in the outlet end of the tank. Effluent is usually pressure-dosed (using a programmable timer) over the single-pass media filter surface where it then percolates down through the me-

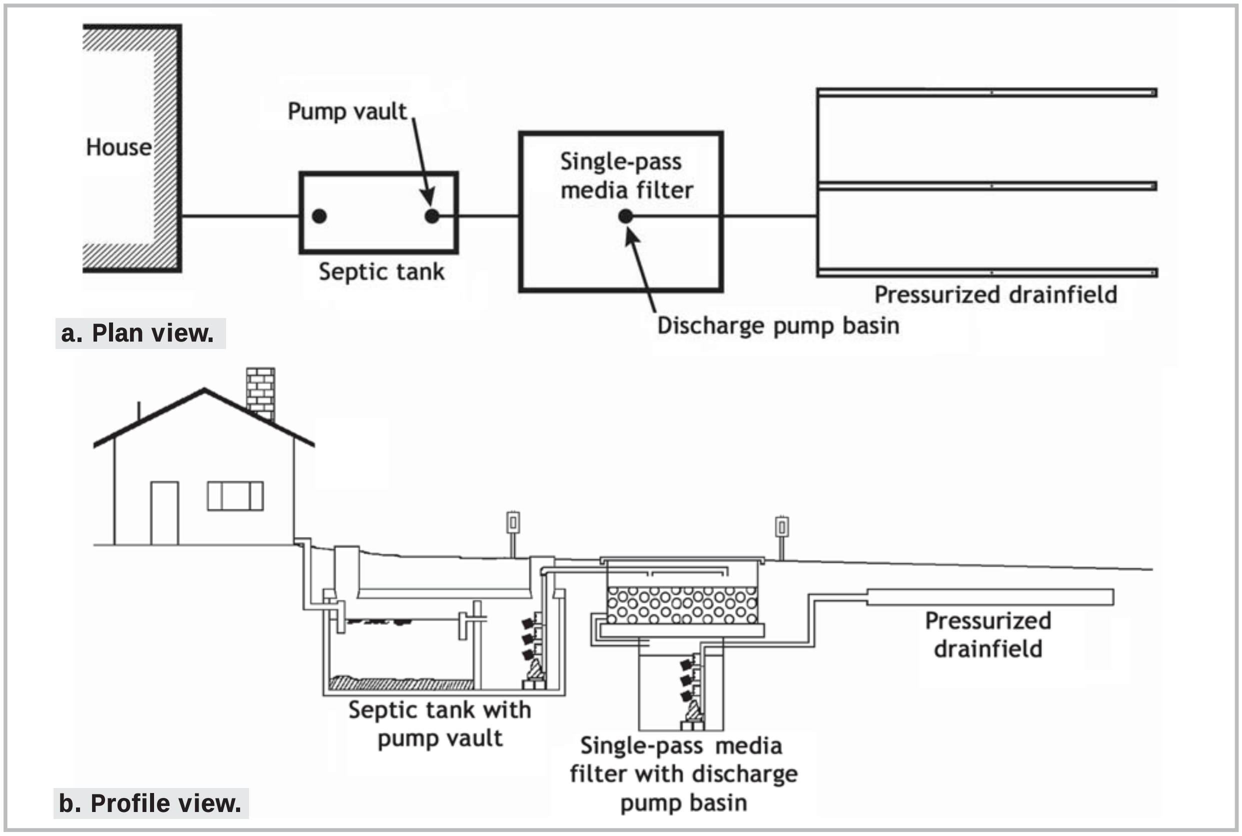


Figure 7-3. Configuration for a single-pass media filter treatment train with an internal pump vault/basin.

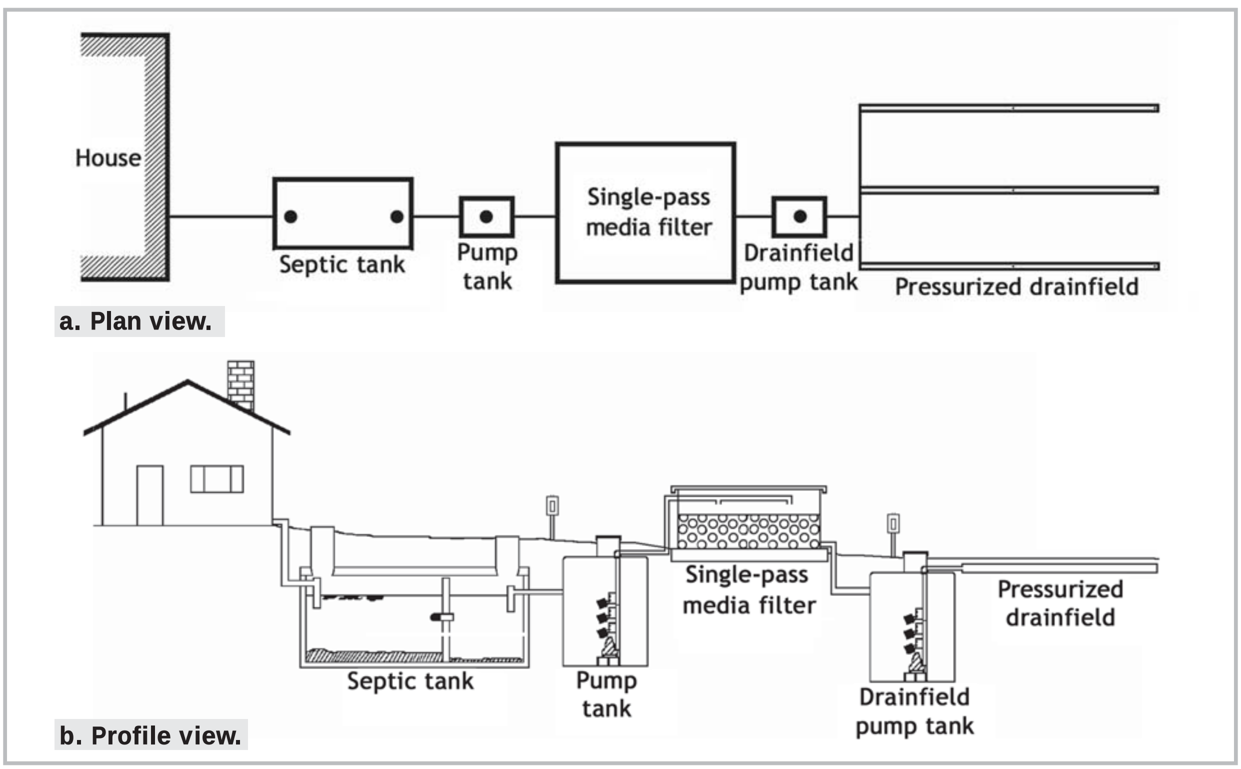


Figure 7-4. Configuration for a single-pass media filter treatment train with external pump tanks.

dia bed and is collected in either an internal or external pump tank or basis to be demand-dosed to a pressurized drainfield.

In Figure 7-4, effluent leaves the house, enters a septic tank, and flows by gravity to a separate pump tank from where it is dosed to the single-pass media filter. Typically, this pump is controlled by a programmable timer. Filtered effluent is collected in the drainfield pump tank located after the media filter, where it is demand-dosed to a pressurized drainfield.

Although not that common, some media filters may have a treatment train that is completely gravity fed. In Figure 7-5, effluent flows from the house into a septic tank and by gravity flows onto the surface of the media filter. Effluent percolates down through the media, is collected in the filter bottom drain, and flows by gravity into a drainfield. At the time of this writing, some Canadian peat filters are configured in this gravity-fed manner.

Recirculating media filters

Overview

A recirculating media filter treats wastewater by recirculating effluent that has passed through the filter bed back to the septic tank or to a separate recirculation tank. 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 recirculated to the filter bed 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. This splitting process may be controlled in the following ways:

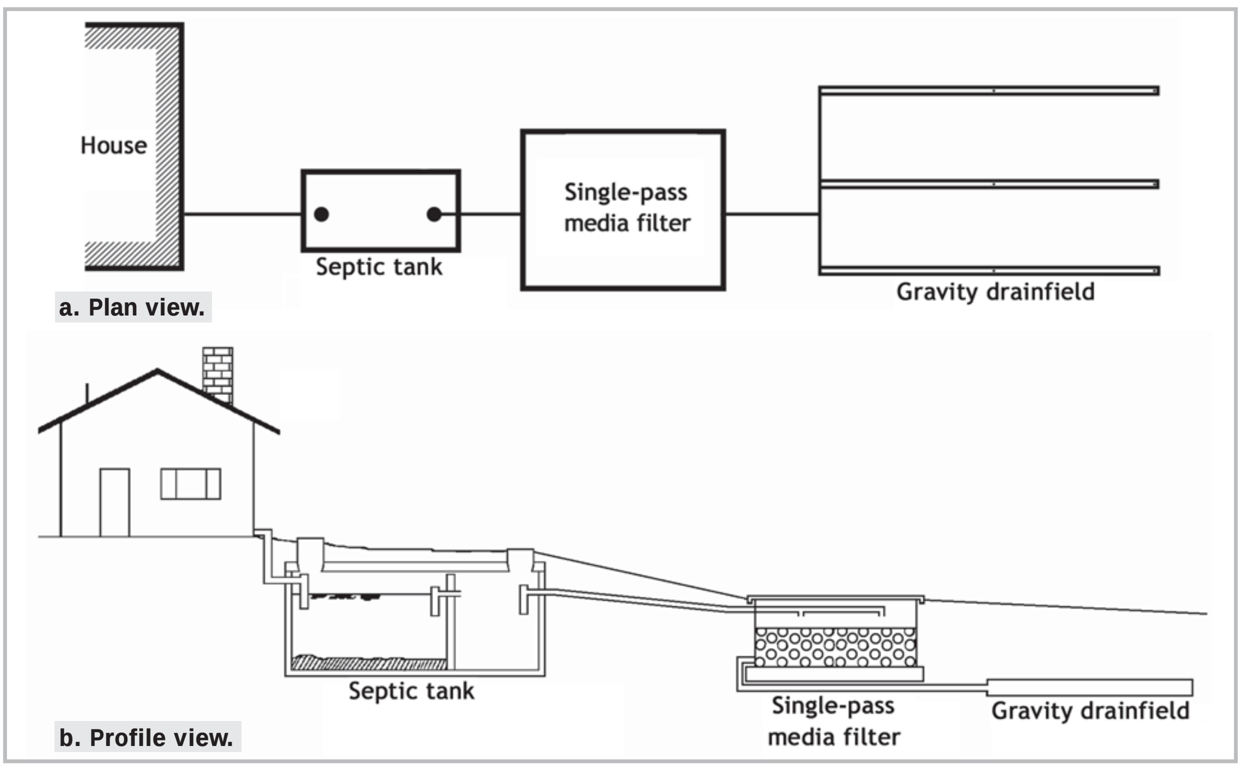


Figure 7-5. Configuration for a single-pass media filter treatment train utilizing gravity flow.

- Dam/divider at the filter bed base
- Floating ball valve device, known as a recirculating splitter valve or floating ball valve, located in the recirculation tank, septic tank, or processing tank
- Tipping bucket device
- Splitter box
- Distribution plate
- Pressurized pipe and valve assembly

Treatment

Recirculating media filters are effective in reducing BOD_5 and TSS in wastewater. Nitrogen removal in recirculating media filters is enhanced by circulating the filtrate back to the carbon-rich anaerobic processing, septic, or recirculation tanks. Processing tanks are a combination septic and recirculation tank containing a pump vault in the outlet end. Solids settling, denitrification, recirculation and mixing, and effluent dosing are all expected to occur in a processing tank. Please see Chapter 5 for further discussion on processing tanks.

Recirculating sand /gravel filters have been used for nitrogen reduction for over three decades, and many regulatory programs accept them for this purpose. Recirculating sand or gravel filters differ only in the size of the media used. Textile and foam media have recently been used for nitrogen reduction. The service provider is encouraged to check with local or state regulatory programs regarding the status of media filter use for nitrogen removal. Recirculating media filters do achieve some bacterial reduction; however, the reduction is limited (due to high hydraulic loading rates and short retention times), and they are generally not considered pathogen reduction technologies.

In Figure 7-6, effluent leaving the house enters the septic tank and flows by gravity into

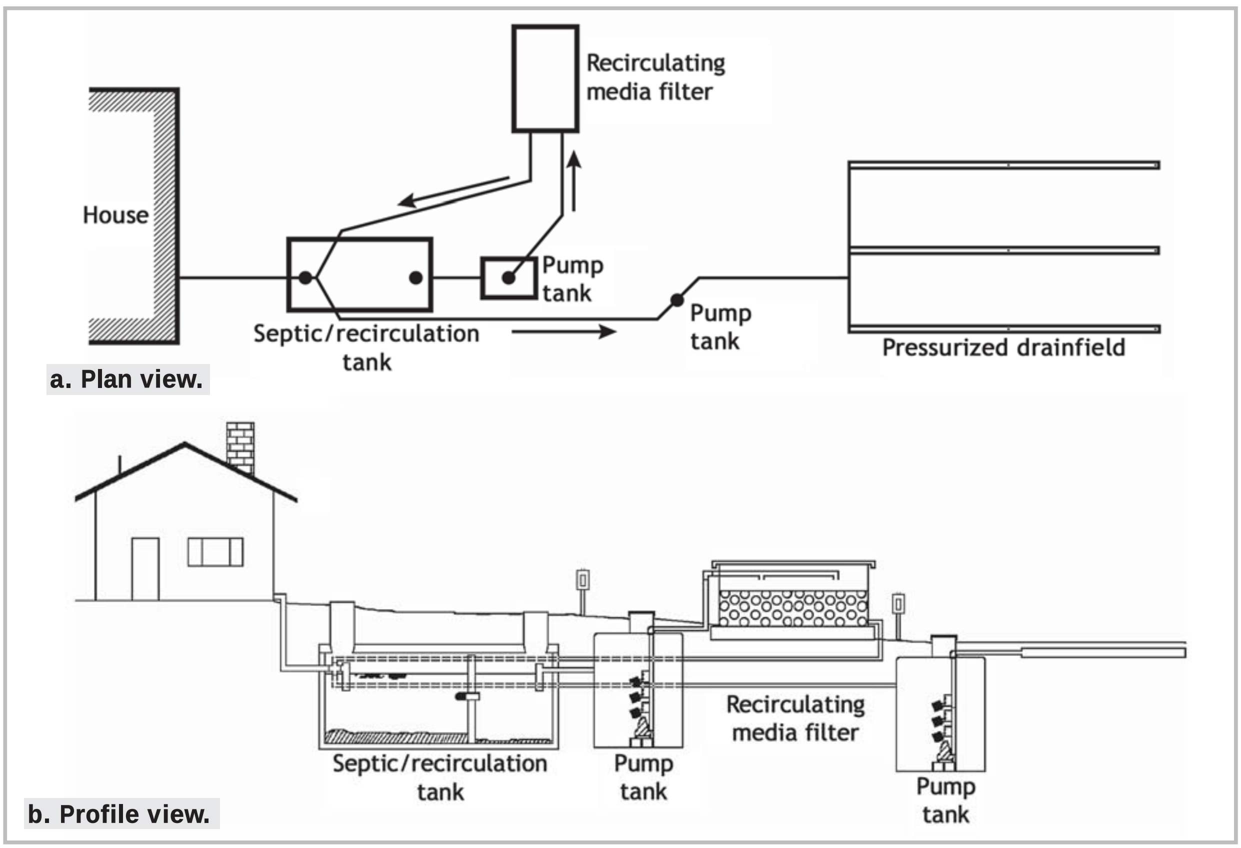


Figure 7-6. Configuration 1 for recirculating media filters using a separate pump tank.

a pump tank where it is pressure-dosed to the recirculating filter surface. Typically, time-dosing is used to distribute effluent. Effluent is then collected at the media filter base and recirculated back to the septic tank for further treatment. If tank effluent levels are high, effluent is diverted to the discharge basin for final dispersal in the pressure-distribution drainfield.

In Figure 7-7, effluent leaves the house and enters the septic tank where it then flows by gravity to a separate recirculation tank. The effluent is time-dosed to the recirculating media filter surface, passes through the bed, and flows back to the recirculation tank for further treatment. If the wastewater level is high in the recirculation tank, a floating ball valve diverts flow to the drainfield discharge basin for final dispersal. This is a very typical treatment train for a recirculating sand/gravel filter system.

In Figure 7-8, effluent leaves the house and enters the processing tank containing a screened pump vault in the outlet end of the tank. This tank also serves as a combination septic tank and recirculation tank. Effluent is time-dosed to the recirculating media filter surface, percolates through the bed, and collects at the filter base. Filtrate is typically split between recirculating back to the processing tank for further treatment or directed to the soil treatment area for dispersal.

There are several methods to achieve recirculation. The typical way is to use a floating ball splitter valve. In this case, filtrate flows back to the tank if the level is low. If the tank level is high, the floating ball valve diverts flow to the drainfield (which could be either pressure-dosed or gravity-fed).

Some technologies may pressure-dose media filter effluent from a sump in the filter base through gate valves that control flow back to the

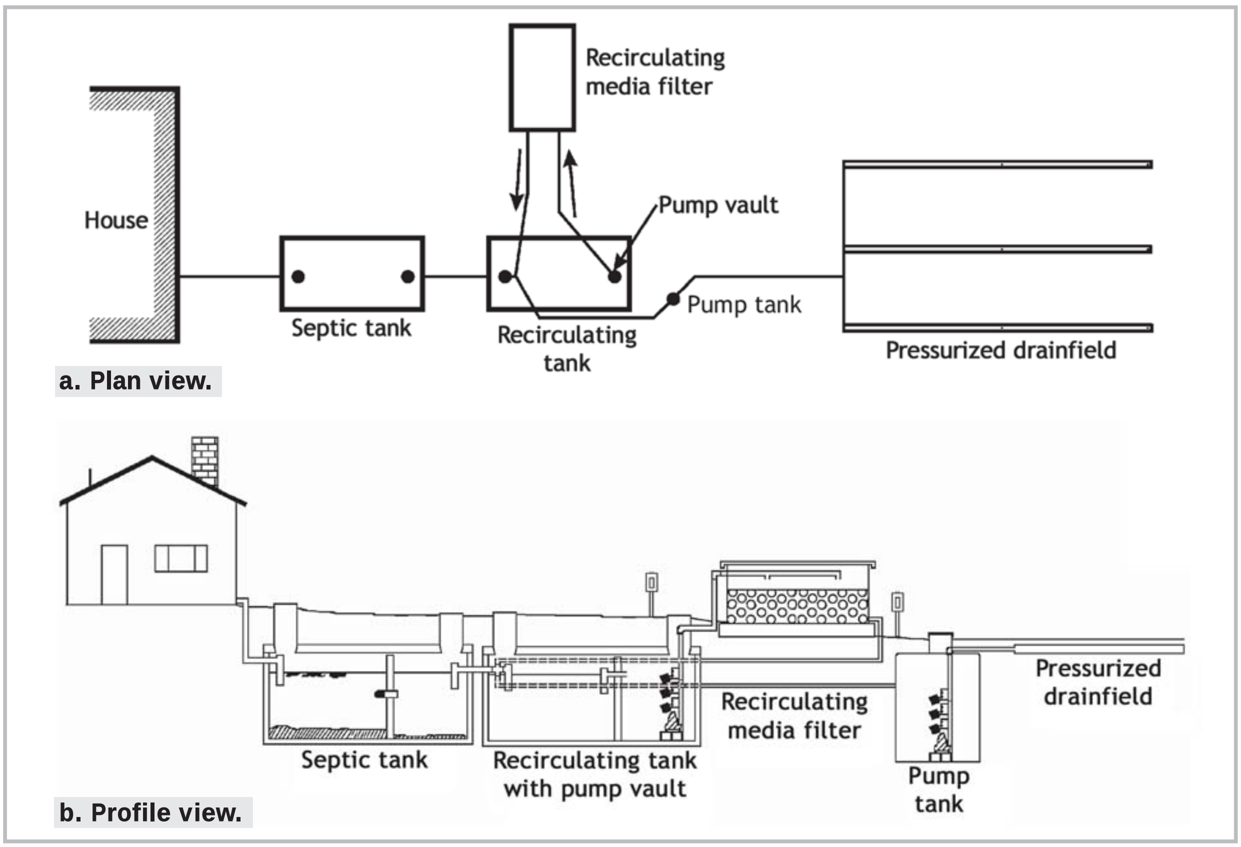


Figure 7-7. Configuration 2 for recirculating media filters using a separate recirculation tank.

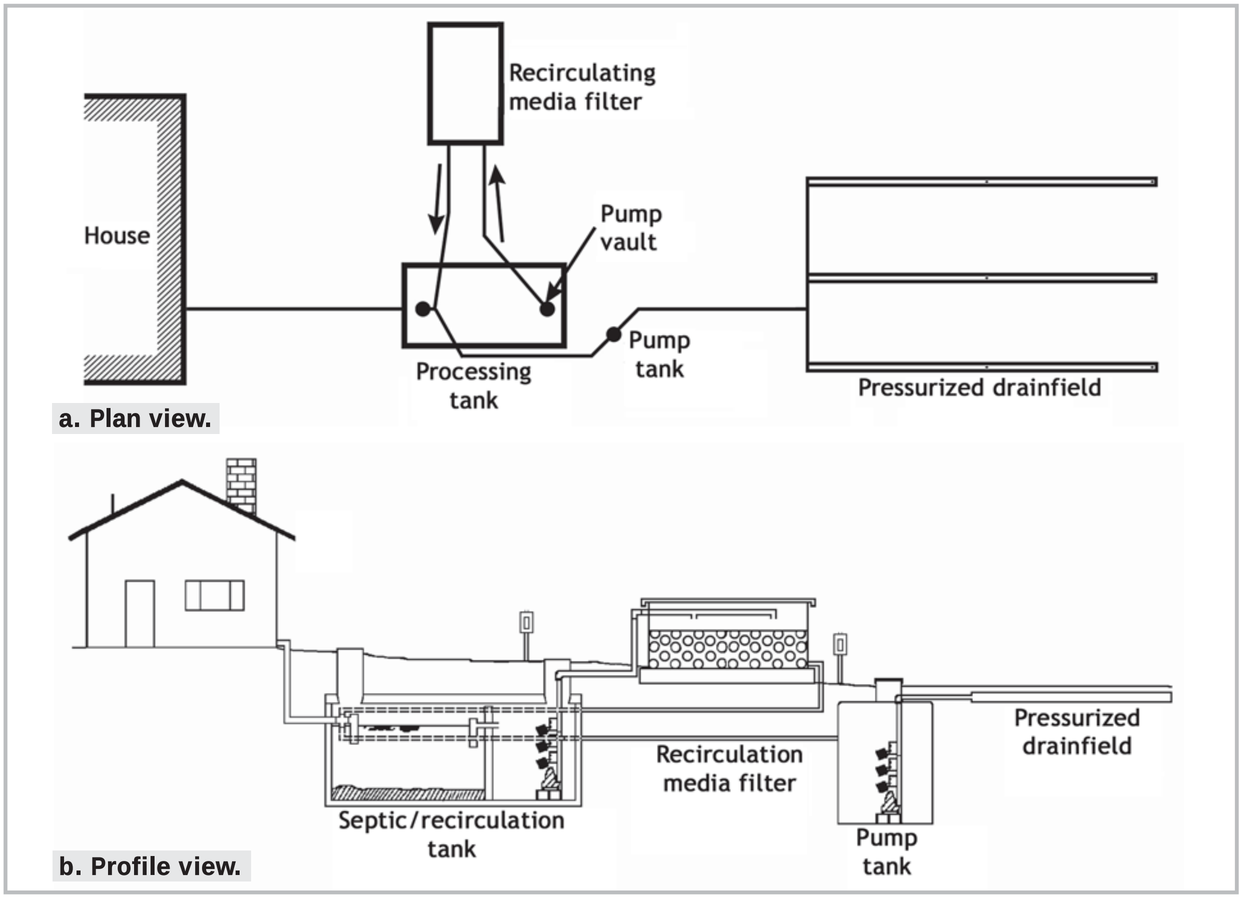


Figure 7-8. Configuration 3 for recirculating media filters using a processing tank.

tank and the drainfield. Other technologies may have either a barrier at the filter base or an external D-box that diverts gravity flow to both the processing tank and drainfield.

All of these flow splitting methods, except the barrier at the filter base (not usually accessible), would require some level of maintenance. The service provider is encouraged to determine what splitting method is being used to recirculate effluent.

Understanding recirculation ratios

The recirculating ratio of a system determines the amount of effluent that recirculates through the pretreatment unit before it is available for final treatment and dispersal in the drainfield.

The typical recirculation ratio ranges from 5:1 to 3:1 “forward flow.” The volume that recirculates over the filter media divided by the forward flow is the recirculation ratio. Forward flow is the effluent that actually reaches the final treatment and dispersal component during a specific period of time. The volume of effluent generated at the source (the home’s forward flow) is the same volume available for final treatment and dispersal (additions to the system from rainfall on the filter are usually not factored in).

The recirculation ratio directly influences the level of dissolved oxygen (DO) in the recirculating 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 recirculating tank. A higher recirculating ratio (for example, 5:1 versus 3:1) means that more oxygenated effluent is delivered to the recirculating tank.

DO levels need to be checked in the recirculation tank in order to assess if the recirculation ratio is in need of adjustment. Too much recirculation leads to excess oxygen in the recirculation 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. Higher DO 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 may be increased to achieve more treatment.

Changing recirculation ratios

The recirculation ratio of a system can be changed by simply changing the amount of effluent pumped to the media filter over time. The average forward flow of a recirculating media filter system is not likely to change if the use of the residence remains the same, but the timers that control the amount of effluent to the media can be adjusted to suit the system's needs.

In a typical recirculating filter, the programmable timer is set to turn the pump on and off in preset intervals. The most common way of changing the pumping intervals is to change the pump 'off' time, increasing or decreasing the number of pump events to the media. The pump 'on' time is generally set by the manufacturer or designer and is a function of how the media accepts and treats a certain amount of effluent, so generally it is not advisable to change it.

The recirculation volume to the media can be calculated from the readings at the control panel. The pump cycle counters, pump 'on' time, and the pump delivery rate for both the pump delivering effluent to the media filter and the pump delivering effluent to final dispersal are needed to calculate the recirculation ratio. Please review the calculation example in Appendix A for more detail.

The shorter the pump 'off' time, the more the filter will be recirculating and vice versa. Great care should be exercised when changing the recirculation ratio to more than 5:1, because the media might not be designed to handle the amount of effluent flowing through it. Consult the manufacturer or designer of the filter for a recirculation ratio greater than 5:1.

Types of media filters

Single-pass sand filter

Single-pass sand filters are normally used to polish effluent from septic tanks or aerobic treatment processing steps prior to final dispersal. The term "sand filter" refers to a biological and physical wastewater treatment component consisting of an underdrained bed of sand or gravel to which pretreated effluent is periodically applied. Filtrate collected by the underdrain is then distributed to a drainfield for final treatment and dispersal.

Specific maintenance tasks for single-pass sand filters

- Visually check surface of filter for settling, damage, erosion, or depressions.
- Check landscape position of the filter. Assess whether runoff/surface water is collecting over the filter.
- Check for surface water infiltration into sand filter components.
- Determine whether the type of cover over the system is at grade or below grade. If below grade, note the condition of vegetation over the filter.
- Check clarity, transparency, and odor of effluent after passing through the sand filter. Check for an oily film in the effluent.
- Measure distal head pressure on the lateral end before and after cleaning.
    - Distal head pressure in the laterals is evaluated using squirt height or the

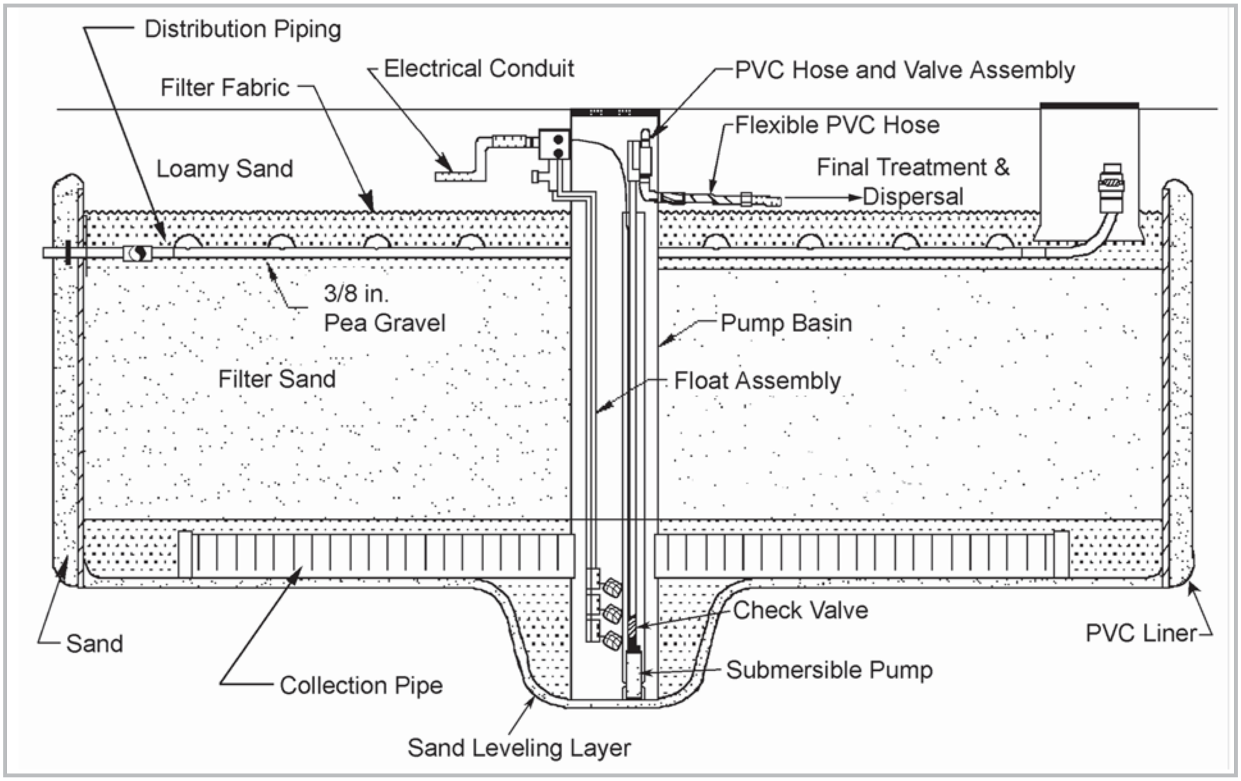


Figure 7-9. Cross section of an example of a buried single-pass sand filter with an internal pump basin sump (profile view).

liquid height in a clear viewing tube. This clear tube is attached to the end of the lateral and held vertically while the lateral is pressurized. The height from the lateral invert to the top of the effluent in the tube is the squirt height.

- Check effluent level in internal pump basin that houses the drainfield pump. Level should be below the elevation of the base of the sand media to avoid wicking effluent up into the sand media.
- Check that the high level alarm is set to engage below the elevation of the base of the sand media.
- Check for sand media within the sump. Sand in the sump could indicate improper installation of pea gravel within the filter underdrain.
- Clean distribution laterals by flushing, snaking with a bottle brush (or pressure washing), and flushing again.
- Check the function of each float in the sump.
- Check pump operation in automatic and manual modes.
- Check electrical junction box for damage or moisture.
- Verify proper operation of all alarms.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

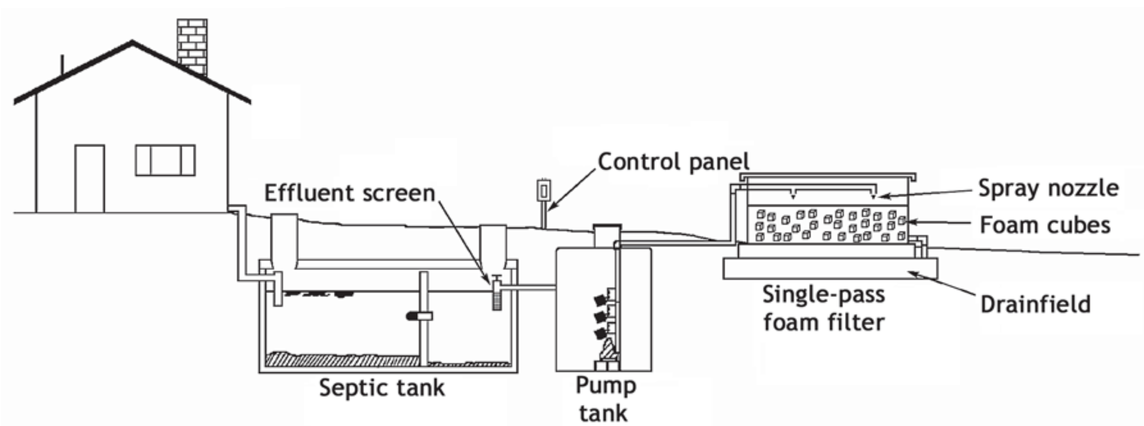
Single-pass foam filter

Foam filters use 2- to 3-inch cubes of open-cell polyurethane foam material that is randomly arranged in prefabricated modular units. The absorbent media utilizes internal surface areas within the foam cubes to help maximize microbial treatment and detention times. The foam media is usually dosed by helical spray nozzles.

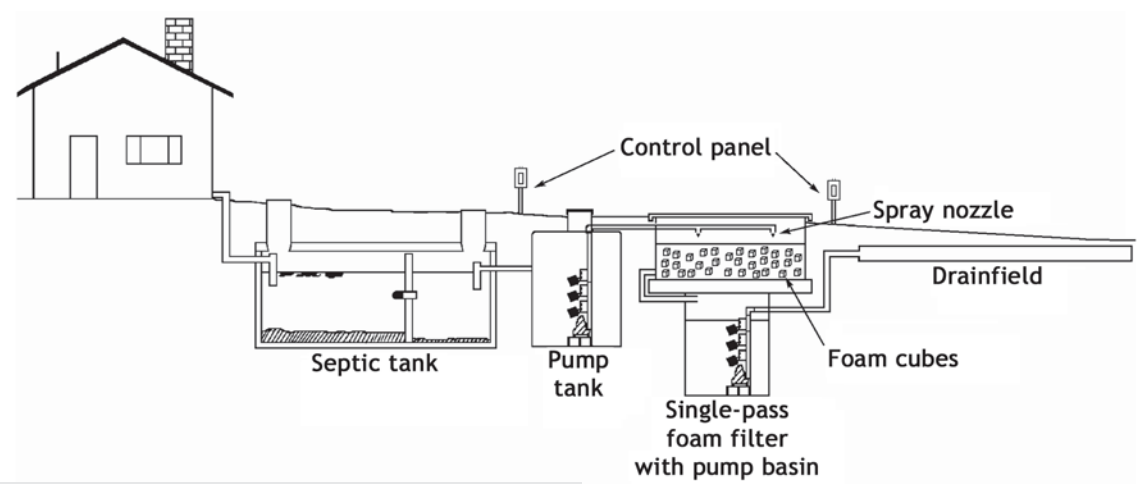
Specific maintenance tasks for single-pass foam filters

- Check for soil settling, erosion, depressions, or possibility of surface water collection around filter unit.
- Check for damage to the filter cover/lid.
- Check for settling of media within the filter.
- Inspect filter for odors and surface ponding.
- Inspect overall condition of the media.
- Check clarity, odor, and transparency of treated effluent.
- Check with manufacturer concerning acceptable effluent ponding levels at base of foam filter. Some technologies use this zone as a sump area for a drainfield dosing pump.
- Inspect for biomat buildup on media.
- Remove and clean spray nozzles annually (or as needed), and check for equal spray distribution.
- Flush laterals while nozzles are removed.
- Verify proper operation of all alarms.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)



a. Above ground configuration (profile view).



b. Below ground configuration (profile view).

Figure 7-10. System configurations for a single-pass foam filters.

Single-pass peat filter

Absorbent peat media filters consist of a distribution system, peat media, and an underdrain system. Peat filters typically come in pre-fabricated modular units made of fiberglass or high-density polyethylene. Some filters are gravity-fed, using a tipping distribution-box mechanism. Others are pressure-dosed using either demand- or time-dosing. Types of peat material are sphagnum peat (from North America) and coarse fibric peat (from Ireland).

Peat tends to settle, decompose, and/or deteriorate over time and may need to be replenished or replaced entirely at some point

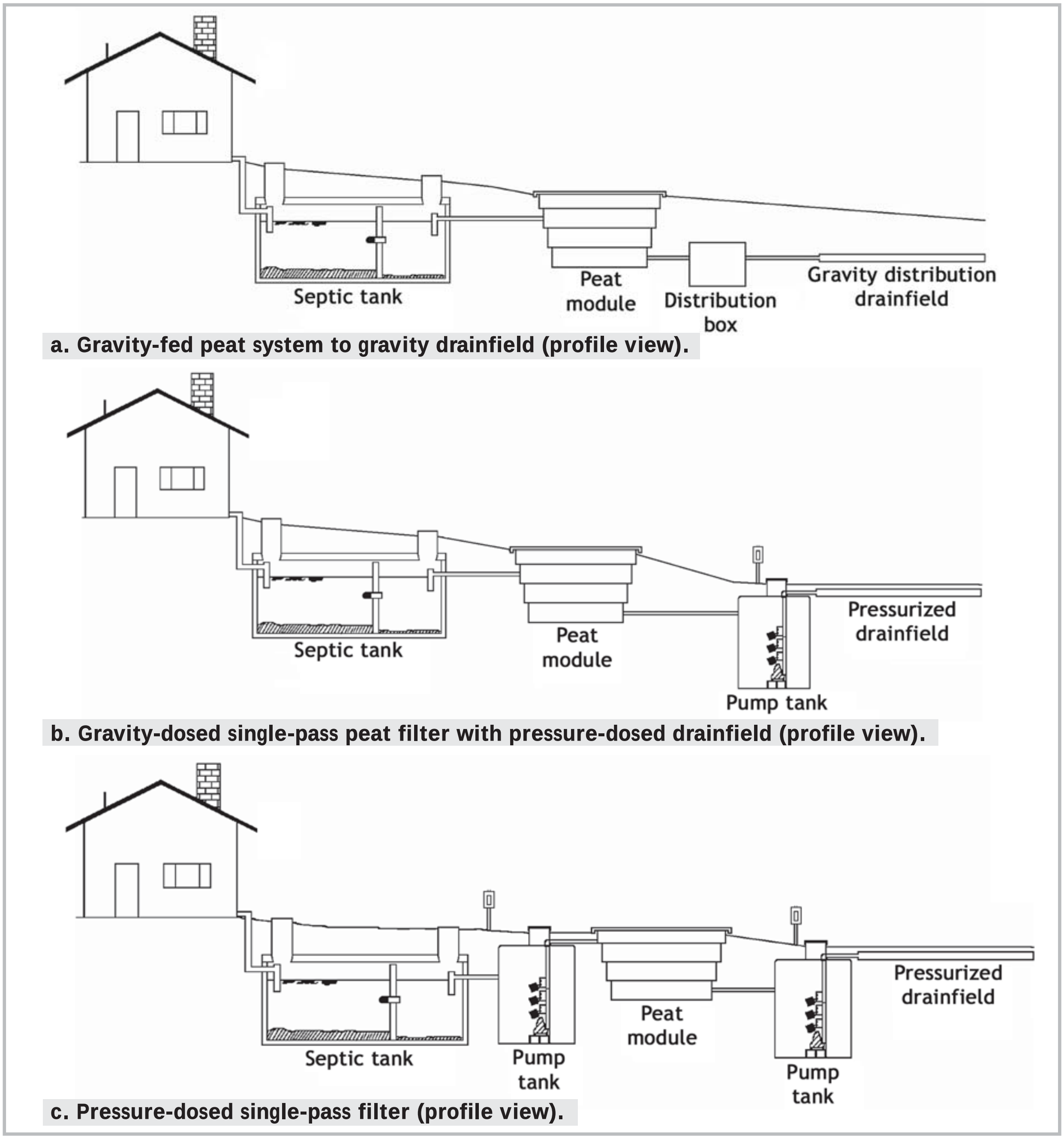


Figure 7-11. System treatment train configurations.

during use. Peat replacement frequency is dependent upon wastewater flow and characteristics and the type of peat used. Typically, peat needs to be completely replaced after 4 to 12 years of use. Peat replacement frequency may also be dictated by state or local regulations.

Additional peat material may need to be added to the module yearly to ensure that distribution laterals remain covered; otherwise, odor problems may occur (especially during cold months of the year).

After effluent passes through a peat filter, it can be pressure-dosed or gravity-fed to the final dispersal component. Some areas allow placement of the module directly on a bed of gravel or crushed stone with drain holes drilled in the bottom of the units. The stone/gravel bed serves as the dispersal component. (See Chapter 8 for peat filters used as a soil treatment area). The service provider is encouraged to check local or state regulations.

Specific maintenance tasks for single-pass peat filters

- Check for surface water and infiltration into components.
- Check for soil settling, damage, erosion, depressions, or possibility of surface water collection around the modules.
- Check for damage to the filter cover/lid. (If the air holes in the lid are allowing reptiles and rodents into the filter, plastic vents may be installed.)
- Check for excessive odors or any ponding at the surface of the filter.
- Check the clarity of the peat filter effluent. The effluent color may vary from a dark tea to a light amber color from the tannins leaching from the media. Color is darker at the time of start-up and lightens with time.
- Check the odor of the peat filter effluent. Effluent may smell musty, but it should not smell septic.
- Check for fine peat particles suspended in effluent. This may indicate that peat is decomposing and needs to be replaced.
- Check for wastewater bypassing the peat media. Pest damage (from ants, mice, and snakes) and frozen media can divert wastewater flow.
- If peat settling or channeling occurs, media may need to be raked to prevent odors or treatment bypass.
- Rake the peat media as needed to fluff it up. (Some companies advise against this. Check the manufacturer's guide.)
- Check for settling and decomposition of peat media, and replace it as necessary.
- Check to see if additional peat material is needed to cover distribution laterals (this will keep odor risks low).
- Make sure no heavy objects are placed over the peat filter; they could damage the distribution network.
- Verify proper operation of all alarms.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Recirculating sand/gravel filters

These at-grade, free access filters are composed of coarse sand and/or fine gravel and are covered with peastone to grade. The larger media size is necessary because of the higher hydraulic loadings these filters are designed to handle. The recirculation ratio ranges between 5:1 and 3:1 of the total flow generated at the source (forward flow).

Effluent passing through the recirculating filter is collected in an underdrain pipe. The effluent is then directed to a recirculating device that directs the effluent either to the recirculation tank if tank level is low or to final treatment and dispersal if tank level is high.

Specific maintenance task for recirculating sand/gravel filters

- Check surface of filter for settling, damage, erosion.
- Check for surface water collection or infiltration into the filter or components.
- Inspect top of filter, and remove any vegetation growing in the pea gravel. Place pressure on the laterals so that they are not pulled out of the pea gravel during this process.
- Check filter surface and clean/rake if necessary.
- Check for odors.
- Check for ponding in inspection port (if present).
- Check clarity, transparency, and odor of effluent before the final treatment and dispersal technology. Check for an oily film in the effluent.
- Flush, snake, and re-flush laterals. Put pressure on the laterals so they are not pulled out of the filter during snaking.
- Visually inspect the recirculating device, and clean if necessary.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Recirculating textile filter

Composed of geosynthetic fabrics or geotextiles, textile filters provide surface area within the media itself and void volume between the pieces of media. Textile filters have two common configurations: (1) randomly-sized textile coupons arranged in three separate horizontal lifts and (2) vertically hanging sheets of fabric. The textile material is contained in a prefabricated fiberglass container.

Specific maintenance tasks for recirculating textile filters

- Check for soil settling, damage, erosion, depressions, or possibility of surface water collection around the textile container.
- Inspect filter cover/lid for structural damage.
- Inspect for ponding. The textile filter should never be saturated or have any standing effluent in media.
- Check treated textile filter effluent for clarity, transparency, and odor. Check for an oily film in the effluent.
- Check for uniform spraying out of orifices (view stains on underside of filter lid or on filter fabric surface for distribution pattern).
- Textile filter should receive a dose of wastewater at least once every 30 minutes to prevent the media from drying out.
- The typical dose duration is 20-30 seconds and should not be more than 60 seconds.
- Flush, snake, and reflush laterals. Laterals

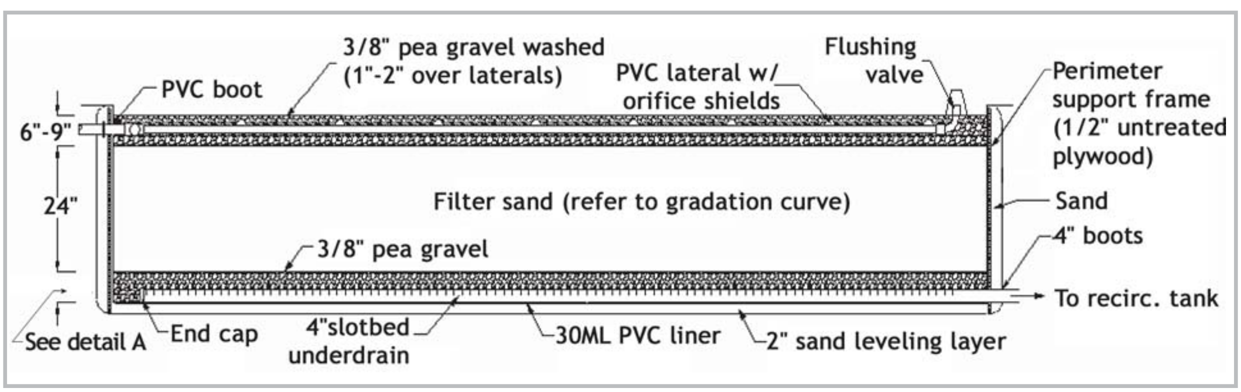


Figure 7-12. Schematic of a recirculating sand/gravel filter. (Source: RIDEM Sand Filter Guidance Document)

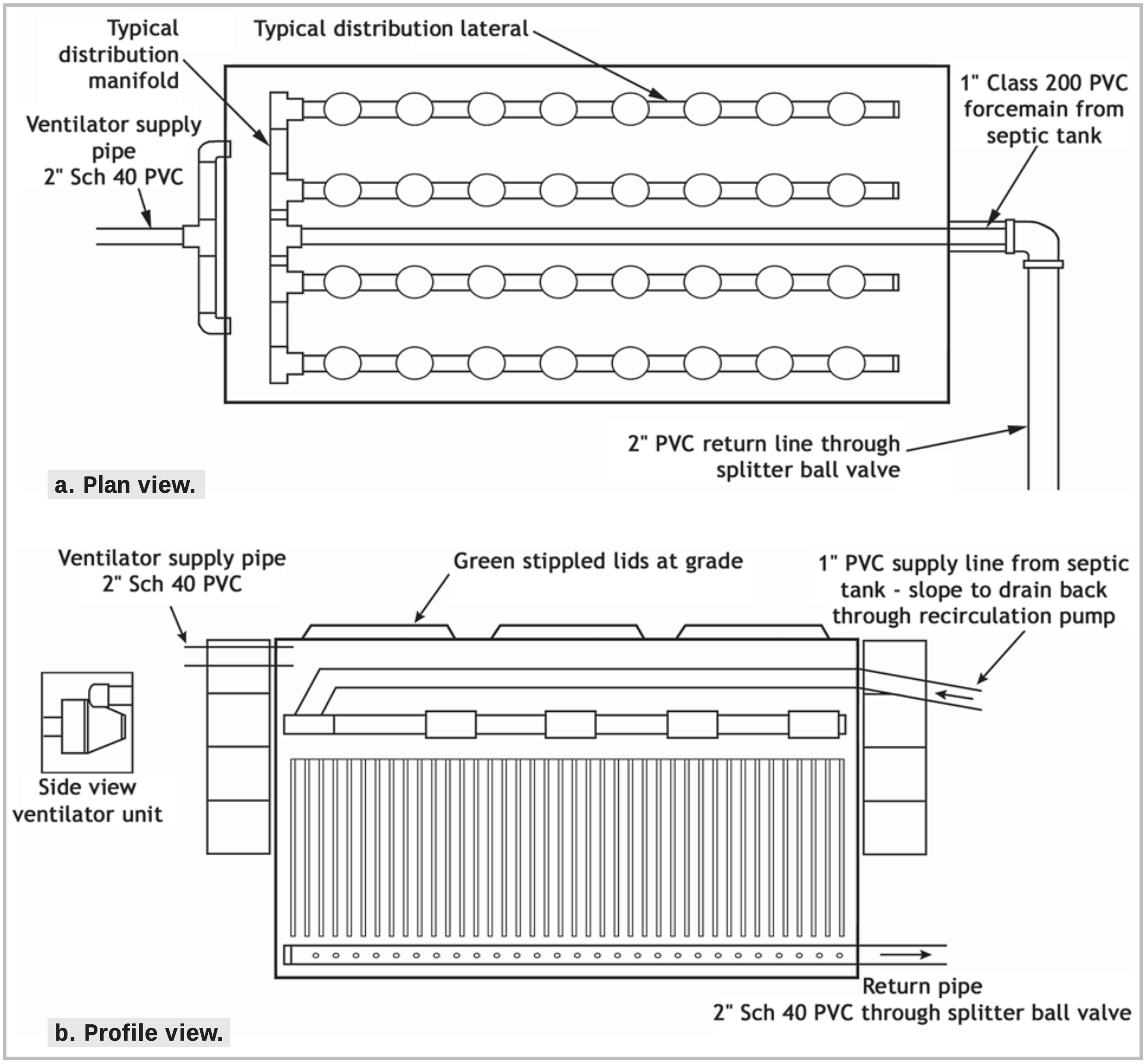


Figure 7-13. Recirculating textile filter.

can be cleaned by either pressure jetting the lines or snaking with a bottle brush, attached to a plumbers snake.

- If an excessive amount of solids is on the media surface, check recirculation ratio. The most likely reason for too many solids is too much recirculation (check dissolved oxygen level in processing tank to verify).
- *Cleaning the textile filter:* The media can be cleaned by hosing or lightly pressure washing the media and removing the recirculating device. This allows the solids to drain back into the processing tank. If the media filter contains hanging sheets of textile fabric, the service provider should be careful not to tear the sheets while pressure washing. (NOTE: It is not recommended to clean the textile media too often, as a light build up of organic material is normal and beneficial.)
- *Inspect venting/air intake devices:* Identify whether the type of air intake device is passive or active. If passive, vegetation should be removed from around the

vent as lack of oxygen flow can impede nitrogen removal. If an active air intake is used, make sure the blower unit is pressurizing the textile filter. In both situations, clean the intake screen as needed.

- Tightly secure the filter lid after service to ensure that a tight seal is made between the lid and gasket to prevent odors from escaping the textile filter.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Recirculating foam filter

Foam filters use 2- to 3-inch cubes of open-cell polyurethane foam material that is randomly arranged in prefabricated modular units, typically in wire baskets within a container. The effluent is distributed evenly over the media by helical-type spray nozzles.

Specific maintenance tasks for recirculating foam filters

- Check for soil settling, erosion, depressions, or possibility of surface water collection around filter unit.
- Check for damage to the filter cover/lid.
- Check for settling of media within the filter.

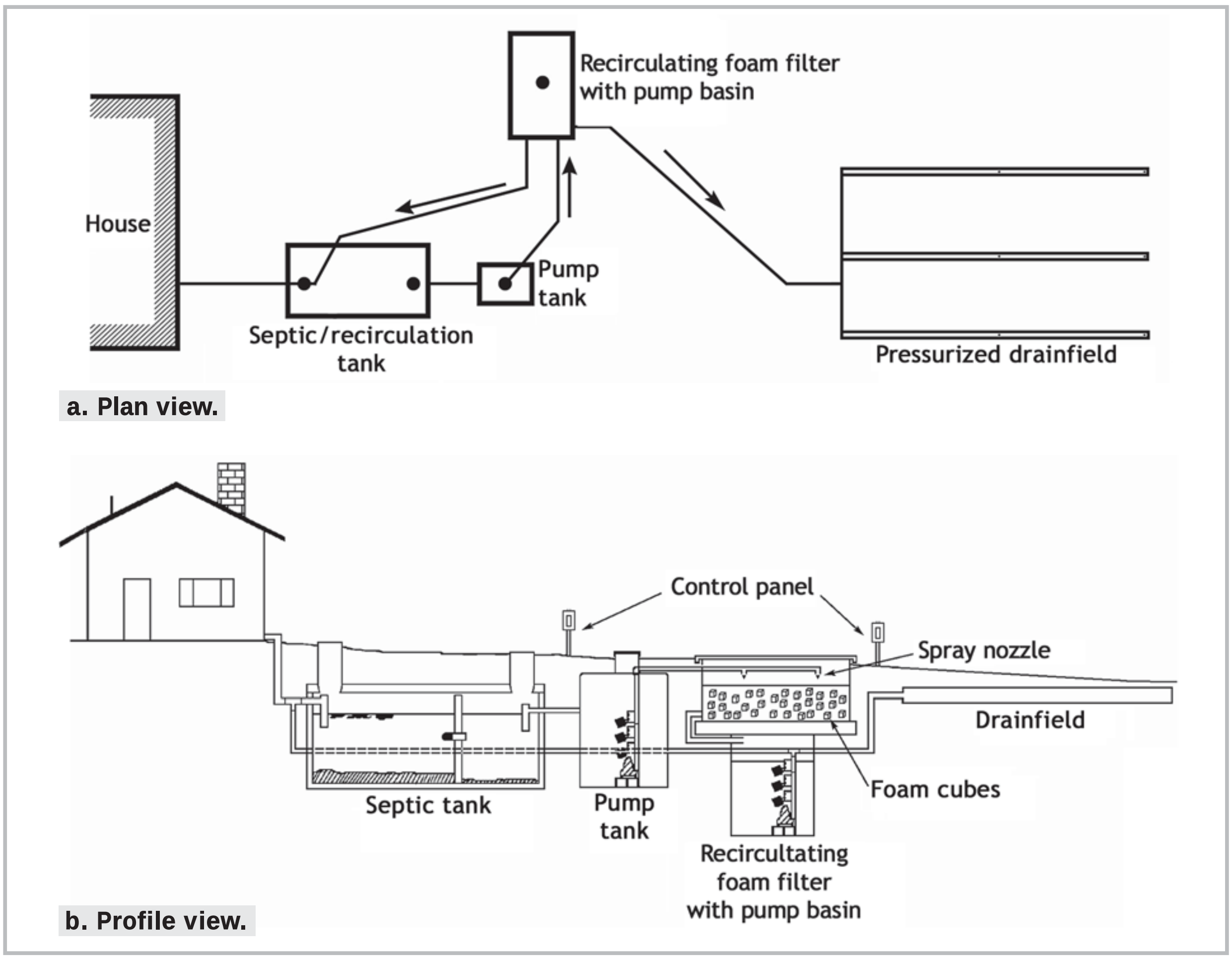


Figure 7-14. Recirculating foam filter.

- Inspect filter for odors and surface ponding.
- Inspect overall condition of the media.
- Check clarity, odor, and transparency of treated effluent.
- Check with manufacturer concerning acceptable effluent ponding levels at base of foam filter. Some technologies use this zone as a sump area for a pump that doses the drainfield as well as to the inlet of the septic tank for recirculation.
- Inspect for biomat buildup on media.
- Remove and clean spray nozzles annually (or as needed), reinstall and check for equal spray distribution.
- Flush laterals while nozzles are removed.
- Verify proper operation of all alarms.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Trickling filter

Trickling filters provide aerobic treatment of wastewater. Wastewater is generally pumped from a recirculation tank or compartment, dispersed over a media bed, and allowed to drain back into the tank. The wastewater is aerated as it flows through the media bed, which may consist of a variety of media such as tire chips, gravel/stone, and rigid plastics configured into a number of shapes (e.g., honeycomb blocks, rings, or cylinders). A trickling filter uses filtration, adsorption, and assimilation for removal of contaminants from wastewater. Wastewater should flow in a thin film over the media to allow time for treatment.

The media serves as a substrate where a biological film grows and is fed by the nutrients contained in the wastewater. As the biological film establishes and continues to grow, it will eventually exceed its own ability to cling to the media surface. The biological film material breaks off and washes down through the media bed, and either returns to the recirculation tank or settles out in a clarifier compartment. The clarifier typically contains a solids return pump dedicated to moving accumulated settled biological materials back to the head works of the septic tank for decomposition.

Final effluent moves by gravity out of the trickling filter sump through a standard sanitary tee assembly.

Specific maintenance tasks for trickling filters

In the clarification compartment:

- Visually check (using a sludge measuring device) that the solids blanket (composed of accumulating solids that wash off media) is below the inlet of the pump that recirculates effluent to the top of the media. If not, then adjust float accordingly.

In the sludge return compartment or zone:

- Visually check that the solids blanket level is slightly above the level of the sludge return pump inlet.
- Adjust the solids return pump rate as needed if a thick solids blanket is accumulating. Record these changes. (See Chapter 6 for more pump O&M).

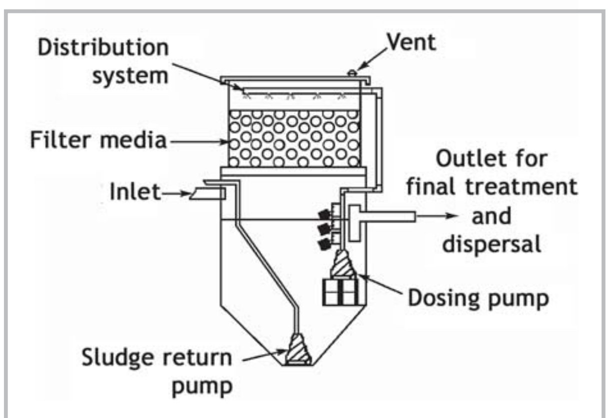


Figure 7-15. Trickling filter schematic (profile view).

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Upflow media filters

An anaerobic upflow media filter is characterized by a long detention time and production of anaerobic effluent. It uses physical removal mechanisms that include flocculation, sedimentation, and absorption. Anaerobic digestion may also occur in the bed. These filters are generally filled with sand, gravel, or wood chip media, but other non-degradable media types can also be used.

Following a septic tank, upflow media filters can remove additional TSS, BOD_5, and nitrate nitrogen. They are generally not used for pathogen removal. For increased nitrogen removal, aerobic treatment processes can be used in conjunction with an upflow media filter.

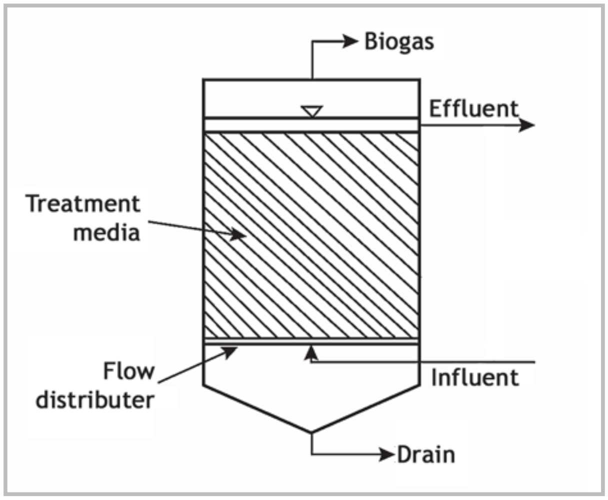


Figure 7-16. Schematic of the upflow anaerobic filter process (profile view).

Specific maintenance tasks for upflow media filters

- Check for soil settling, damage, erosion, depressions, or possibility of surface water collection around or running into the upflow media filter.
- Inspect filter cover/lid for structural damage.
- Check treated filter effluent for clarity, transparency, and odor. Check for film in the effluent.
- Periodically flush the accumulated solids in the media. Draining the media and allowing it to air dry will also unclog the pores in the system.
- Pump sludge accumulation as necessary.
- Inspect the inlet and outlet of the system for plugging. Clean and flush as necessary.
- Check the bypass device for proper functioning.
- Check for proper functioning of the system alarms.
- Evaluate the odor control system.
- Visit the site three or four times a year for inspection.
- Tightly secure lid after service to ensure that a seal is made between the lid and gasket to prevent odors from escaping the upflow media filter.

(Note: It is important to seek information and training on each specific technology as manufacturer's O&M guidelines will vary. It is recommended that service providers also seek manufacturer training for each product they operate.)

Operation and maintenance for all media filters

Media filter maintenance requirements depend on the type of filter. The best care for a media filter is accomplished by following the recommendations of the unit's manufacturer. However, the following general guidelines may be used as a basis for maintenance of the system (**Form 7-1 Media filters** (MF).):

1. Check what kind of system is in place and note the type of media in the filter. Determine the type of distribution

method on the system: pressure or gravity distribution.

2. There should be no strong odors near the filter if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids and risers. Also check the roof vent location, prevailing winds, and atmospheric pressure as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

3. Determine the type of cover on the media filter. The filter can be either buried, free access, or have a lid. The cover on a buried media filter should promote surface water runoff. The material should also allow oxygen transfer to the media surface. Trees and shrubs should not be allowed to grow over a buried filter. The lids on media filters should open and close freely and be secured. Free access filters generally have access through the cover material (usually pea gravel). The distribution component should be accessible. There should be no surface water infiltration into the components. No vegetation should be allowed to grow in free access filters.

4. Air supply/entry can be through the cover material or a specific vent or screen. Determine whether the air intake device is passive or active. If passive, vegetation should be removed from around the vent as lack of oxygen flow can impede nitrogen reduction. If an active air intake is used, make sure the fan unit is blowing into the textile filter. In both situations, clean any intake screens as needed.

   Evaluate the type of air supply system used to provide air to the unit. The air supply system may be operated in a continuous or timed mode. The time on and time off should be recorded for future reference. The air supply system must have an electrical supply and be running. The pressure should be measured and recorded using a pressure or vacuum gauge. The air flow can also be measured using an air flow gauge and then recorded. Make sure the air intake is free of obstructions. Clean blocked vents and access ports as needed.

5. The media surface in the filter accepts wastewater and is the starting point for the wastewater treatment process. Vents and inspection ports to the media filter surface or underdrain system allow determination of the level of ponding. Ponding can indicate clogging of the media filter surface. Clogging in the media filter may occur due to physical and biological factors. Physical clogging is caused by the accumulation of solid material within or on the media surface. Biological clogging is due to excessive microbial growth within the filter. An accumulation of biological slime and a decrease in the rate of decomposition of entrapped wastewater contaminants within the filter accelerates filter clogging. The media filter can be allowed to rest to dry and break down the biological materials growing in the filter. Some free access media filters can be raked to break the inhibiting crust that has developed on top of the media filter due to the accumulation of fine materials. This will allow effluent to infiltrate into the media.

   Where applicable, the surface layer of media can be removed from the filter when it is clogged with fine particles. Media can be replaced if the bed cannot be regenerated. Likewise, if repeated removals of the media surface layers have occurred, then partial replacement will be needed.

If the filter bed has an exposed surface, damage from any animal activities should be prevented.

6. Effluent is collected from the outlet of the media filter and evaluated for effluent quality. Clarity, turbidity, dissolved oxygen, pH, presence of oily surface film, color, odor, and temperature can provide guidance on the current status of the system.

7. Measure the distal head in inches (also known as squirt height) before and after cleaning. The distal head in the lateral line determines the flow rate of water leaving the orifices. Checking the distal head at the end of the lateral can be used to estimate how evenly the water is being distributed. If required, reset the lateral distal head pressure to the original value by adjusting the pressure-regulating valve located on the beginning of the lateral.

8. Gravity distribution systems may also be in use. Note the gravity distribution device used. If applicable, check for uniform distribution of effluent and proper operation of the distribution device.

9. The filter drainage sump should be checked for ponding or solids buildup. Some systems may have gravity drainage to the final treatment and dispersal component—make sure these systems are operable. Underdrain vents should be present and operable.

10. Recirculating filters usually have a recirculation tank for collecting effluent from the media filter and returning it to the filter. Some systems may return the partially treated effluent to the septic/recirculation tank. If this is the case, inspect the tank with the same procedures as for a septic tank. The dissolved oxygen concentration gives an indication of the recirculation rate and oxygen transfer. The recirculation device should be checked and cleaned. The recirculation rate can be estimated and changed if a different aeration rate is needed. The actual recirculation ratio can be calculated at the site by dividing the actual pump recirculation by the actual pump discharge. (NOTE: If recirculation is achieved by way of a dam/divider at the filter base, this O&M step is not applicable.)

    The recirculation tank should be pumped when less than 70 percent of the tank is operable or when there is a substantial increase in sludge accumulation. The sludge accumulation pattern will vary based on pump location and type.

11. Trickling filters have a clarification chamber and a sludge return process. The clarification chamber collects solids that have fallen off the media surface. The settled solids blanket needs to be below the intake of the recirculation pump. If the pump has a screened inlet or an effluent screen in a pump vault, these screens need to be cleaned.

    A sludge return pump is used to transfer settled solids back to the pretreatment component. The quantity of effluent returned to the pretreatment tank can be adjusted by changing the sludge return pump time on the system programmable timer. In some systems, the sludge return pump may be manually controlled and operated.

12. Manufacturers of specific units may recommend additional maintenance for their product. These activities should be performed, and the completion of these activities should be documented in the comments section.

13. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, transport, and store samples using standard wastewater sampling procedures. Record the chain of custody (COC) information and deliver the sample to an authorized laboratory. Retain a signed COC from the testing laboratory to complete the system file. Report the sampling analysis results to the proper entities.

Form 7-1. Operational checklist: Media filter (MF).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ____________________ Employee: ____________________
Date of last service: ____________________________ By: ❑ You ❑ Other:______________
Date of last inspection: __________________________

1. Type of media filter:

Single pass:	❑ Sand	❑ Foam	❑ Peat	❑ Other: ______________
Recirculating:	❑ Sand/gravel	❑ Foam	❑ Textile	❑ Other: ______________
Trickling filter:	❑ Gravel	❑ Plastic	❑ Textile	❑ Other: ______________
Upflow filter:	❑ Gravel	❑ Plastic	❑ Wood chips	❑ Other: ______________

   a. Manufacturer: ______________________ Model #: ______________________
   b. Distribution method: ❑ Pressure distribution ❑ Gravity distribution

2. Conditions at media filter
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ____________________________
3. Cover
   a. Type of cover: ❑ Free access ❑ Buried ❑ Lid
   b. Filter cover intact. Yes____No_____
   c. Method of securing cover: ______________
   d. Distribution component accessible. Yes____No_____
   e. Surface water/infiltration into components. Yes____No_____
4. Venting/Air supply: ❑ Passive ❑ Active ❑ Not present
   a. Supply: ❑ Aspirator ❑ Compressor ❑ Blower ❑ Free air (go to 4.g)
   b. Operation: ❑ Continuous ❑ Timed (On_____min, Off ______ min)
   c. Air supply unit operating properly. Yes____No_____
   d. Pressure at air supply unit: ____________psi
   e. Air flow at air supply unit: ____________cfm
   f. Air filter/screen: ❑ Cleaned ❑ Replaced
   g. Venting appears operable. Yes ____No____
5. Media surface
   a. Biomat on surface. Yes____No_____
   b. Uniform gravity distribution. N.A._____Yes____No_____
   c. Uniform spray pattern. N.A._____Yes____No_____
   d. Ponding in/on media. Yes____No_____
   e. Plugging/clogging of distribution components. Yes____No_____
   f. Media appears to be settling. Yes____No_____
   g. Appropriate maintenance performed. Yes____No_____
   h. Pest activity at surface. Yes____No_____
6. Effluent quality
   a. Turbidity: ___________NTU
   b. Oily film on the surface of effluent. Yes____No_____
   c. DO at outlet: __________mg/L
   d. pH at outlet: ______________
   e. Temperature at outlet: ______________
   f. Bypass or overflow noticed. Yes____No_____
   g. Effluent odor after passing through media filter:
      ❑ None ❑ Mild ❑ Strong
   h. Effluent color after passing through media filter:
      ❑ Clear ❑ Brown ❑ Black

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable

Form 7-1 (continued). **Operational checklist: Media filter (MF)**

Reference #:______________________

7. Pressure distribution: N.A__________
   a. Distal head before cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): ____________in
   b. Lateral condition
      i) Laterals in need of cleaning. Yes____No_____
      ii) Laterals cleaned. Yes____No_____
      iii) Method for cleaning laterals:______________________
   c. Distal head after cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): ____________in
8. Gravity distribution: N.A__________
   a. Device: ____________
   b. Uniform distrubtion. Yes____No_____
   c. Operating properly. Yes____No_____
9. Filter drainage systems
   a. Ponding in media filter sump. Yes No
   b. Effluent level below filter media. Yes____No_____
   c. Gravity drainage operational. N.A._____Yes____No_____
   d. Solids buildup in sump area. N.A._____Yes____No_____
   e. Underdrain vents present. Yes____No_____
   f. Underdrain vents appear operable. Yes____No_____
10. Additional tasks for recirculating filters
   a. DO in recirculation tank: __________mg/L
   b. Inspected recirculating device. N.A._____Yes____No_____
   c. Cleaned recirculating device. N.A._____Yes____No_____
   d. Design recirculation ratio: ________:_______
   e. Actual recirculation ratio: ________:_______
   f. Recirculation changed to: ________:_______
   *If dam configuration, recirculation device cannot be inspected or cleaned
11. Additional tasks for trickling filters
   11.1 Clarification chamber
   a. Solids blanket below recirculation pump inlet. Yes____No_____*
   *If no, was system pumped out. Yes____No_____
   b. If screened inlet, was screen cleaned. Yes____No_____
   11.2 Sludge return
   a. Solids blanket slightly above return pump. Yes____No_____
   b. Changed solids return rate. Yes____No_____
      i) Pump: ❑ Off ❑ On
      ii) Changed from ____ min to ____min
12. Manufacturer's required maintenance performed. Yes____No_____
   (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
13. Lab samples collected for monitoring. Yes____No_____
   Types of analysis:______________________________________
   ____
   ____

7. ❑ Acceptable ❑ Unacceptable
8. ❑ Acceptable ❑ Unacceptable
9. ❑ Acceptable ❑ Unacceptable
10. ❑ Acceptable ❑ Unacceptable
11.1. ❑ Acceptable ❑ Unacceptable
11.2. ❑ Acceptable ❑ Unacceptable

Aerobic treatment units

Overview

An aerobic treatment unit (ATU) may include a trash tank, aeration chamber, air supply system, clarifier, and sludge return mechanism. The unit uses biological processes to transform both dissolved and solid constituents into gases, cell mass, and non-degradable material. An important feature of the biological process is the synthesis and separation of microbial cells from the treated effluent. 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 also involves the nitrification of ammonium (NH_4^+) in the waste and the reduction of pathogenic organisms. Nitrification is the breakdown of ammonium (NH_4^+) to nitrate (NO_3^-) by microorganisms in aerobic conditions.

Treatment

Treatment systems consist of several processes that function together to provide a high quality effluent. These are gross solids (trash) removal, aeration, clarification, and sludge return. These processes are generally contained within separate chambers of a single tank. A series of tanks can be configured to have wastewater pass through an aerobic treatment train (Figure 7-17).

Wastewater exiting the home may enter a trash tank that primarily serves to remove materials that cannot be decomposed with a biological culture. Trash tanks provide some level of anaerobic treatment depending upon tank size and configuration. Some treatment trains do not incorporate a separate trash tank. In this case, the materials are all collected in the aeration chamber.

Wastewater then enters a mixed culture (mixed liquor) aeration chamber where aerobic organisms live with oxygen supplied by an air supply system. The aeration chamber may contain suspended-growth and/or attached-growth microorganisms. In a suspended-growth system, the microbes float freely in the wastewater (Figure 7-18). In an attached-growth system, the aeration chamber contains media (generally plastic) to which the organisms attach themselves. Wastewater circulates through this media to carry the wastewater constituents to the microbial biomass (Figure 7-19). The rate of biomass accumulation in suspended-growth and on

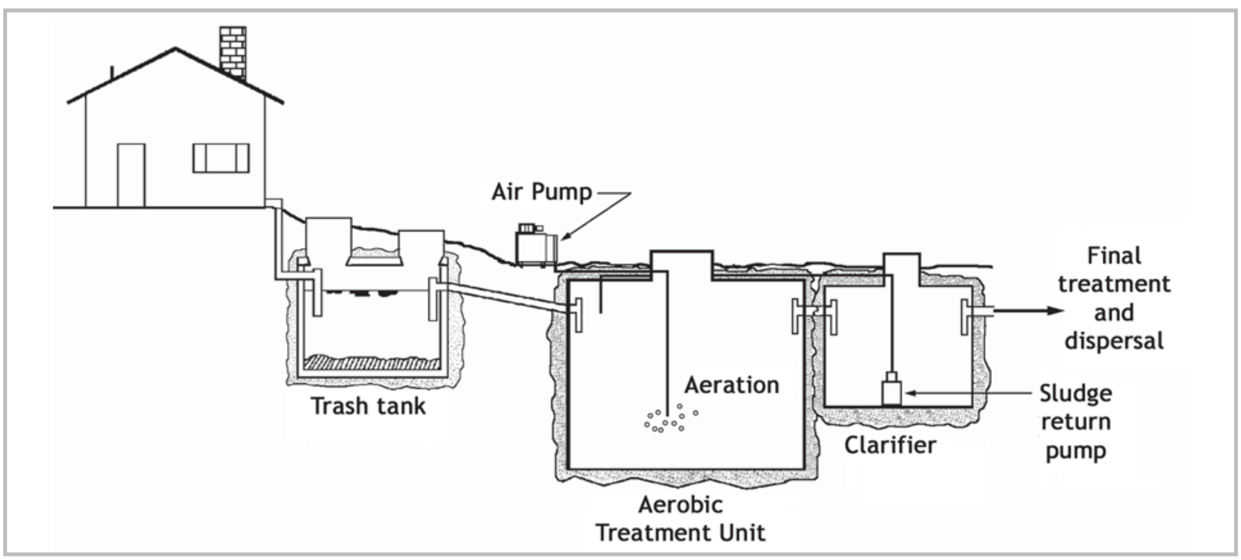


Figure 7-17. General schematic of an aerobic treatment unit train (profile view).

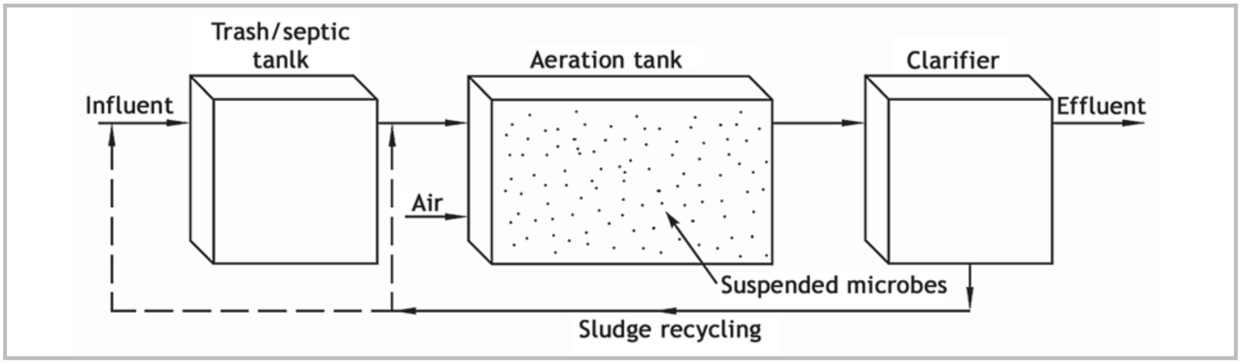


Figure 7-18. Generic treatment train using a suspended-growth treatment process. (Source: EPA, 2002)

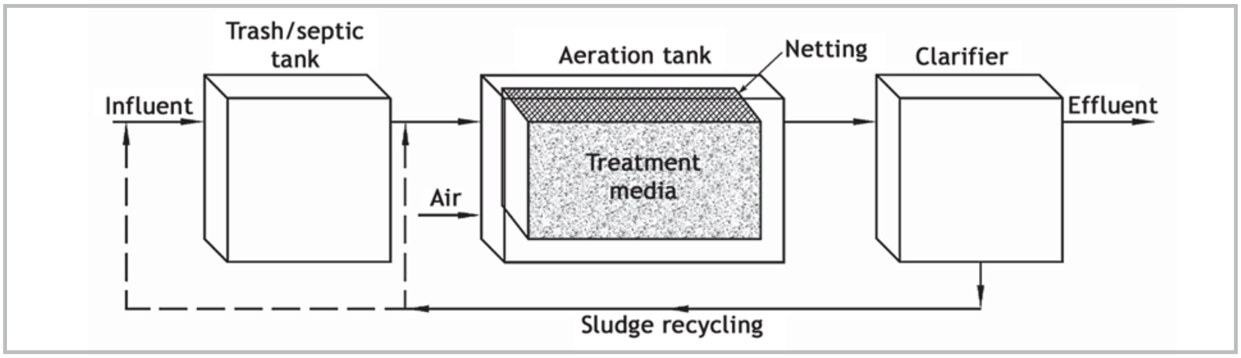


Figure 7-19. Generic treatment train using an attached-growth treatment process. (Source: EPA, 2002)

the media in attached-growth systems depends on the organic loading but is usually stable because the wastewater source is somewhat stable.

Some submerged-growth aerobic treatment processes incorporate both suspended-growth and attached-growth processes. Their treatment components will have suspended-growth microbes in the aeration chamber but will also have submerged media to facilitate attached-growth microbes.

These aerobic treatment processes are characterized as an extended aeration treatment process. The microbes grow in a submerged condition in the presence of excess oxygen and a limited food supply. The aeration unit holds the wastewater for a relatively long detention time to allow conversion of the waste constituents by the microbes. Because of the limited food supply and excess oxygen, the microbial cells begin to consume their own cell tissue to obtain energy for cell maintenance. This consuming of their cell tissue is described as endogenous respiration. The biomass accumulation in the ATU is minimized through endogenous respiration.

In both suspended-growth and attached-growth regimes, oxygen is introduced to the aeration chamber through the use of aerators, compressors, or blowers. Aerators develop a vacuum that draws air into the effluent. Air must move freely through the aspirator. Compressors used in aerobic treatment units typically deliver a relatively lower volume of air at a greater pressure. Both rotary and linear compressors are used for onsite wastewater treatment systems. Blowers generally deliver a greater volume of air at a lower pressure. Because each of these air supply components uses a different mechanism to convey air into the effluent, they are generally not interchangeable. Compressors and blowers generally convey air from the air supply to the aeration chamber through a pipe. Orifices or diffusers with various sizes of openings distribute air into the wastewater. The air conveyed into the system must also exit; thus, a venting mechanism is required for proper air flow through the aeration chamber.

Wastewater exiting the aeration chamber enters the clarifier. Calm conditions in the clarifier allow biomass suspended in the wastewater to settle. Turbulence or excessive effluent velocities will carry solids through the clarifier. Clarifiers can be oriented vertically or horizontally. In vertical clarifiers, the flow enters through the bottom of the chamber (Figure 7-20). To prevent solids from moving out of the clarifier, the rate of upward flow of wastewater must be lower than the settling rate of the solids. This particular diagram has a central point for collection and discharge of the clarified effluent. The clarifier cone pictured in Figure 7-20 would be placed into a tank with an aeration chamber on the outside. Other clarifier configurations have a vertical clarifier in a separate compartment with a single sloping wall. Effluent is collected from a discharge point near the top of the clarifier. Another approach for vertical clarification is to have the clarifier on the outside wall of a round tank. The discharge weir can be a circumferential weir extending around the outside of the tank and be a complete 360 degrees.

In horizontal clarifiers, wastewater flows from the inlet to the outlet at a uniform elevation (Figure 7-21). The horizontal velocity through the chamber must allow time for the solids to settle below the elevation of the outlet before the effluent passes through the tank.

Solids settling within the clarifier should be returned to a previous component. Most vertical settling chambers have a passive sludge return process (Figure 7-20). Solids pass through the bottom of the clarifier and return to the aeration chamber. Horizontal clarifiers generally have a separate tank where solids accumulate and require an active sludge return process (Figure 7-21).

Another approach to clarification of effluent is active filtration. Some aerobic treatment unit products incorporate filtration media to filter biomass from the effluent before it is discharged. These approaches utilize filtration of the effluent through a porous material or facilitate settling in a plate settling process.

Sequencing batch reactor

A sequencing batch reactor is a specific type of aerobic treatment unit that uses a single treatment tank to perform both aeration and clarification (Figure 7-22). The cycle begins as wastewater enters the tank. The full tank is aerated for biological treatment. After aeration, the mixing system is stopped, and the solids are allowed to settle. Clarified effluent is decanted from the clear zone in the tank. The cycle is

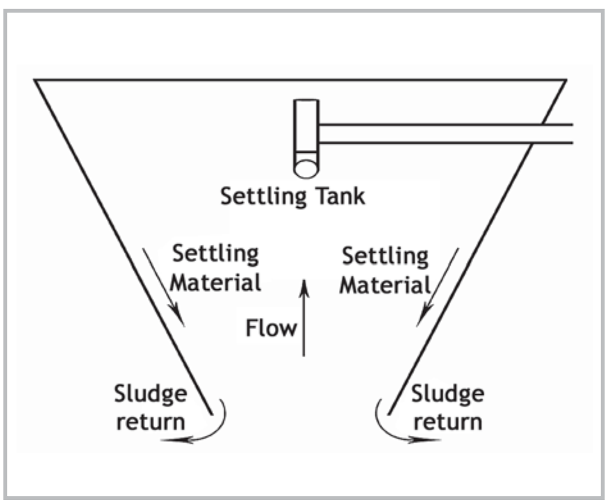


Figure 7-20. Vertical clarifier with a passive sludge return process (profile view).

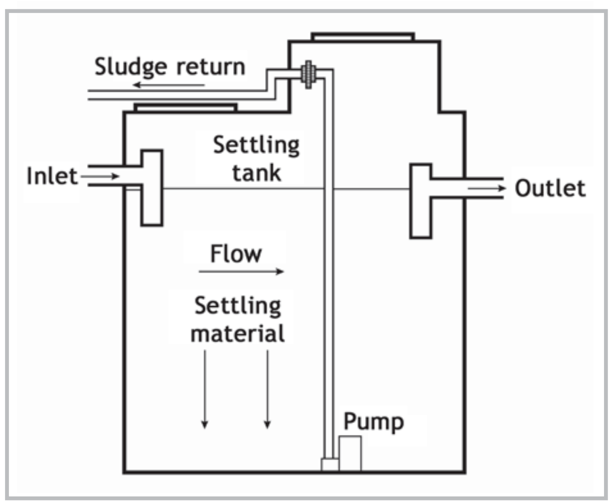


Figure 7-21. Horizontal clarifier with an active sludge return process (profile view).

completed when the system moves into an idle period for development of anoxic conditions to facilitate nitrogen removal.

Rotating biological contactor

A rotating biological contactor is an aerobic treatment unit that uses an attached-growth media that passes through an open air space (Figure 7-23). Media disks are attached to a central rotating shaft generally located above the wastewater. A motor provides energy to slowly rotate the shaft. The media-covered disks pass sequentially through the wastewater and air as they rotate. Exposing the media to the air transfers oxygen to the biomass in the system. Build up of biological material on the disks will occasionally slough off and settle at the bottom of the tank. There should be a sludge return process for the accumulation of sludge at the bottom of the tank.

Operation and maintenance

The best care for an aerobic treatment unit is accomplished by following the recommendations of the unit's manufacturer. However, the following general guidelines may be used as a basis for maintenance of the system (**Form 7-2 Aerobic treatment units** (ATU).):

1. Specify the type of aerobic treatment unit, and note the manufacturer and model number.

2. Aerobic microbial treatment processes may have a mild, musty, aerobic smell. However, the odor should not be a strong anaerobic odor. If odors are detected, determine the source by checking for damaged lids and risers. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

   Further evaluation will be required to determine the actual cause of the odor. (Some detergents used at the source may cause some odors). Foaming can be a valuable component of the wastewater treatment process; however, excessive foaming may be caused by excessive soap or constituents in the wastewater.

3. Make note of where the access is located on the ATU. If access is farther than 6 to 7 feet from any tank wall, it may

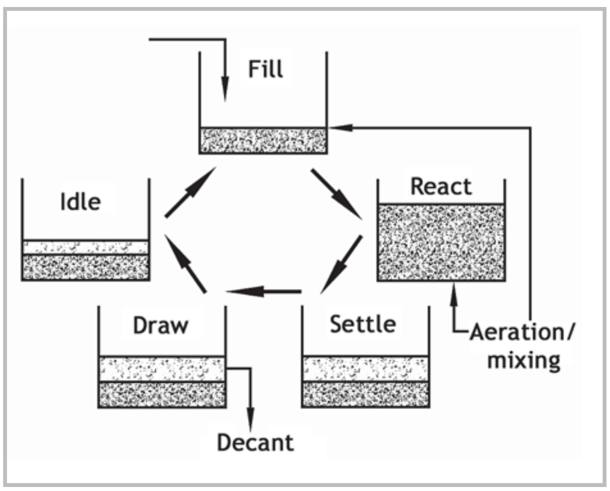


Figure 7-22 Sequence of processes occurring in a sequencing batch reactor. (Source: EPA, 2002)

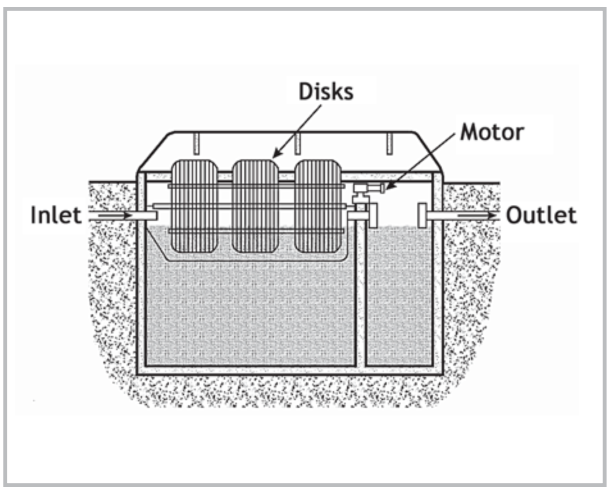


Figure 7-23. Diagram of a generic rotating biological contactor (profile view).

limit maintenance in those areas, especially during pumpout services.

ATU access must be adequate for inspecting contents and servicing the tank. If there is a riser on the tank, it should be in good condition and properly sealed to prevent infiltration. Check the riser/tank seam for stains that would indicate infiltration of groundwater or surface water. Ideally, the riser should come to grade so that no digging is required to reach it. Some jurisdictions may not require access to grade, so some digging may be required. If it is buried, note how much cover is on the tank.

The lid on the tank or riser should be securely fastened with safety screws (screws that require a non-standard tool) or other means. The lids must be readily removable by the service provider but child-proof. The lids must be operable as designed, and there may be no obstacle placed near or on top that makes them inoperable. The lids must not be so heavy as to make them inoperable. If the tank was uncovered by the owner, note that on the checklist.

4. Evaluate the type of air supply system used to provide air to the unit. The air supply system may be operated in a continuous or timed mode. The time on and time off should be recorded for future reference. The air supply system must have an electrical supply and be running. The pressure should be measured and recorded using a pressure or vacuum gauge. The air flow can also be measured using an air flow gauge and then recorded. Make sure the air intake is free of obstructions. Clean blocked vents and access ports as needed.

5. The aeration chamber must be evaluated to verify proper mixing of the wastewater. Presence of an obvious rollover of the contents in the tank verifies that mixing is occurring. Mixing puts the wastewater constituents in contact with the microbes.

   Test the dissolved oxygen (DO) level in the aeration chamber. DO concentration is critical to support the aerobic environment for the microbes. The dissolved oxygen concentration should be maintained at 2.0 mg/L or above.

   Optimum pH is neutral, but can range from 6.5 to 7.5. Temperature in the unit can vary. However, a moderate temperature is best. Too low or high of a temperature will not be conducive to microbial growth.

   A measurement of settleability is taken to evaluate the density of mixed liquor in suspended-growth aeration chambers. The settled solids should measure between 20 to 60 percent after a period of 30 minutes.

   Biomass color should also be noted. A good aerobic biomass will have a brown color. A black color will tend to indicate an anaerobic condition or dead microbes.

   Sludge pumping can be recommended for systems with a settleability rate greater than 60 percent. Some suspended-growth units may need pumping before this density of biomass is reached. Note whether the unit should have sludge pumped. Removing solids from the aeration chamber, pretreatment tank, and pump tank should be performed at the time of pumping any of the other compartments, such as the septic and trash tank.

6. Aerobic treatment units using attached-growth media require a few additional evaluations. The media may become plugged with biomass. The media should be evaluated for proper mixing or effluent flow through the media. Media may float as the biomass accumulates, and some attached growth systems employ restraining methods to keep the media submerged. If the media is floating, it may need cleaning or restraining to keep it submerged. Media with excessive biomass can be washed using air or water. Note whether this is done and which method was used. In some systems, the media may need to be replaced.

7. The clarification chamber removes solids from the effluent. If a scum layer is present on the clarifier, record the thickness of the layer. This floating material may be removed by pumping, skimming, or mixing to facilitate settling. There should be a clear zone below the outlet to prevent solids bypass during flow events. An effluent screen or tertiary filter may be placed in the outlet of the clarifier. These may need to be cleaned to remove biomass. The turbidity, dissolved oxygen, pH, and temperature should be recorded to evaluate treatment performance. Note the relative odor and the color of the effluent passing through the unit.

8. The sludge return may operate in a passive or active mode. The passive mode can be evaluated visually. Operate the pump manually to evaluate performance in the active mode.

9. If a control panel is used, it should be watertight with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm test switch. The presence of a control (HAND-OFF-AUTO) switch allows the service provider to check pump function without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions it should be in the AUTO position. If the panel has a cycle counter, and/or an hour meter (elapsed time meter), record the present and last readings. If there are no meters, they are strongly recommended as an upgrade to facilitate O&M activities.

10. Alarms may be used in aerobic treatment unit systems to monitor the effluent level in the unit and air delivery to the aeration chamber. Presence of these alarms should be noted, and their operation should be checked.

    Some units may include an event counter to record the number of alarm events. The present reading can be compared to previous readings to determine the number of alarm events. If elapsed time meters (ETM) are present, record the readings and calculate the total run time.

    Some units may also have battery backups for alarms. If present, the operation of the alarm using the battery backup should be evaluated.

    If telemetry is used to monitor system components, check to make sure it is operating properly.

11. Manufacturers of specific units may recommend additional maintenance for their product. These activities should be

performed, and the completion of these activities should be documented in the comments section.

12. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain signed COC from laboratory to complete the system file. Report the information to the proper entities.

Form 7-2. Operational checklist: Aerobic treatment unit (ATU).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ___________________________ By: ❑ You ❑ Other:______________
Date of last inspection: _________________________

1. Type of ATU:
   ❑ Suspended-growth ❑ Attached-growth ❑ Sequencing batch reactor
   ❑ Combination attached/suspended-growth
   ❑ Rotating biological contactor ❑ Other:______________
   a. Manufacturer:________________ Model #: ______________
2. Conditions at the ATU
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Was foam/residue observed outside the unit. Yes____No_____
3. ATU access
   a. Located at grade. Yes____No_____
   b. If 'No', how deep is tank buried. ______________
   c. Risers on tank. Yes____No_____
   d. Evidence of infiltration in the risers. Yes____No_____
   e. Lids securely fastened. Yes____No_____
   f. Lids in operable condition. Yes____No_____
4. Venting/Air supply
   a. Air supply method:
      ❑ Aspirator ❑ Aerator ❑ Compressor ❑ Blower ❑ Free air (go to 4.g)
   b. Operation: ❑ Continuous ❑ Timed (On: _____min, Off:_____ min)
   c. Air supply unit operating properly. Yes____No_____
   d. Pressure at air supply unit: ____________psi
   e. Air flow at air supply unit: ____________cfm
   f. Air filter/screen: ❑ Cleaned ❑ Replaced
   g. Venting appears operable. Yes ____No____
5. Aeration chamber
   a. Mixing in aeration chamber. Yes____No_____
   b. DO in aeration chamber: ___________mg/L
   c. pH in aeration chamber: ______________
   d. Temperature in aeration chamber: ______________
   e. Settlability test:
      Settled ___%, Floating ___% in _________ min
   f. Biomass color in the aeration chamber:
      ❑ Brown ❑ Black
   g. Sludge pumping recommended. Yes____No_____
6. Additional tasks for attached-growth: media evaluation
   a. Plugging. Yes____No_____
   b. Floating. Yes____No_____
   c. Media washed. Yes____No_____
      If washed, indicate method used: ❑ Air ❑ Water
   d. Media replaced. Yes____No_____
7. Clarification chamber
   a. Scum layer. Yes____No_____
      If yes, thickness: _____________in
   b. Clear zone depth below outlet: _____________in
   c. Effluent screen/tertiary filter cleaned. N.A.___ Yes____No_____

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable

Form 7-2 (continued). **Operational checklist: Aerobic treatment unit (ATU)**

Reference #:____________________

d. DO in clarifier: ____________mg/L
e. pH in clarifier: ________________
f. Temperature in clarifier: ________________
g. Effluent odor after passing through unit:
❑ None ❑ Mild ❑ Strong
h. Effluent color after passing through unit:
❑ Clear ❑ Brown ❑ Black
i. Effluent turbidity: ____________NTU

8. Sludge return operating: ❑ Passive ❑ Active
a. If active, pump was checked manually. N.A.___ Yes_____No______
b. If active, pump operating properly. N.A.___ Yes_____No______

9. Control Panel: N.A.____________________
a. Controls operating properly. Yes_____No______
b. Is enclosure watertight. Yes_____No______
c. Alarm test switch operating properly. Yes_____No______
d. At time of inspection, control switch was set to: N.A. ____________
"Hand/Manual" __
"Auto"__________
e. If auto, setting: Time On:________ (min) Time Off:_________ (min)

10. Alarm(s): N.A.____________
a. Types: ❑ Air pressure ❑ High water ❑ Remote
b. Alarms operating. Yes_____No______
c. Alarm readings:

		Reading (present)	Reading (last)	Difference	N.A.
i.	ETM			hours	
ii.	Alarm Counter			Events (NC)	

Elapsed time in alarm status: _____(PTR) - _____(LTR) = ______Time (hours)
Number of alarm events: ______(PACR) - ______(LACR) = ______Events (number)
d. Battery backup charged. N.A.___Yes______No______
e. Telemetry operable. N.A.___ Yes_____No______

11. Manufacturer's required maintenance performed. Yes_____No______
(If 'Yes', attach Manufacturers Inspection form to this report, if supplied)

12. Lab samples collected for monitoring. Yes_____No______
Types of analysis:____
____
____

8. ❑ Acceptable
❑ Unacceptable

9. ❑ Acceptable
❑ Unacceptable

10. ❑ Acceptable
❑ Unacceptable

ETM: elapsed time meter
LACR: last alarm counter reading
LTR: last time reading
NC: number of cycles
PACR: present alarm counter reading
PTR: present time reading

Constructed wetlands

Overview

A constructed wetland is used to recreate the treatment processes that occur in natural wetlands. The constructed wetland is a basin or cell containing microorganisms, media, and plants that provide treatment of incoming effluent. These systems can be either free-water surface or subsurface-flow wetlands. In free-water surface wetlands, microorganisms attach to the aquatic plants. They operate with water levels above the media surface. In subsurface-flow wetlands, the cell is filled with graded gravel media or other porous material that is resistant to the corrosive and dissolving properties of wastewater (Figure 7-24).

These cells have an influent distribution device and an effluent collection device. The effluent to be treated flows through the bed contacting the media and attached organisms. It is important to maintain an even cross-sectional flow throughout the wetland to assure proper treatment. The wetland has the possibility of becoming plugged with debris and organic matter, which will prevent even cross-sectional flow.

The wetland cell is generally an earthen basin lined with compacted native clay, bentonite clay, concrete, PVC, hypalon, or ethylene propylene diene terpolymer (EPDM) rubber. The plants used in the wetland must be able to survive in a saturated medium. Both soft tissue and hard tissue plants can be used in the wetland. However, some experts believe that hard tissue plants are better because they may provide a pathway for oxygen to enter the wetland during the winter months.

Treatment

Septic tanks are used as the precedent treatment process to constructed wetlands. The tank should be sized appropriately to maximize the reduction of settling solids and should be serviced at regular intervals to maintain efficient solids removal.

Once the wastewater leaves the septic tank, it enters the wetland. The pathogens and nutrients entering the wetland are believed to be removed from the effluent by microbes living on the surfaces of the media and plant roots. Other processes such as filtration, nitrification, denitrification, and adsorption also help in removing

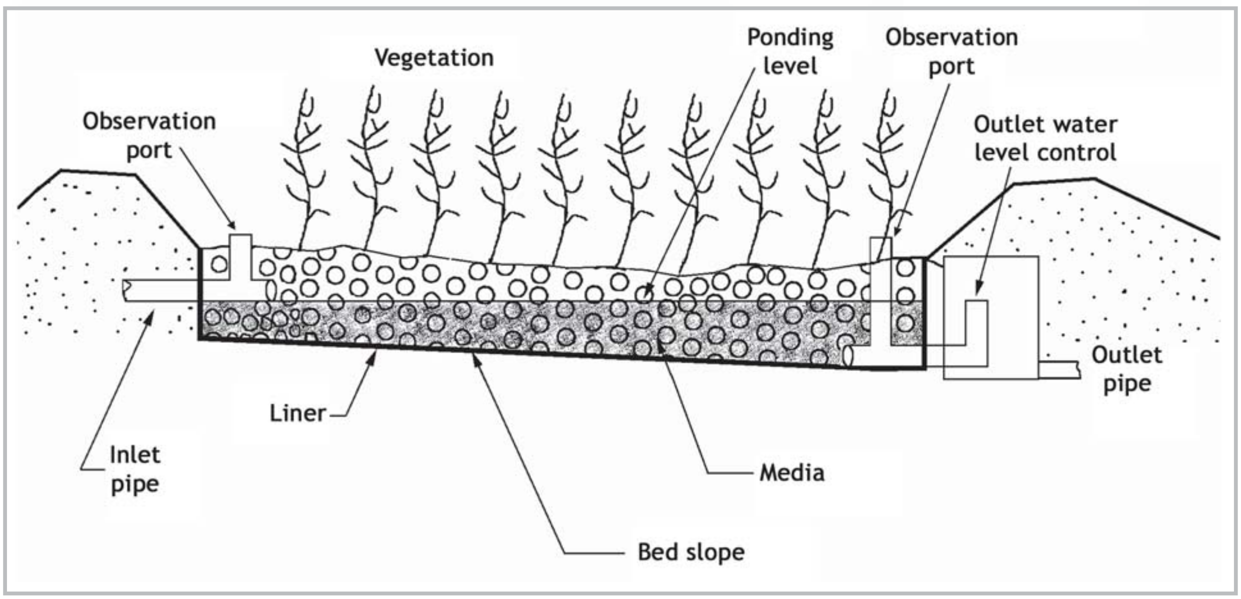


Figure 7-24. General schematic of a subsurface-flow constructed wetland (profile view).

the pathogens and nutrients. The plants provide oxygen to the bed and remove a small percentage of the nutrients. The longer the hydraulic retention time in the wetland, the better the quality of the effluent that exits the wetland. As the wastewater flows through the media, it exits the wetland through a water-level control sump. A water-level control device allows the water level to be raised or lowered as needed to prevent overflow and maintain enough effluent for plant growth. Wetlands may be gravity dosed or pressure dosed.

Operation and maintenance

The proper care of a subsurface-flow constructed wetland can be accomplished through the following tasks (**Form 7-3. Constructed wetland** (CW).):

1. Evaluate the wetland system one cell at a time, and use a new sheet for every cell. (Many wetland systems are in a series of multiple cells for increased wastewater treatment.) Note the type of media and the size of gravel, if used. Identify the flow regime as a surface, subsurface flow, or combination system. Note whether the wetland system is gravity or pressure dosed.

2. Evaluate the presence of odor when walking up to the system. Odor is an indication of service or repair being needed. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

   Maintain cover over the sides of synthetic liners (e.g., polyethylene, PVC hypalon, EPDM, neoprene, or butyl rubber) that extend above the substrate and water level. This will help prevent UV degradation of the liner.

   Repair any earthen berm erosion as soon as it is noted. Repair leaks around the berms/retaining walls as soon as noted by plugging, sealing, etc. Mow earthen berms or around retaining dikes to maintain an attractive site. Reroute surface drainage around or away from the wetlands.

   As with any onsite system, access should be limited. People should be prevented from accessing the treatment system. This could be accomplished by a combination of signage and adequate fencing.

   Prevent pets from digging in the wetlands, destroying vegetation, and moving substrate and mulch.

3. The front of the wetland is more susceptible to plugging due to solids carried over from the septic tank. If the header distribution area is plugged, this could be an indication of a problem in the septic tank. There may be an increase in the water level at the header, which may cause odors. The media at the front end of the wetland may need to be cleaned or replaced to prevent plugging.

   Check adjustable standpipe or hose in the water-level control structure to ensure that effluent is not leaking from joints. Repair as necessary.

   Maintain the water level in the bed during extended periods of no flow (e.g., long vacations). Without flow, wastewater in the cell may evaporate and be used by the plants in hot weather. During severe freezing conditions, effluent may freeze solid, damaging the roots and tubers. Plan to have water added to the system as needed.

4. Vegetation should remain healthy during the growing season. Check the vegetation for signs of disease or other stress (e.g., yellowing or browning, withering, or spots). Natural seasonal changes will occur with temperature and day length changes.

   If vegetation does not appear healthy and water levels are correctly maintained, add a balanced liquid fertilizer periodically (three times a growing season) to the wastewater by flushing down a toilet. “Normal” domestic sewage may not contain all the trace nutrients and elements required by vegetation growing in a gravel substrate.

   Replace dead plants as necessary, and fill voids with new plants. Divide and replant decorative flowering species (e.g., iris) to enhance the appearance of the system. Remove weeds, trees, and shrubs from the wetlands. These species will shade and crowd the desirable wetland plants.

   Prevent excessive shading of wetland vegetation by controlling growth of trees or high shrubs near the wetland cells. Most wetland plants need at least six hours of sunshine each day. Dispose of plants properly to avoid contact with effluent.

   Removal of healthy plants may be necessary for proper functioning of the system. If the plants are too dense, their roots will take up all the pore space. This will eliminate paths for the wastewater to flow and lead to hydraulic flow problems.

   If desired for visual aesthetics, remove mature wetland vegetation after the plants have browned in the fall. However, cut only about two-thirds of plant height. The removed material may be used to mulch the bed surface, but this may also cause clogging of the substrate.

   Do not apply herbicides or pesticides that can damage vegetation either on or near the system.

5. Effluent quality should be evaluated to determine system performance and document current status of the system. Clarity, dissolved oxygen, pH, and temperature should be noted, as well as the relative odor and color of the effluent leaving the cell.

6. Standing water on the substrate surface in a subsurface-flow wetland is the probable cause of any objectionable odor. Any low and high spots on the substrate surface that create small standing pools should be leveled by raking and/or filling with additional substrate. If the effluent level is too high and causes standing water on most of the substrate surface, lower the water level with the water-level control structure so that the effluent level is about 3 inches below the substrate surface.

   Adjust wastewater level using the pipe/tubing in the water-level control structure. For a swivel standpipe, gradually rotate it down to lower the level and up to raise the level. For a system with adjustable tubing length, lower or raise the top of the tubing. Note that wastewater levels will temporarily increase with flow surges.

To conveniently check the water level relative to the gravel surface, remove a small area of media or place an inspection port (4-inch diameter) in the gravel and observe the water level inside the pipe.

Surface ponding in the wetland cell that cannot be controlled by water level adjustment is probably caused by either excessive flows above the design basis, clogging of the substrate by excessive solids from the septic tank, or roots that have blocked the underdrain. Check the cleanout in front of the wetland. Solids accumulated in the pipe indicate plugging of the wetland by excessive solids from the septic tank. Plugged substrate may need to be replaced, beginning with the front where most of the plugging probably occurred.

If there are no solids in the cleanout, ponding is probably caused by excessive wastewater flow that exceeds the hydraulic capacity of the substrate. If possible, decrease flow through water conservation. A flow equalization tank can be used to control hydraulic surges. If ponding is not eliminated, additional septic tank and wetlands capacity may be needed for the increased flow.

7. Recirculating wetlands usually have a recirculation tank for collecting effluent from the constructed wetland and returning it back to the wetland. Some systems may return the partially treated effluent to the septic tank. If this is the case, inspect the septic tank with the same procedures as for a recirculation tank. The dissolved oxygen concentration gives an indication of the recirculation rate and oxygen transfer. The recirculation device should be checked and cleaned if it contains residuals. The recirculation rate can be estimated and changed if a different aeration rate is needed. The actual recirculation ratio can be calculated at the site by dividing the actual pump recirculation by the actual pump discharge. (NOTE: If recirculation is achieved by way of a dam/divider at the filter base, this O&M step is not applicable.)

   The recirculation tank should be pumped when less than 70 percent of the tank is operable or when there is a substantial increase in sludge accumulation. The sludge accumulation pattern will vary based on the pump location and type.

8. Inspection ports are the best method to evaluate the depth of the water. If they are not present, they should be recommended as an improvement.

9. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from laboratory to complete system file. Report information to the proper entities.

Form 7-3. Operational checklist: Constructed wetland (CW).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: ______________________ Employee: ______________________
Date of last service: ____________________________ By: ❑ You ❑ Other:______________
Date of last inspection: __________________________

1. Constructed wetland: Cell # : ________/ _________
   a. Media: ❑ None ❑ Gravel, average diameter: _____________in
      ❑ Other:________________________________
   b. Flow regime: ❑ Surface ❑ Subsurface ❑ Combination
   c. Distribution: ❑ Pressure ❑ Gravity
2. Conditions at the constructed wetland
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Type of border material: _______________
   d. Border material in good repair. Yes_____No_____
   e. Evidence of water/soil entering wetland. Yes_____No_____
   f. Fence present and operable. N.A.____Yes_____No_____
   g. Animal activity at wetland surface. Yes_____No_____
3. Water level management
   a. Header distribution plugged. Yes_____No_____
   b. Water level control option available. Yes_____No_____
   c. Water level adjustment needed. Yes_____No_____
4. Vegetation
   a. Is species appropriate. Yes_____No_____
   b. Is vegetation alive. Yes_____No_____
   c. Replanting needed. Yes_____No_____
   d. Vegetation removal required. Yes_____No_____
5. Effluent quality
   a. Turbidity: ____________NTU
   b. Oily film on the surface of effluent. Yes_____No_____
   c. DO in outlet: ____________mg/l
   d. pH in outlet: _______________
   e. Temperature in outlet: _______________
   f. Bypass or overflow noticed. Yes_____No_____
   g. Effluent odor after passing through wetland:
      ❑ None ❑ Mild ❑ Strong
   h. Effluent color after passing through wetland:
      ❑ Clear ❑ Brown ❑ Black
6. Additional tasks for subsurface flow wetlands
   a. Media surface level. Yes_____No_____
   b. Water level below media surface: _____________in
7. Additional tasks for recirculating wetlands
   a. DO in recirculation tank: ___________mg/l
   b. Inspected recirculating device. N.A.____Yes_____No_____
   c. Cleaned recirculating device. N.A.____Yes_____No_____
   d. Design recirculation ratio: ________:_______
   e. Actual recirculation ratio: ________:_______
   f. Recirculation changed to: ________:_______
   *If dam configuration, recirculation device cannot be inspected or cleaned
8. Inspection ports
   a. Inspection ports present. Yes_____No_____
   b. Inspection ports intact. Yes_____No_____
9. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:______________________________________

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable
8. ❑ Acceptable ❑ Unacceptable

Lagoons

Overview

Lagoon treatment systems are generally preceded by a septic tank placed between the residence and the lagoon. The lagoon will generally have a discharge outfall for effluent exiting the lagoon, although some local regulations may not permit discharge from lagoons. (NOTE: This is a high risk system, and safety issues about public access must be addressed.)

Treatment

A lagoon is a large basin filled with wastewater undergoing some combination of physical, chemical, and biological treatment processes that render wastewater more acceptable for discharge to the environment. Lagoons are used for BOD_5 removal, nitrification, phosphorus reduction, and waste stabilization. The following are the four types of lagoons classified based on the presence and source of oxygen:

- Aerobic
- Facultative
- Partial-mixed aerated
- Anaerobic

Aerobic lagoons use photosynthesis to provide oxygen for aerobic conditions throughout the water column. Facultative lagoons have a surface zone that is aerobic and a subsurface zone that may be anoxic or anaerobic. Partial-mixed aerated lagoons become aerobic through devices such as floating mechanical aerators or submerged diffused aeration. In an anaerobic lagoon, the entire depth is anaerobic. We are only going to discuss maintenance requirements for the aerobic and facultative types because partial-mixed aerated and anaerobic lagoons are used mostly for industrial or agricultural uses and are rarely seen in residential systems.

A lagoon is also called a pond or stabilization pond. Sizing of the lagoon for treatment is sensitive to precipitation and evaporation rates. The required area is design dependent and must conform to local and state regulations. Most states require berms to prevent overflow, a buffer zone, and a fence to keep children and animals out (Figure 7-25). Lagoons perform best when multiple lagoons are placed in a series because this minimizes short-circuiting of the system. The effluent in lagoons should be pretreated with a minimum of a septic tank (Figure 7-26). They are usually lined with clay or artificial materials to prevent seepage into the soil and groundwater. Unlined lagoons are used when native soil conditions are expected to prevent contamination of groundwater.

It is not unusual for a lagoon to be designed 20 to 150 times greater than the average daily flow from the residence, depending on the final discharge load. Size can usually be reduced if aerated effluent flows into the lagoon. Aerobic lagoons are shallow (with a depth of 1 to 3 feet) to allow light to penetrate the full depth of the lagoon, resulting in photosynthetic activity of algae and other single-cell organisms that produce oxygen. The oxygen allows bacteria to degrade

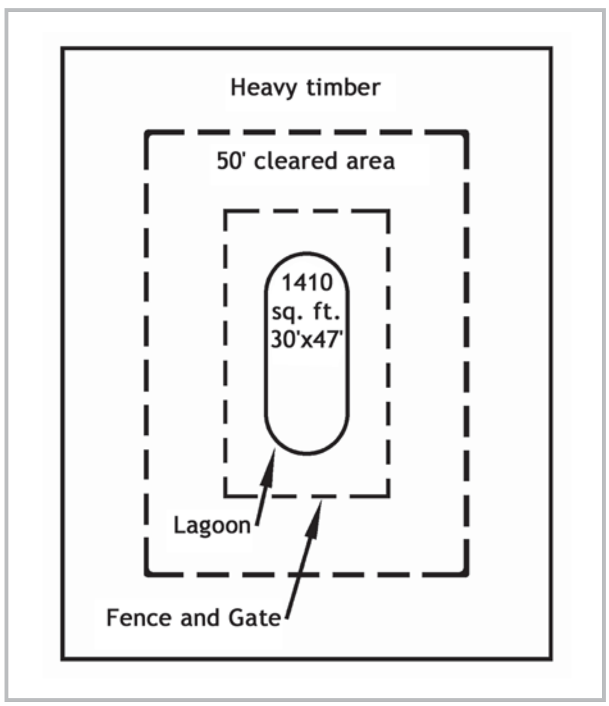


Figure 7-25. Lagoon barriers (plan view).

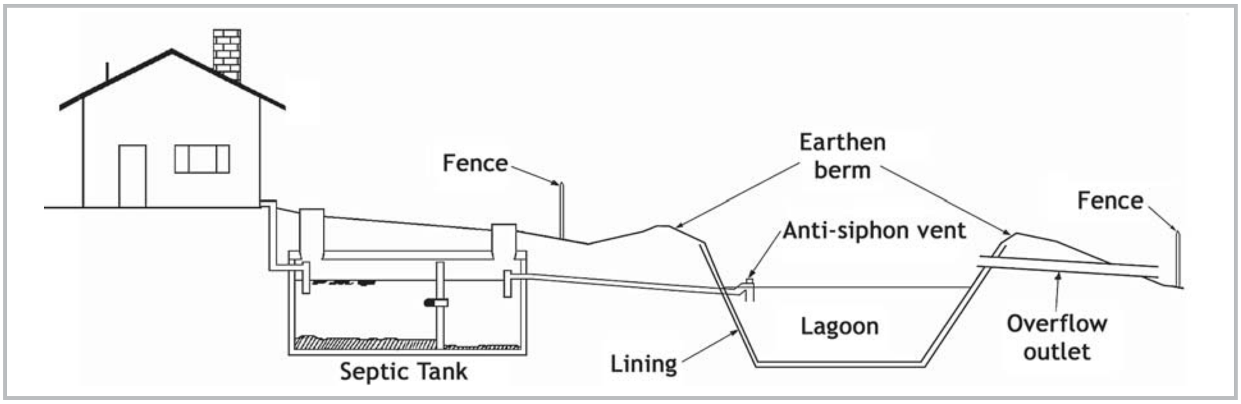


Figure 7-26. General treatment train for a lagoon (profile view).

organics aerobically. No plants should be present in the lagoon. Typical retention time is short, usually around 5 days. Aerobic lagoons are limited to use in warm, sunny climates.

Facultative lagoons are the most common and versatile lagoons for residential onsite wastewater treatment systems. They are 5 to 8 feet deep and designed based on BOD_5 loading rates. Treatment is accomplished by bacterial action in an upper aerobic layer and a lower anaerobic layer. Settleable solids are deposited on the lagoon bottom. Oxygen is provided by natural surface aeration and photosynthesis. The concept is to design for a long enough retention time and low enough organic loading rate to achieve aerobic conditions in the surface area.

Lagoons require berms that are 2 feet above the liquid working level and a buffer area of at least 300 feet. Trees are removed from the perimeter to maximize the exposure of the lagoon's surface to sunlight and wind.

Operation and maintenance

The proper care of the lagoon can be accomplished through the following evaluations (**Form 7-4. Lagoon maintenance** (**LM**).):

1. Evaluate the lagoon system one cell at a time, and use a new sheet for every cell. (Many lagoon systems are in a series of multiple cells for increased wastewater treatment.) Identify the type of lagoon being used at the site. It can be identified as aerobic or facultative.

2. Evaluate the presence of odor at the system. Strong odor is an indication of anaerobic conditions or improper inlet placement. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

   Indicate the color of the wastewater. Color can be used to indicate a symptom of a problem, but it does not necessarily mean that there is a problem. Turnovers and blooms are a normal occurrence in lagoons, and they often produce odors. A green color would indicate the presence of algae, which may be using all the available oxygen. A purple color indicates the presence of anaerobic bacteria.

   The surface should be free of large floating materials. (If preceded by a septic tank, regular O&M on the septic tank should prevent large floating materials from reaching the lagoon.) Periodic pumping of the lagoon may be necessary for solids removal.

   If the lagoon has an exposed surface, vector activity, such as animals, should be prevented.

3. The top of the berm should be flat and be a minimum of 4 feet wide. The outsides should be gently sloped to shed surface water. Indicate whether the border is in good repair. Any erosion should be filled and reseeded as soon as it is noted. Repair leaks around the berm walls by plugging, sealing, etc. as soon as noted. Reroute any surface drainage away from the lagoon. Berms should be free of animal burrows that create structural challenges and channels for water movement.

   Berms should have grass cover to reduce erosion. Woody vegetation should not be present on the berms. Tree roots cause water flow channels and can reduce structural integrity of the berm. Mow earthen berms to maintain an attractive site.

   Check that a fence is in place and secured. It should be a minimum of 4 feet tall and equipped with a lockable gate. It should be constructed of chain link, woven or welded wire, hog panel, or cattle panel. Proper signage is necessary to prevent trespassing.

4. The wastewater should be free of vegetation. If vegetation is present in the lagoon, it should be manually removed using the proper precautionary measures. There may be some vegetation, such as cattails and duck weed, along the edges of the lagoon that will not interfere with treatment, as long as they are not blocking any inlets or outlets or growing excessively.

5. Maintain the working water level at least 2 feet below the top of the berm, dependent upon state regulations. Measure the depth of the lagoon. If the working water level is too high, check outflow pipes (if used) for clogging. Water levels will temporarily increase with flow surges. Note whether a water level control option is available.

6. Effluent quality should be evaluated to determine system performance and document current status of the system. Clarity, dissolved oxygen, pH, and temperature should be noted, as well as the relative odor and color of the effluent leaving the cell.

7. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from the laboratory to complete system file. Report the information to the proper entities.

Form 7-4. Operational checklist: Lagoon maintenance (LM).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ______________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Lagoon: Cell #: ________ / ___________
   a. Type: ❑ Aerobic ❑ Facultative
2. Conditions at the lagoon
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Color of lagoon water:
      ❑ Clear ❑ Green ❑ Purple ❑ Other:____________
   d. Sludge pumping necessary. Yes_____No_____
   e. Animal activity at surface. Yes_____No_____
3. Border around lagoon
   a. Type of border material: ______________
   b. Border effective and in good repair. Yes_____No_____
   c. Evidence of water/soil entering lagoon. Yes_____No_____
   d. Berm free of burrowing animals. Yes_____No_____
   e. Berm protected from erosion. Yes_____No_____
   f. Trees present on the berm. Yes_____No_____
   g. Fencing is present and operable. Yes_____No_____
4. Vegetation in lagoon
   a. Floating vegetation present. Yes_____No_____
   b. If yes, vegetation removed. Yes_____No_____
   c. Vegetation at edges present. Yes_____No_____
5. Water level management
   a. Water level below freeboard: ____________ft
   b. Water level relative to: ❑ Outlet ❑ Berm ____________in
      ❑ Above ❑ Below
   c. Water level control option available Yes_____No_____
6. Effluent quality
   a. Turbidity: __________NTU
   b. Oily film on the surface of effluent. Yes_____No_____
   c. DO at outlet or across from inlet: __________mg/l
   d. pH at outlet or across from inlet: ______________
   e. Temperature in outlet: ______________
   f. Bypass or overflow noticed. Yes_____No_____
   g. Effluent odor after passing through lagoon (if discharging):
      ❑ None ❑ Mild ❑ Strong
   h. Effluent color after passing through lagoon (if discharging):
      ❑ Clear ❑ Brown ❑ Black
7. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____________________________________
   ____
   ____

Notes

2. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

5. ❑ Acceptable ❑ Unacceptable

6. ❑ Acceptable ❑ Unacceptable

Disinfection

Overview

Onsite wastewater treatment systems distributing wastewater on the ground surface are required to include a disinfection component as part of the pretreatment process. Additionally, some subsurface drip systems applying wastewater into shallow soils require disinfection prior to dispersal. Disinfection is the destruction or inactivation of disease-causing organisms. The disinfection component reduces the concentration of the pathogenic constituents to an acceptable level. This usually relates to a health standard or a maximum required number of organisms for infection.

Wastewater can be disinfected with many methods. Chlorine, ultraviolet light, and ozone will be discussed to provide a greater understanding of how they operate. For onsite wastewater treatment systems, the most common form of disinfection is chlorination.

Chlorine

Chlorination is the process of adding chlorine to wastewater to reduce the population of pathogenic organisms. Chlorine passes through the cell walls, oxidizing and destroying the cell enzymes. It is important to have an appropriate holding time to allow the chlorine to react with the microorganisms. The length of contact time necessary for proper treatment decreases as the chlorine concentration increases. Generally, 30 to 60 minutes of contact time is required for typical wastewater strengths and chlorine concentrations.

Chlorine reacts with ammonia to form chloramines. Chloramines are not as effective as hypochlorus acid ($HOCL^-$) and the hypochlorite ion (OCL^-) for disinfection.

The O&M service provider should be aware of safety and health issues when providing service to a technology that utilizes chlorine. Service providers should familiarize themselves with the proper handling and storage procedures for the different forms of chlorine available.

Tablet chlorinators

Tablet chlorinators generally have four components:

- Chlorine tablets
- Tube(s) that holds the tablets
- Device that puts the chlorine tablets into contact with the wastewater
- Contact chamber where the chlorinated wastewater is stored to allow sufficient contact time before it is distributed

In preparation for chlorination, wastewater from a home is treated with at least an aerobic treatment unit. Pretreatment is necessary to remove significant amounts of organic matter and solids that can otherwise reduce the effectiveness of the disinfection process.

A tablet chlorinator usually consists of a basin where the tubes containing a stack of chlorine tablets are placed (Figure 7-27). The top of the tubes should extend above ground surface and be protected by a cap. The bottom tablet in the tube is in contact with the wastewater flowing through the basin. As that tablet dissolves and/or erodes, the tablet above falls by gravity to replace it.

A tablet can dissolve quickly or slowly, depending on the volume and flow of wastewater coming into contact with it, the properties of the tablet, and the length of contact time. A balance

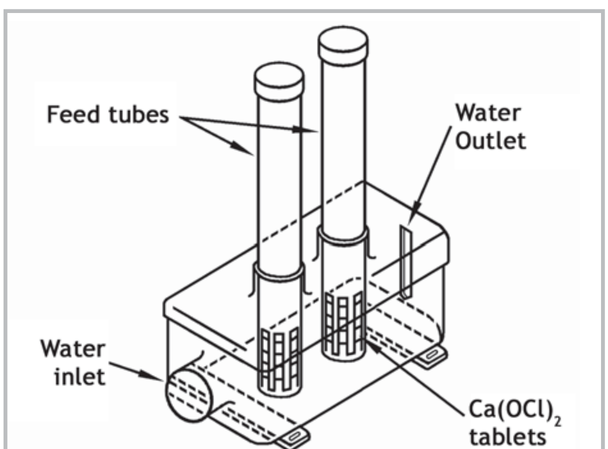


Figure 7-27. Chlorine stack feeder.

must be struck regarding the contact time in the chlorinator basin. If the contact time is too long, the wastewater becomes over-chlorinated, and the tablets are consumed rapidly; if the contact time is too short, the wastewater is not disinfected sufficiently.

Use only chlorine tablets that are approved for use in wastewater. They are made of calcium hypochlorite ($Ca(OCl)_2$). These tablets dissolve in the wastewater and release the hypochlorite that becomes hypochlorous acid, the primary disinfectant.

Do not use swimming pool chlorine tablets. They are often made from trichloroisocyanuric acid, which is not approved for use in wastewater treatment systems. Read the list of active ingredients on the tablet label to make sure you are using calcium hypochlorite.

Growing awareness and understanding of the effects of chlorine on the environment are prompting many companies to optimize the performance, reliability, and safety of their chlorination products. If you measure chlorine residual using the DPD colorimetric method, keep in mind that it is sensitive to heat and sunlight and has a limited shelf life.

Liquid chlorinators

Liquid chlorinators are also used for disinfecting residential wastewater. These devices typically use liquid chlorine bleach that is dosed into the wastewater prior to distribution.

These systems generally use an aspirator to draw chlorine from a reservoir (Figure 7-28). The chlorine is discharged into the pump tank to react with the wastewater. The aspirator requires that the pump be operating to develop the vacuum to draw a chlorine dose into the pump tank.

Dechlorination

Chlorine residual is generally used as an indicator of appropriate disinfection. Chlorine residual is measured in the pump tank to determine if a sufficient quantity of chlorine is being dosed into the wastewater. Chlorine residual should be maintained at a level less than 0.2 mg/L.

Dechlorination is used to remove residual chlorine before effluent is dispersed. The dechlorination approach currently available is the use of tablets made typically of sodium bisulfate. These tablets are stored in a stack tube and placed in the contact basin. Effluent passing through the contact basin is treated by the dissolving tablets in the same manner as described for tablet chlorination.

Chlorine residual tests can evaluate proper performance of the dechlorination system. When utilizing a dechlorination system, there should be no chlorine residual measurable in the effluent.

Operation and maintenance

Chlorine disinfection O&M will include the following activities (**Form 7-5. Disinfection unit-chlorine** (**DUC**).):

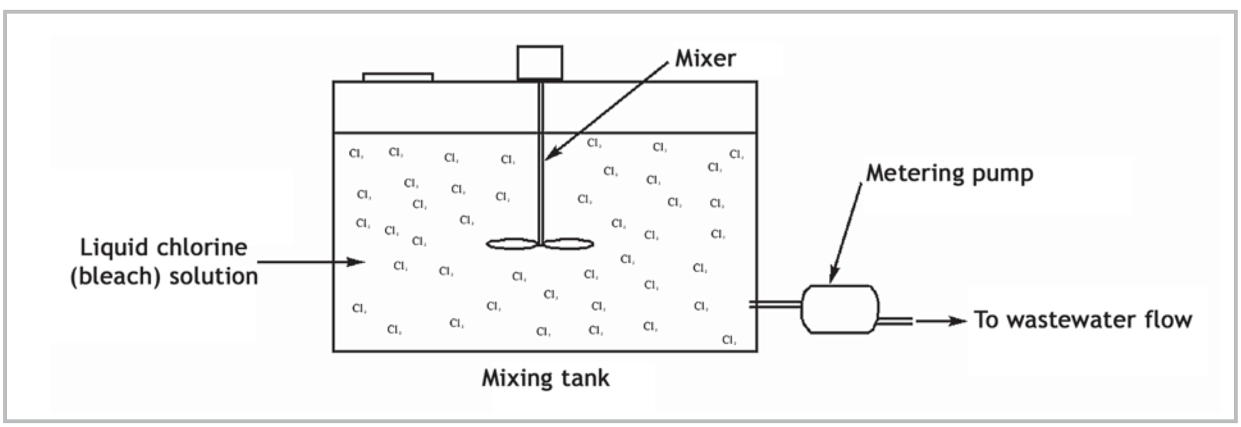


Figure 7-28. General schematic of a liquid chlorination system (profile view).

1. If a chlorinator and dechlorinator are present, use a new form for each component. Note the manufacturer and the model number for the units. Identify the type of chlorine disinfection method being used at the site: tablet or liquid. Note and record the condition of the unit.

2. Tablet chlorination utilizes the contact basin for contact of the effluent with the tablets. The basin must be level, watertight, and free of residuals. Soil settling/ movement can shift the basin resulting in an off-level basin, a situation that must be corrected upon discovery.

   Tablets are placed in the stack tube of the contact basin. Generally, a small number of tablets (four to eight) are placed in the tube at a time. There must be an adequate number of tablets in reserve so they can be readily replenished as needed. Tablets may wick effluent up the stack tube, causing the tablets to expand and lodge in the stack tube instead of feeding down into the effluent. Lodged tablets must be physically removed from the tube.

   Chlorine residual is monitored in the effluent. Chlorine can be read as total or free residual. Record the method of testing used.

3. Liquid chlorination systems store chlorine in a reservoir for dosing in the tank. Confirm the presence of liquid chlorine at the proper concentration in the reservoir, and note the type of chlorinator and the injection method used. There should be proper mixing of the liquid chlorine from the reservoir with the wastewater. Measure and note the total or free chlorine residual level and the testing method used.

4. Tablet dechlorination is commonly used to remove chlorine from the effluent before dispersal. These tablet dechlorination devices have similar O&M requirements as tablet chlorinators. (see Number 2)

5. If a control panel is used, it should be watertight with all connections sealed to prevent moisture or chlorine gases from entering. Check the function of the alarm test switch. The presence of a control (HAND-OFF-AUTO) switch allows the service provider to check pump function without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions it should be in the AUTO position. If the panel has a cycle counter and/or an hour meter (elapsed time meter), record the present and last readings. If there are no meters, they are strongly recommended as an upgrade to facilitate O&M activities.

6. Manufacturers of specific units may recommend additional maintenance for their products. These activities should be performed, and the completion of these activities should be documented in the comments section.

7. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from laboratory to complete system file. Report the information to the proper entities.

Form 7-5. Operational checklist: Disinfection unit – chlorine (DUC).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Operation of chlorination system
   a. Manufacturer: Chlorinator: ________ Dechlorinator:_________
   b. Model #: ____
   c. Method: ❑ Tablet ❑ Liquid
   d. Unit appears to be in good condition. Yes_____No_____
2. Tablet chlorination: N.A. __________
   a. Chlorinator appears to be operable. Yes_____No_____
   b. Chlorine tablets in place. Yes_____No_____
      Type:____
   c. Tablets come in contact with effluent. Yes_____No_____
   d. If tablets added, how many: ______________
   e. Contact chamber appears operable. Yes_____No_____
   f. Contact chamber and stack feeder cleaned. Yes_____No_____
   g. Chlorine residual: ❑ Free ❑ Total ___________ppm
      Testing method:__________________________________
3. Liquid chlorinator: N.A. __________
   a. Chlorine present in reservoir. Yes_____No_____
      Type:____
   b. Injection method operating correctly. Yes_____No_____
      Type:____
   c. Contact chamber appears operable. Yes_____No_____
   d. Proper mixing occurring. Yes_____No_____
   e. Chlorine residual: ❑ Free ❑ Total ___________ppm
      Testing method:__________________________________
4. Tablet dechlorination: ❑ Required ❑ Not required
   a. Dechlorination appears operable. Yes_____No_____
   b. Dechlorination tablets in place: Yes_____No_____
      Type:____
   c. Tablets come in contact with effluent. Yes_____No_____
   d. If tablets added, how many: ______________
   e. Contact chamber appears operable. Yes_____No_____
   f. Contact chamber and stack feeder cleaned. Yes_____No_____
   g. Chlorine residual: ❑ Free ❑ Total ___________ppm
      Testing method:__________________________________
5. Control panel: N.A.__________
   a. Controls operating properly. Yes_____No_____
   b. Is enclosure watertight. Yes_____No_____
   c. Alarm test switch operating properly. Yes_____No_____
   d. At time of inspection, control switch was set to: N.A.__________
      "Hand/Manual"__
      "Auto" _________
   e. If auto, setting: Time On:_______ (min) Time Off:________ (min)
6. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
7. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:_____________________________________
   ____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable

Ultraviolet light

Overview

Disinfection by ultraviolet (UV) light is a process in which electromagnetic energy from a source (lamp) is emitted into a chamber or zone through which effluent passes. The UV light destroys the microorganisms present in the effluent by altering their genetic material and retarding their ability to reproduce.

Treatment

UV light, created by an electrical current passing through mercury vapor inside a lamp, penetrates the cell wall of microorganisms and destroys their genetic material. The lamp emitting the UV radiation is usually encased in a quartz or Teflon sleeve that comes into direct contact with the wastewater (Figure 7-29). Wastewater never comes in contact with the UV lamp itself. The effectiveness of a UV disinfection system depends on the following factors: presence of suspended solids, wastewater flow rate, turbidity, time of exposure, distance the UV light needs to travel within the reactor chamber, intensity of the UV light, and the configuration of the system.

Wastewater characteristics – For UV disinfection to be effective, UV radiation must come in direct contact with the microorganisms present in the wastewater. High turbidity and TSS levels limit UV light penetration in the reactor chamber and the amount of UV light absorbed by the organisms. TSS in the wastewater may shield the microorganisms present from the UV light. The type of advanced treatment technology used immediately before the UV unit can have a profound influence on UV light penetration in the reactor chamber and thus on number of organisms killed. (See Table 7-1 below for wastewater characteristics that may affect UV disinfection unit performance.)

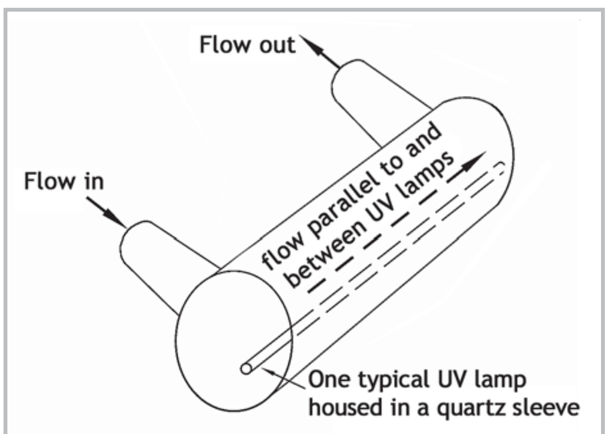


Figure 7-29. Ultraviolet light disinfection unit.

Wastewater flow rates – High flow rates through the reactor chamber can also limit UV light contact with organisms, primarily by reducing the organism's *time of exposure* to the UV light.

Intensity of UV light – Such factors as lamp placement and configuration in the reactor, lamp fouling (from solids buildup), distance between lamp and electrical power source (voltage drop), and age of the lamp all affect the intensity of UV radiation in the reactor chamber.

Unlike increasing the chlorination dosage when there are more interferences present, increasing UV intensity has no effect on high levels of TSS. UV dosage is measured by power or intensity, the surface area, and the contact time. If the UV radiation cannot penetrate the microorganisms, it is useless.

If the protective sleeve is not cleaned regularly, UV penetration will be poor. Regular cleaning by mechanical, chemical, or ultrasonic methods is needed to assure system performance. The frequency of cleaning depends on the type of technology that comes before the UV disinfection step and the wastewater characteristics. Generally, time-dosed media filters that are producing less than 20 mg/L of BOD_5 and TSS each should be visited twice per year to clean tubes. Non-time-dosed treatment units and technologies producing effluent with higher TSS and BOD_5 levels may require two to four times more frequent cleaning, depending on other factors noted above. The service provider

Table 7-1. Wastewater characteristics affecting UV disinfection performance. (*Source: USEPA, 1999.*)

Wastewater Characteristic	Effects on UV Disinfection
Ammonia	Minor, if any.
BOD	Minor, if any. Although, if a large portion of the BOD is humic compounds, then UV transmittance may be diminished.
Hardness	Affects the solubility of metals that can absorb UV light. Can lead to the precipitation of carbonates on the quartz tubes.
Humic materials, Iron	High absorbency of UV light. Can coat quartz tubes, inhibiting the transmittance of UV radiation to the organisms.
Nitrate	Minor, if any.
Nitrite	Minor, if any.
pH	Affects solubility of metals and carbonates.
TSS	Absorbs UV radiation and shields embedded bacteria.

is encouraged to adjust maintenance frequency to meet the demands placed upon each system. For instance, a UV lamp used on a system serving a seasonally used home visited only on weekends would require less quartz tube cleaning than a lamp serving a home that is occupied year-round and is producing wastewater flow at or near design levels.

To clean a small residential UV unit, the service provider should remove the lamp and quartz tube assembly from the housing, manually wipe the quartz tube with a clean cloth, and then reassemble the unit. Other manufactured UV products for larger residential or commercial flows may employ a mechanical wiper mechanism and external rod that may not require disassembly.

Chemical cleaning is usually done with a citric acid solution, but vinegar solutions and sodium hydrosulfite are also used. Chemical and ultrasonic cleanings are usually done only on larger systems.

Most manufacturers of small residential-sized UV units recommend lamp replacement every 12 to 24 months (8,760 to 17,520 hours) for continuously operating lamps. Some units may operate lamps in cycles rather than continuously. Repeated on/off lamp cycles usually reduce their lifespan. The service provider should check with the manufacturer to verify lamp replacement frequency.

The distance of electrical power line run from power source to lamp may influence voltage at the lamp itself. The manufacturer should be consulted if low voltage is detected at the lamp. Lamp ballast lifespans range from 10 to 15 years but are usually replaced every 10 years. Service providers should check with manufacturers for the compatible lamp ballast. Adequate ventilation should be provided for the ballast to prevent overheating, which shortens its life and can even result in fire. Quartz sleeves or tubes normally last 5 to 8 years but are usually replaced every 5 years.

The UV lamp can be located in insulated outdoor structures or in heated spaces of the structure served, both of which must protect the unit from dust, excessive heat, freezing, and vandals.

UV units may be configured with either gravity flow or pressurized flow.

Operation and maintenance

UV light disinfection O&M will include the following activities (**Form 7-6. Disinfection unit-ultraviolet light** (DUUL)). Unplug the unit before servicing. Proper eye protection should be used when servicing UV disinfection unit. Operators should not look directly at the UV light with the power on.

1. Note if the unit is pressure or gravity dosed. Also note the manufacturer and the model number for the unit. Electricity is required for proper operation of the device. Make sure the lamp is turned on (before it is turned off for maintenance). Look for corrosion at the point where the lamp plugs into the electrical lead. If corrosion is present, clean the surfaces and check the voltage at the end of the lead. The lamp ballast should generally be replaced every 10 years with a compatible part. However, always follow the manufacturer's recommendation. Note whether the ballast was replaced during the visit. If it was not replaced, note the last replacement date.

2. If the unit is equipped with a UV light intensity sensor to monitor, record the intensity reading. An alarm can monitor light intensity and signal the need for maintenance or repair. If a light-intensity alarm is present, check its function manually by turning the light off to ensure it is operating as designed.

3. Check for any damage to the UV unit and contact chamber that might cause effluent leakage. Note whether the contact chamber is cleaned.

   Note whether the sleeve is quartz, Teflon, or some other material. Using gloved hands, remove the sleeve assembly and lamp from the housing. Using a clean cloth, separate the UV lamp from the protective tube. Wipe the outside of the protective sleeve to clean at the recommended frequency of one to four times per year (or more), depending upon site specifics. Note whether the sleeve is replaced during the visit. If it is not replaced, note the last time this was done. Sleeves should be replaced every 5 years or sooner if cracks appear or if discoloration cannot be removed. Note whether the lamp is replaced during this visit. If it is not replaced, note the last date this was done. Replace lamp yearly, as recommended by manufacturer or as required by permit.

4. The system requires clear effluent for effective light transmission through the effluent. Check the turbidity with a meter. Monitor the flow rate, as excessive flows result in limited treatment. Indicate any other wastewater characteristics that may compromise treatment.

5. If a control panel is used, it should be watertight, with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm test switch. The presence of a control (HAND-OFF-AUTO) switch allows the service provider to check pump function without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions it should be in the AUTO position. If the panel has a cycle counter and/or an hour meter (elapsed time meter), record the present and last readings. If there are no meters, they are strongly recommended as an upgrade to facilitate O&M activities.

6. Note where the housing unit is located (buried directly in the ground or in a pump chamber). The UV housing unit

or chamber must be inspected for cracks or leaks. Check for excessive dust in the housing unit.

7. Manufacturers of specific units may recommend additional maintenance for their products. These activities should be performed, and the completion of these activities should be documented in the comments section.

8. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from the laboratory to complete the system file. Report the information to the proper entities.

Form 7-6. Operational checklist: Disinfection unit - ultraviolet light (DUUL).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Power supply
   a. Dosing method: ❑ Pressure dosed ❑ Gravity fed
   b. Manufacturer:______________ Model #:________________
   c. Power supplied to the unit. Yes____No_____
   d. UV lamp 'ON'. Yes____No_____
   e. Electrical system is free of corrosion/damage. Yes____No_____
   f. Ballast replaced during this visit. Yes____No_____
   g. Last replacement date: ____ / ____ / ___
2. UV controls
   a. Unit equipped with a lamp intensity sensor. Yes____No_____
   b. If so, what was intensity reading: ____________
   c. Alarm present. Yes____No_____
   d. Alarm operating properly. Yes____No_____
3. Contact chamber, lamp, and sleeve conditions
   a. Evidence of damage or leakage. Yes____No_____
   b. Contact chamber cleaned/flushed of solids. Yes____No_____
   c. Type of protective sleeve: ❑ Quartz ❑ Teflon ❑ Other: ______
   d. Protective sleeve free of buildup. Yes____No_____
   e. Protective sleeve cleaned. Yes____No_____
   f. Protective sleeve replaced during this visit. Yes____No_____
   g. Date last replaced: ____ / ____ / ___
   h. UV lamp replaced during this visit. Yes____No_____
   i. Date last replaced: ____ / ____ / ___
4. Influent characteristics
   a. Turbidity: ___________ NTU
   b. Flow rate: ___________gpm
   c. Indicate wastewater characteristics that may compromise treatment:
   ____
   ____
5. Control panel: N.A. ___________
   a. Controls operating properly. Yes____No_____
   b. Is enclosure watertight. Yes____No_____
   c. Alarm test switch operating properly. Yes____No_____
   d. At time of inspection, control switch was set to: N.A. ___________ "Hand/Manual" __ "Auto"__________
   e. If auto, setting: Time on:_______ (min) Time off:________ (min)
6. Housing unit: Location:________________
   a. Appears in good condition. Yes____No_____
   b. Leaks/Cracks present. Yes____No_____
   c. Excessive dust present. Yes____No_____
7. Manufacturer's required maintenance performed. Yes____No_____
   (If 'Yes', attach Manufacturers Inspection form to this report, if supplied)
8. Lab samples collected for monitoring. Yes____No_____
   Types of analysis:____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable

Ozone

Ozone (O_3) is a powerful disinfectant that, like chlorine, destroys microorganisms through oxidation. It disinfects by reacting with the organic matter of the cell and is particularly effective against Giardia and cryptosporidium. It has the very desirable quality that it is unstable and leaves no residual. Additionally, ozone does not form disinfection byproducts. The extra oxygen atom binds in a split second to all the organic matter it contacts. After this oxidation process, all that remains is the pure and stable oxygen molecule.

An ozonation system consists of the ozone generator, an air dryer or oxygen source, a means of adding the ozone into the wastewater, a mixing/contact chamber, and a ventilation device. Ozone is produced by discharging electricity in very dry (desiccated) air. A high voltage (6,000 to 20,000V) is applied to two electrodes to create a continuous arc (corona), and the high voltage converts O_2 to O_3. The feed gas for the ozone generator may be air or pure oxygen. Air feed systems must remove dust and moisture from the incoming air for effective generation. If pure oxygen is used, 1 to 10 percent is converted to ozone; if air is used, only 1 to 4 percent is converted to ozone. About 80 to 95 percent of the energy is converted to heat, which must be removed, usually through cooling water.

For ozone to be effective, it must be added to the effluent and dispersed as finely as possible. This is accomplished either by using a fine bubble diffuser (Figure 7-30) or a venturi configuration. The mixing/contact chamber must be configured so that there is adequate contact time for disinfection. Note the baffled configuration in Figure 7-30 that slows down the flow through the chamber.

Ozone interferences include TSS, BOD_5, COD, humic materials, nitrite, nitrate, and pH. TSS increases ozone demand and shields embedded bacteria. Organic compounds measured as BOD_5 or COD can exert an ozone demand. Ozone oxidizes iron, manganese, and hydrogen

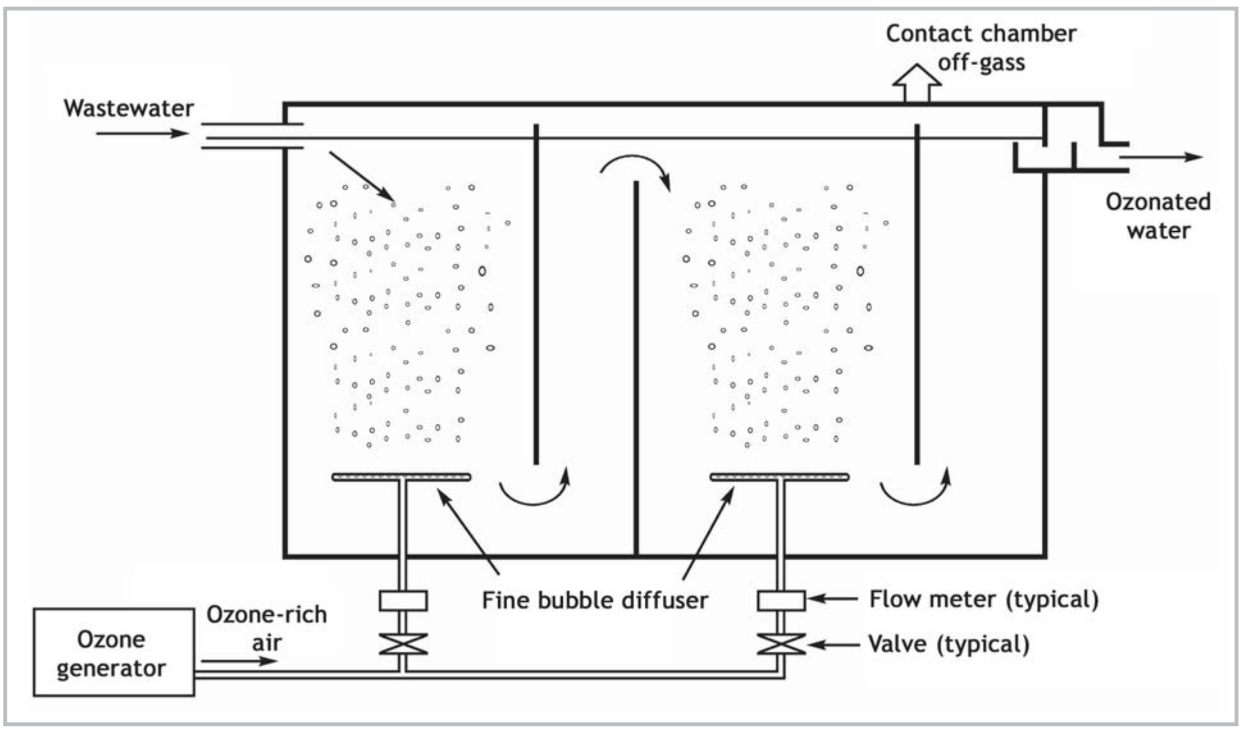


Figure 7-30. General schematic of an ozone system (profile view).

sulfide, which results in precipitates downstream of the ozone injection point. The degree of interference depends on the functional groups and chemical structure. If water reuse is anticipated, provisions must be made to remove precipitates from the wastewater stream. Settling and filtration are acceptable methods for removal of precipitates in this situation.

Humic materials affect the rate of ozone decomposition and exert ozone demand. Nitrite is oxidized by ozone, and nitrate can reduce effectiveness of ozone. Ammonia has little or no effect, except when the pH is high, and then it may react with the ozone. The pH affects the rate of ozone decomposition.

The amount of interference these constituents exert on the effectiveness of ozone disinfection is minimal. This is especially apparent when compared to the decrease in effectiveness of other forms of disinfection due to interferences.

Ozone has an acute toxicity associated with it. It is important when using this technology to demonstrate extra caution. Ozone is a toxic gas and can cause illness if inhaled in sufficient quantity. Some ozone generators are equipped with ozone monitors and a safety system that shuts down the generator at 0.3 ppm. It is best also to set an alarm at 0.1 ppm, so people can take action in time to avoid problems. Checking the function of such an alarm requires the use of a device that introduces ozone into the air space housing the monitor.

Ozonation equipment for the onsite wastewater treatment industry is not as readily available as other forms of disinfection. This material was developed with the best available information on this technology. As ozone disinfection becomes more readily available, more information on O&M of ozonation equipment will become available. A service provider should review manufacturer maintenance requirements of all technologies to assist with proper O&M.

Operation and maintenance

Ozone disinfection O&M will include the following activities (**Form 7-7. Disinfection unit-ozone (DUO)**.):

1. Note the manufacturer and the model number for the unit. Also note whether the generator is supplied with free air or pure oxygen. The filter or screen on the air intake should be cleaned. Make sure the ozone generator is operating as designed. You should be able to hear the motor running and see the air being dispersed in the contact chamber.

2. Note if the unit is pressure or gravity dosed. Confirm that the wastewater delivery system is operational. There should be a constant flow of wastewater to the contact chamber.

3. Visually confirm that there is sufficient mixing of ozone and wastewater in the contact chamber. Visually inspect the contact chamber for any leaks or cracks. Check the dissolved oxygen concentration in the contact chamber. The DO level should be between 3-5 mg/L.

4. There should be adequate ventilation of the contact chamber. Make sure the air vent is not blocked and off-gas is venting properly.

5. The housing unit must protect the unit from excess dust, moisture, extreme temperatures, and vandals. Make sure the unit is intact and free of dust that may clog the air intake.

6. Make sure the ozone sensor is functioning. Record the ozone detection reading. If a safety alarm is present, make sure it

is operating properly. This is done by introducing an outside source into the air space to see if the alarm activates.

7. If a control panel is used, it should be watertight, with all connections sealed to prevent moisture or sewer gases from entering. Check the function of the alarm test switch. The presence of a control (HAND-OFF-AUTO) switch allows the service provider to check pump function without activating a float or program. Note the position of the control switch, keeping in mind that under normal operating conditions it should be in the AUTO position. If the panel has a cycle counter and/or an hour meter (elapsed time meter), record the present and last readings. If there are no meters, they are strongly recommended as an upgrade to facilitate O&M activities.

8. Manufacturers of specific units may recommend additional maintenance for their products. These activities should be performed, and the completion of these activities should be documented in the comments section.

9. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to an authorized laboratory. Retain a signed COC from the laboratory to complete the system file. Report the information to the proper entities.

Form 7-7. Operational checklist: Disinfection unit - ozone (DUO).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ________________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Ozone generator
   a. Manufacturer:________________ Model #:____________________
   b. Air supply: ❑ Free air ❑ Pure oxygen
   c. Ozone generator operating properly. Yes_____No_____
   d. Filter/Screen: ❑ Cleaned ❑ Replaced
2. Wastewater delivery system operating properly. Yes_____No_____
   a. Dosing method: ❑ Pressure-dosed ❑ Gravity-dosed
3. Contact chamber
   a. Proper mixing. Yes_____No_____
   b. Cracks/leaks present. Yes_____No_____
   c. DO concentration: ___________ppm
4. Ventilation appears operable. Yes_____No_____
5. Housing unit: Location:________________
   a. Appears in good condition. Yes_____No_____
   b. Leaks/cracks present. Yes_____No_____
   c. Excessive dust present. Yes_____No_____
6. Ozone sensor
   a. Sensor functioning. Yes_____No_____
   b. If 'yes,' what was the reading: ___________ppm
   c. Safety alarm present. Yes_____No_____
   d. Alarm operating properly. Yes_____No_____
7. Control panel: N.A. ___________
   a. Controls operating properly. Yes_____No_____
   b. Is enclosure watertight. Yes_____No_____
   c. Alarm test switch operating properly. Yes_____No_____
   d. At time of inspection, control switch was set to: N.A. ___________
      "Hand/Manual" __
      "Auto"__________
   e. If auto, setting: Time on:_______ (min) Time off:________ (min)
8. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes,' attach Manufacturers Inspection form to this report, if supplied)
9. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable

Chapter 8

Final Treatment and Dispersal Components

Learning objectives

Upon completion of this chapter, you should be able to:

1. Understand the methods and components of the following final treatment and dispersal systems:
    a. Gravity distribution systems
    b. Evapotranspiration beds
    c. Low-pressure pipe
    d. Shallow narrow drainfields
    e. Bottomless sand filters
    f. Bottomless peat filters
    g. Mound systems
    h. Drip field
    i. Spray field
    j. Outfalls

Gravity distribution

2. Understand the methods that may be used for effluent dispersal in a gravity drainfield.
3. Understand the purposes of and O&M requirements for the following components in drainfield:
    a. Sequential distribution
    b. Serial distribution
    c. Parallel distribution
    d. Pressure manifold to gravity distribution
    4. Understand the purpose of the inspection port in a soil absorption area.
    5. Understand and be able to accurately complete Operational checklist 8-1. Gravity distribution (GD).

Evapotranspiration beds (ETB)

6. Identify the main process for water removal from evapotranspiration beds.
7. Understand and be able to accurately complete Operational checklist 8-2. Evapotranspiration beds (ETB).

Low-pressure distribution

8. Understand the components and O&M requirements of a low-pressure distribution system.
9. Understand how distal head may indicate that the component is in need of service.
10. Describe the differences between low-pressure pipe and shallow narrow drainfield systems.
11. Understand and be able to accurately complete Operational checklist 8-3. Low-pressure distribution (LPD).

Media filters as drainfield options

12. Understand the difference between media filters and media filters used as drainfield options.
13. Understand the principles and O&M requirements of bottomless sand filters.
14. Understand the principles and O&M requirements of bottomless peat filters.
15. Understand the principles and O&M requirements of mound drainfields.
16. Understand and be able to accurately complete Operational checklist 8-4a. Bottomless sand filters and mounds (BSF and MS) and Operational checklist 8-4b. Bottomless peat filters (BPF).

Drip field

17. Understand the principles of a drip distribution system.
18. Understand the purpose and O&M requirements for the following components in a drip distribution system:
    a. Vacuum breaker
    b. Pressure compensating emitter
    c. Pressure regulator
    d. Field flushing
19. Understand and be able to accurately complete Operational checklist 8-5. Drip field (DF).

Spray field

20. Understand and be able to accurately complete Operational checklist 8-6 Spray field (SF).

Outfalls

21. Understand and be able to accurately complete Operational checklist 8-7 Outfalls (OS).

Introduction

The final step in the treatment process is dispersal of wastewater into the environment. Several options are available for distributing wastewater in soil. Gravity flow systems are the most widely used dispersal systems. These systems will continue to be used in areas where the soil separation distances can be met, primarily because they are the least expensive alternative and require the least amount of O&M.

Pressurized distribution methods overcome a variety of site limitations. Low pressure, drip, and spray distribution systems are designed to function in difficult areas. These systems are pressurized, which assists in providing even distribution of wastewater. These technologies also facilitate reuse of wastewater in the landscape. These advantages, however, increase the O&M requirements.

Gravity distribution systems

Overview

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 (Figure 8-1). 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 percent of the media is below the perforated pipe. Regulations will 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, which allows 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 1, trench 2, and then to trench 3. Serial (serpentine) distribution denotes that the effluent must pass through one trench before passing into the subsequent trench. Parallel distribution denotes effluent entering all the trenches at a uniform rate.

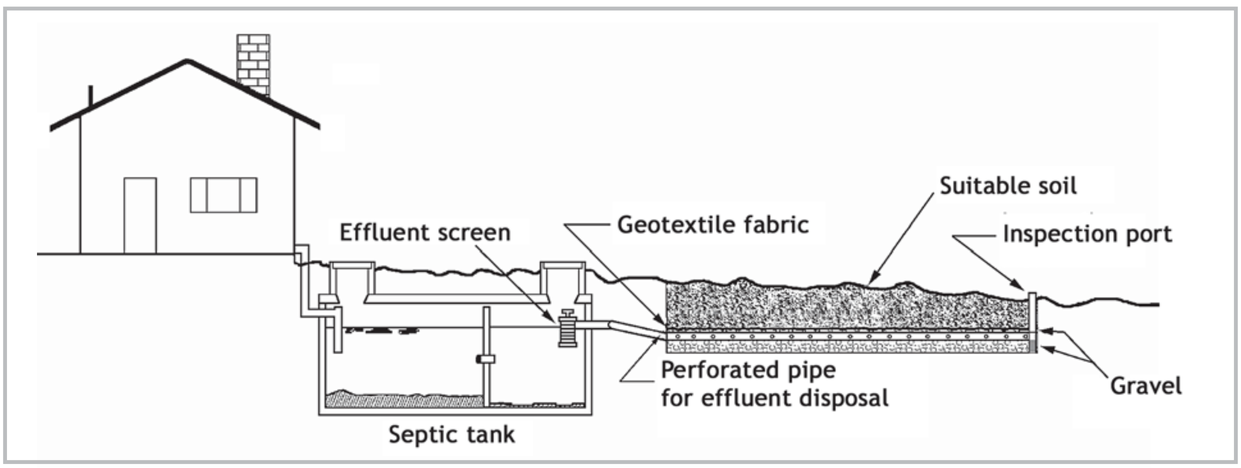


Figure 8-1. Gravity distribution system (profile view).

Sequential distribution can be accomplished on sloping sites using a drop box approach (Figure 8-2). Effluent enters the first drop box and must fill the first trench before conveying over to the next trench. Once the first trench fills, effluent overflows down slope to the second drop box where effluent enters the second trench. The first trench continues to accept effluent at its long-term acceptance rate and excess effluent enters the second trench. After the second trench reaches its long-term acceptance rate, effluent will convey down slope to the third trench. The configuration shown in Figure 8-2 illustrates effluent conveyance to one side of the drop box. A drop box can load trenches placed on both sides of the drop box. Therefore, trenches could extend both directions from the drop box along the contour of the site.

Serial distribution has effluent passing through the first trench before entering the second trench. A serial distribution system placed on a sloping site can use a drop box or solid earth dam for conveying effluent down slope to the second trench (Figure 8-3). Effluent would pass through and fully pond the second trench before conveying down slope to the third trench.

A parallel trench distribution system will load multiple trenches at the same rate. A distribution box can be utilized to distribute wastewater to the individual trenches (Figure 8-4). The distribution box usually has outlet pipes placed at the same elevation to control flow into each trench. Flow control devices can be placed in discharge pipes to control flow to individual trenches. Distribution boxes with weir controls also facilitate even distribution to the individual trenches. All distribution boxes must remain level to facilitate even distribution to the trenches. Over time, distribution and drop

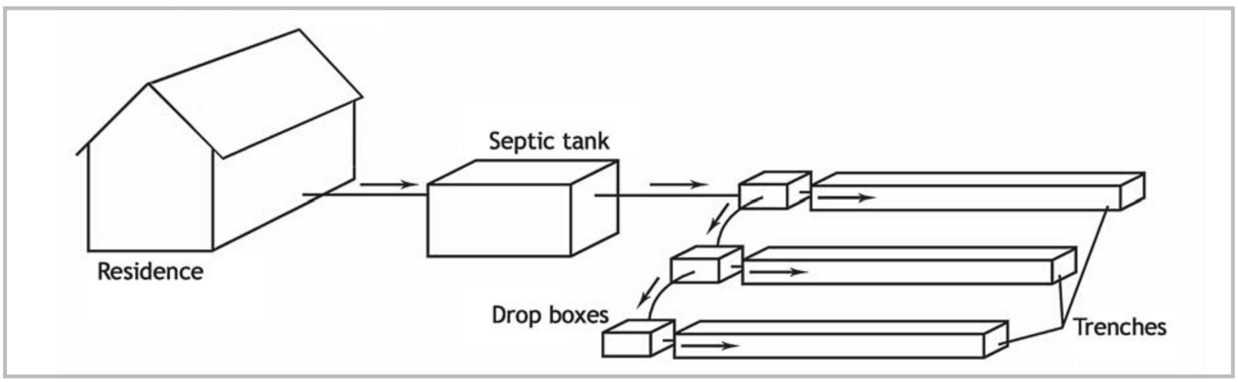


Figure 8-2. Sequential trench using drop boxes on a sloping site.

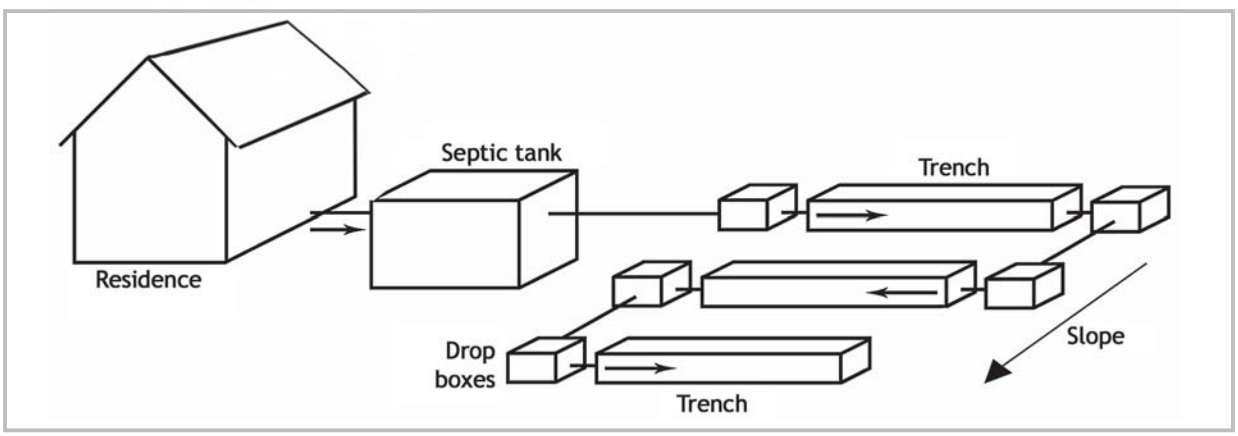


Figure 8-3. Serial trench using drop boxes on a sloping site.

boxes settle and shift. Surface access is needed to re-level or replace a box that fails to distribute or causes problems in the soil treatment area.

Distribution boxes can also distribute effluent on sloping sites (Figure 8-5). The distribution box is located at the highest elevation in the soil treatment area and distributes to each trench. Solid pipe is used to convey the effluent down slope to the trenches at the lower elevation. Distribution boxes require an effective device to control the flow.

Generally, gravity distribution trenches are placed down slope from the residence. However, the best site for the soil absorption area may be upslope from the residence. A pump is then needed to dose effluent to the gravity distribution trenches. A pump tank is placed between the septic tank and gravity distribution trenches (Figure 8-6). A pump is also used if the house plumbing is accidentally stubbed out too low or if the distance between the septic tank and soil treatment area is too great. The pump pressurizes the effluent, sending it to the trenches. Two methods can be used for this: pump-to-sequential distribution and pump-to-parallel distribution.

Pump-to-sequential distribution

Pump-to-serial sequential works the same way as normal gravity drainfield distribution networks, except a pump is needed to get the effluent from the pretreatment component to the final treatment and dispersal component. The effluent is pumped to a drop box, on either a timed-dose or demand-dose. After the wastewater reaches the drop box, it flows into the first trench until that trench has reached its maximum capacity, and then the effluent gravity feeds into the second trench.

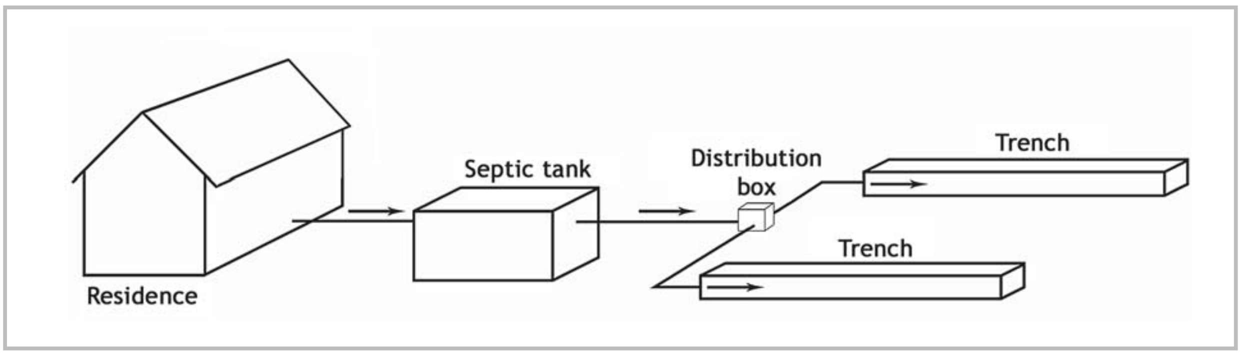


Figure 8-4. Parallel trench using a distribution box on a level site.

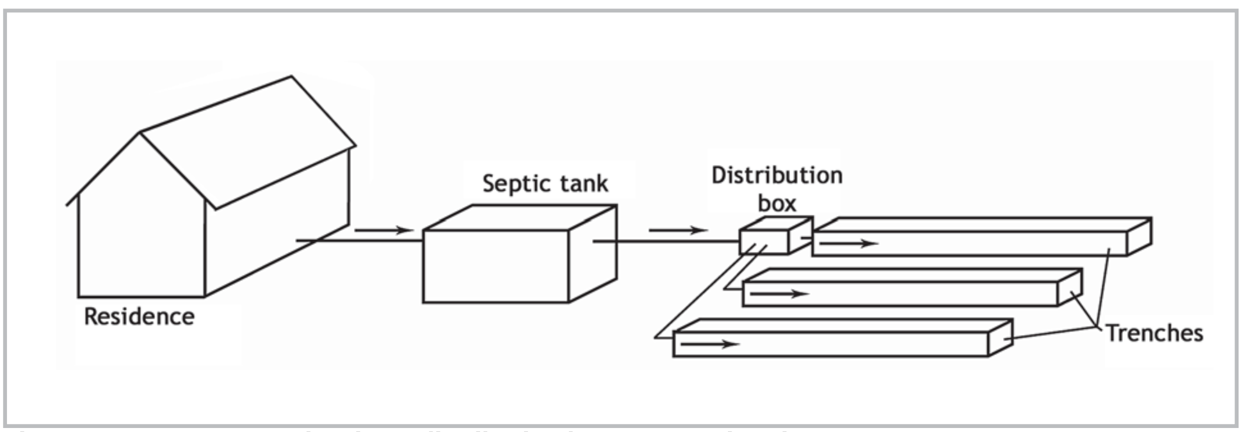


Figure 8-5. Parallel trench using a distribution box on a sloping site.

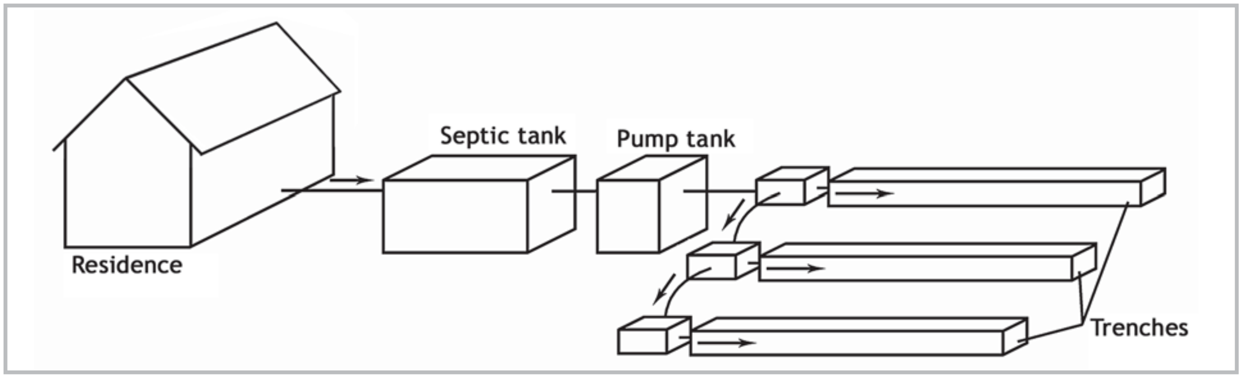


Figure 8-6. Sequential trench using drop boxes on a sloping site with a pump tank.

Pump-to-parallel distribution

A mechanism is needed to distribute the effluent to individual trenches. A pressure manifold can be used to distribute the pressurized effluent to the individual trenches (Figure 8-7). Orifices or ball valves placed in the discharge laterals function as flow controls to regulate flow to each individual trench. Once through the flow control device, effluent gravity flows to the individual trenches (Figure 8-8). The trenches can be placed on a flat or sloping site. The pressure manifold must be placed at the highest point in the system. Some designs may use pump-to-parallel distribution using a distribution box.

Operation and maintenance

The proper O&M of the gravity distribution system can be accomplished through the following tasks (**Form 8-1. Gravity distribution (GD)**):

1. Determine the system type. Record the method for dosing to the distribution field, and then record the method for distribution in the distribution field. Distribution to the field can be accomplished through gravity flow from the pretreatment device, dosing siphon flow to gravity, or pumping to the gravity trenches.

2. Evaluate the presence of odor as you approach the system. There should be no strong odors near the drainfield if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports

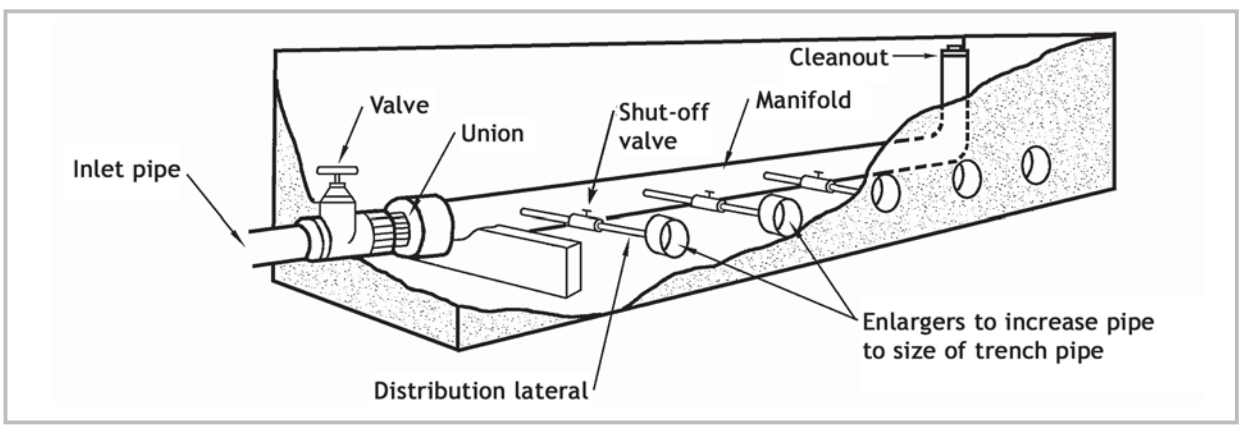


Figure 8-7. Pressure manifold.

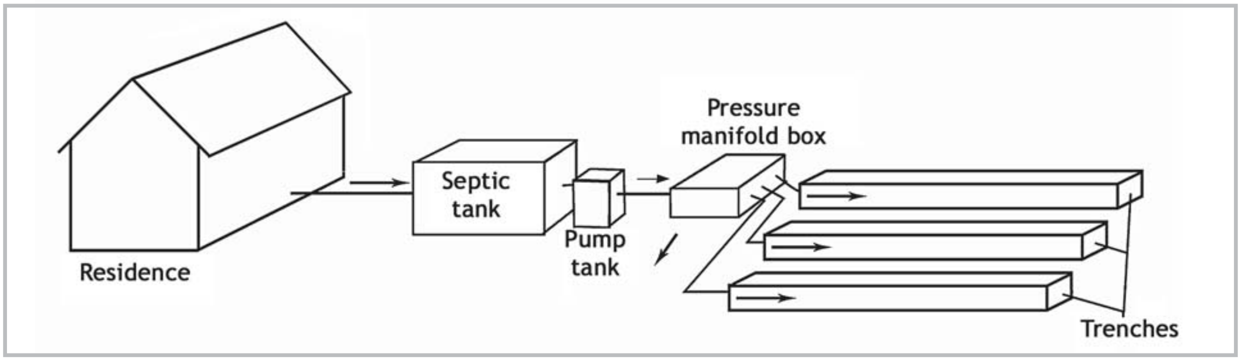


Figure 8-8. Gravity parallel trenches pressure dosed through a pressure manifold.

or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

Vegetation management on and around the drainfield is important for proper performance. Appropriate vegetation may be defined by local regulations. Typically, appropriate vegetation includes mowed grasses and/or short non-woody plants. During the growing season, grasses help remove moisture from the drainfield area. However, some water-loving plants with extensive root systems can cause problems with orifice clogging and water distribution in the system. Check for root intrusion into orifices in the lateral line (while snaking and flushing laterals).

3. Examine the distribution devices. A distribution device is needed to distribute effluent to the individual trenches. These include: distribution boxes, drop boxes, headers, and manifolds. If the system is using a pressure manifold, record the distal head. The distribution devices should be easily accessible. Check for equal distribution in the soil absorption area. Look at grass growth patterns in the yard. It should have even, uniform stripes over the laterals. The boxes must remain level or have some leveling devices to assist with water distribution to the individual trenches. Presence of sludge in the distribution devices indicates potential solids transport to the trenches. If sludge is detected, then the solids level is needed to determine pumping needs. Check for root intrusion in the distribution device.

4. Evaluate each lateral in the drainfield. An evaluation of the extent and depth of ponding can provide some indication on how much of the system is being utilized at the time of inspection and may also be a function of seasonal ground wetness. If fill is used to elevate the system, then the natural soil fill in the interface must be evaluated for leakage. Any leaks are a problem. Check for surfacing effluent at all the laterals, and measure the distance the effluent traveled across ground surface from lateral. Look at the lateral ends for damage, and look for any root intrusion or obstruction to the system. Also note any other areas where effluent is surfacing. This is an indication of a problem.

5. Inspection ports are the best method to evaluate the presence and depth of

ponding. If they are not present, they should be recommended as an improvement. No heavy objects or obstructions of any kind (such as improper landscaping) should impede the service provider from accessing the drainfield.

6. Check the function of the switching valves (if present). Record the type of switching valve, and record if any actions were taken for maintenance. Switching valves are used to automatically or manually divert the flow of effluent to another field or a different part of the field. Some switching valves are used to stop effluent from gaining access to part of the field. Record which laterals are in operation before leaving the site. Check that this has not been changed by the owner during the service interval.

Form 8-1. Operational checklist: Gravity distribution (including pump-to-gravity) (GD).

Service provided on: Date:________ Time:____________ Reference #:____________________
Service provided by: Company: ______________________ Employee:______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Type
   a. Method for dosing to field:
      ❑ Gravity-to-gravity ❑ Pump-to-gravity ❑ Siphon-to-gravity
   b. Method for distribution in the field:
      ❑ Above grade ❑ Bed ❑ Sequential trench
      ❑ Parallel trench ❑ Serial trench
2. Conditions at the drainfield site
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
3. Distribution device
   a. Type: ❑ Distribution box ❑ Drop box ❑ Header
      ❑ Pressure manifold ❑ Other: ____________________
   b. If pressure manifold, distal head: ____________________
   c. Accessible. Yes_____No_____
   d. Intact, providing equal distribution. Yes_____No_____
   e. Free of solids. Yes_____No_____
   f. If 'No,' depth of solids below outlet: ____________in
   g. Root intrusion. Yes_____No_____
4. Distribution in field
   a. Soil treatment area information:

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Lateral #	Ponding		Surfacing Effluent		Distance Effluent Traveled (ft)	Lateral ends	Roots	Obstructions	Notes	Status
	Yes - No	Depth (in)	Yes	No						
1			☐	☐						❑ Acceptable ❑ Unacceptable
2			☐	☐						❑ Acceptable ❑ Unacceptable
3			☐	☐						❑ Acceptable ❑ Unacceptable
4			☐	☐						❑ Acceptable ❑ Unacceptable
5			☐	☐						❑ Acceptable ❑ Unacceptable
6			☐	☐						❑ Acceptable ❑ Unacceptable

Form 8-1(continued). **Operational checklist: Gravity distribution (including pump-to-gravity) (GD).**

Reference #:____________________

Other Areas where Effluent is surfacing.	☐	☐	Location:					❑ Acceptable ❑ Unacceptable

5. Inspection ports
   a. Inspection ports present. Yes_____No_____
   b. Inspection ports intact. Yes_____No_____
6. Switching valves
   a. Switching valve present. Yes_____No_____
   b. Type of valve:________________________________
   c. Operating properly. Yes_____No_____
   d. Action taken if not:________________________________
   e. Laterals in operation: ________________________________

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Evapotranspiration (ET) beds

Overview

An evapotranspiration (ET) bed disperses wastewater by using evapotranspiration—the loss of water from the soil by evaporation and by transpiration from plants growing there.

ET beds are used where the soil cannot treat wastewater before it percolates to groundwater, such as in rocky soils, or where the soil prevents wastewater from percolating from the soil adsorption area, such as in heavy clay soils. ET beds are dependent upon climate and are not suitable for regions that receive more rainfall than evapotranspiration.

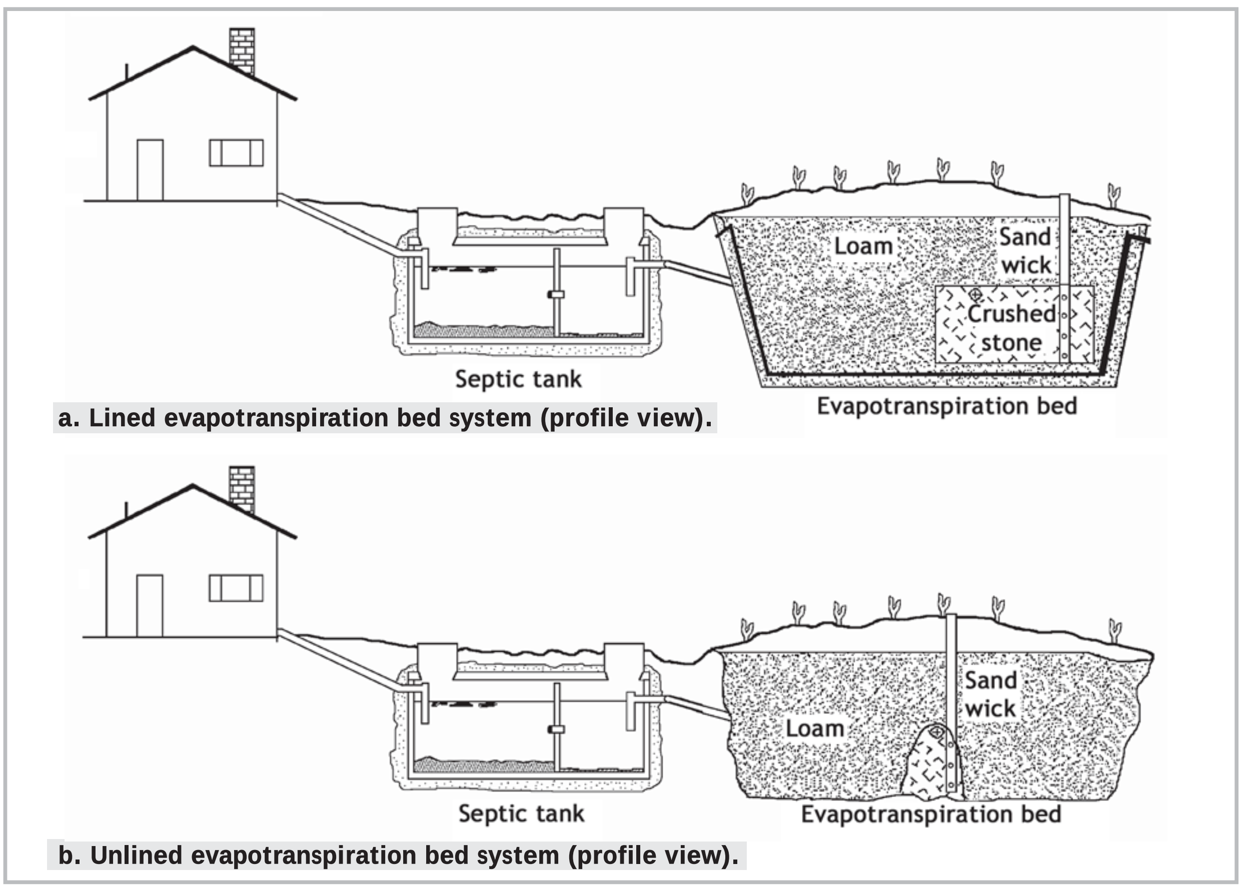
Components

There are two types of ET beds: lined and unlined. In lined systems, the ET bed is lined with 20-millimeter plastic, natural clay, synthetic, or concrete liner (Figure 8-9 (a)). A liner is required if the surrounding soil is very permeable, such as in sandy, gravelly, or karst limestone soils.

Unlined systems can be used in highly impermeable soils such as heavy clays (Figure 8-9 (b)). In unlined systems, wastewater is disposed of by a combination of evaporation, transpiration, and absorption, which is often called an evapotranspiration/absorption (ETA) system.

Function

In ET bed systems, solid materials are removed from the wastewater by a septic tank. Then the wastewater is distributed throughout the ET bed system. Final treatment and dispersal occurs throughout the ET bed system when the



a. Lined evapotranspiration bed system (profile view).

b. Unlined evapotranspiration bed system (profile view).

Figure 8-9. ET bed systems.

water evaporates and plants use the water and nutrients in the effluent and release moisture through transpiration through their leaves.

As the water evaporates, salts, minerals, and solids from the effluent accumulate in the bed. During very wet periods when evapotranspiration is low, ET beds store water until drier periods when evaporation and transpiration occur.

Layout

A liner and sand cushion are placed in the ground, and the storage system is set on the bed bottom. Generally, the storage system consists of a bed of rocks or gravel of a uniform size ranging from 3/4 to 2 inches in diameter, filling the bed to a depth of 12 inches or less depending on the bed's overall depth. Distribution pipes are placed not more than 4 feet apart and no less than 2 feet from the bed walls. The top of the distribution pipe must be flush with the top of the rock media.

Other types of media, such as tire chips, or storage systems, such as leaching chambers, may be used for the storage trenches.

A water-permeable soil barrier (such as a geotextile filter fabric) is placed over the rock. A loam soil is added to fill the bed to within 2 inches of the top. Selecting the proper soil is extremely important in building an ET system. The soil draws the water toward the surface faster than coarse sand.

Wicks, a column of soil that extends through the rock media to the bottom of the bed, draw water continuously from the rocks into the surrounding soil and toward the surface area, where it evaporates or is taken up by plants. The total wick area should be 10-15 percent of the bed surface and uniformly spaced throughout the bed. After the loamy soil is in place, the final 2 inches are filled with sandy loam and mounded in the center with a slope of 2-4 percent toward the outside of the bed (to shed rainwater and stormwater). The last step is to plant vegetation specially selected to transpire the most water, such as Bermuda or St. Augustine grass. Placing grass sod over the bed may be the best approach to establishing grass there.

Using seed may let the mounded soil wash away during heavy rainfall before the grass is established. Larger plants with shallow root systems, such as evergreen bushes, may also be used to help take up water.

If you use grass with dormant periods, be sure to provide adequate vegetation on the beds during these periods. A common solution is overseeding with winter grasses to provide year-round transpiration.

Operation and maintenance

When using more than one ET bed, a switching valve connecting the two beds allows you to alternate the wastewater flow between the beds. When one bed becomes saturated, turn the valve to divert effluent into the other under-loaded bed. An inspection port added to each bed will help you determine water levels during use. Covering the port prevents insects, small animals, and unauthorized people from getting to the bottom of the bed.

The proper O&M of an ET bed can be accomplished through the following tasks: (**Form 8-2. Evapotranspiration bed (ETB)**)

1. Evaluate the presence of odor as you approach the system. There should be no strong odors near the bed if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

Check the vegetation growing on the system as the system matures. The service provider may need to use salt-tolerant grasses, such as Bermuda grass, because salt accumulates in the system. Water leaves salts in the soil when it evaporates. Harvesting the salt-tolerant grasses may reduce the salts in the system if the plants can accumulate the salt in their leaves. The potential for high salt concentrations depends on how much salt is in the water supply. Mow the grass cover regularly. Grass cover is important for transpiration of wastewater. Overseed with a cool-season grass to provide transpiration in the winter. If grass cover is not maintained, the system will probably fail.

2. Identify the method of distribution system to the ET bed: gravity-to-gravity or pump-to-gravity.

   A distribution device is needed to distribute effluent to the individual trenches. These include distribution boxes, drop boxes, headers, and manifolds. If the system is using a pressure manifold, record the distal head. The distribution devices should be easily accessible. Check for equal distribution in the drainfield. Look at grass growth patterns in the yard. It should have even, uniform growth over the beds. The boxes must remain level or have some leveling devices to assist with water distribution to the individual trenches. Presence of sludge in boxes indicates potential solids transport to the drainfields. If sludge is detected, then the solids level is needed to determine pumping needs. Check for root intrusion in the distribution device.

3. Check switching valves. Switching valves can be used to direct flow among multiple beds. Check if they are present and operating. Record which beds are in operation before leaving the site.

4. Check that rainfall and runoff are diverted around the system. The system is designed to handle normal rainfall entering from the top of the system, but excessive rainfall will overload it. Maintain the sloped cover on the system to help rain run off the bed. Evaluate the presence and depth of ponding in the ET bed. Check for surfacing effluent on or around the system.

5. Look for inspection ports. Inspection ports are the best method to evaluate the presence and depth of ponding. If they are not present, they should be recommended as an improvement. No heavy objects or obstructions of any kind (such as improper landscaping) should impede the service provider from accessing the drainfield.

Form 8-2. Operational checklist: Evapotranspiration beds (ETB).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: _______________________ Employee:_______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: ______________________________

1. Conditions at the ET bed
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes____No_____
   d. Vegetation appropriate. Yes____No_____
   e. Excessive vegetative growth. Yes____No_____
   f. Vegetation adequately maintained. Yes____No_____
   g. Preventing accessibility for maintenance. Yes____No_____
2. Distribution to ET bed
   a. Method for dosing:
      ❑ Gravity-to-gravity ❑ Pump-to-gravity
   b. Type: ❑ Distribution box ❑ Drop box ❑ Header
      ❑ Pressure manifold ❑ Other: ____________________
   c. If pressure manifold, distal head: ________________________
   d. Accessible. Yes____No_____
   e. Intact, providing equal distribution. Yes____No_____
   f. Free of solids. Yes____No_____
   g. If 'No' depth of solids below outlet. ____________in
   h. Root intrusion. Yes____No_____
3. Switching valve
   a. Switching valve present. Yes____No_____
   b. Type of valve:______________________________________
   c. Operating properly. Yes____No_____
   d. Action taken if not:__________________________________
   e. Bed in operation: ___________________________________
4. ET bed:

Bed #	Status		Ponding		Surfacing Effluent (Yes - No)	ET Bed Surface Shedding Rainwater (Yes-No)
	Current	End of Service	Yes-No	Depth (in)		
1	❑ Active ❑ Resting	❑ Active ❑ Resting				
2	❑ Active ❑ Resting	❑ Active ❑ Resting				

5. Inspection ports
   a. Inspection ports present. Yes____No_____
   b. Inspection ports intact. Yes____No_____

Notes

1. ❑ Acceptable
   ❑ Unacceptable

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

Low-pressure drainfield (LPD)

Overview

The main objective when using low-pressure distribution is to evenly distribute wastewater over the entire surface of the drainfield trenches. To accomplish even distribution, pumps and small diameter pipes with small diameter orifices are utilized. Two general categories of low-pressure drainfields (LPD) are recognized based upon the strength of wastewater being dosed—low-pressure pipe (LPP) and shallow narrow drainfields. LPP is typically installed in a trench and the pipe is supported by stone or other material. A shallow narrow drainfield is typically installed at the base of a shallow trench. It is critical for the operator to have access to original LPD designs and as-built drawings, as valve/manifold arrangements can vary widely.

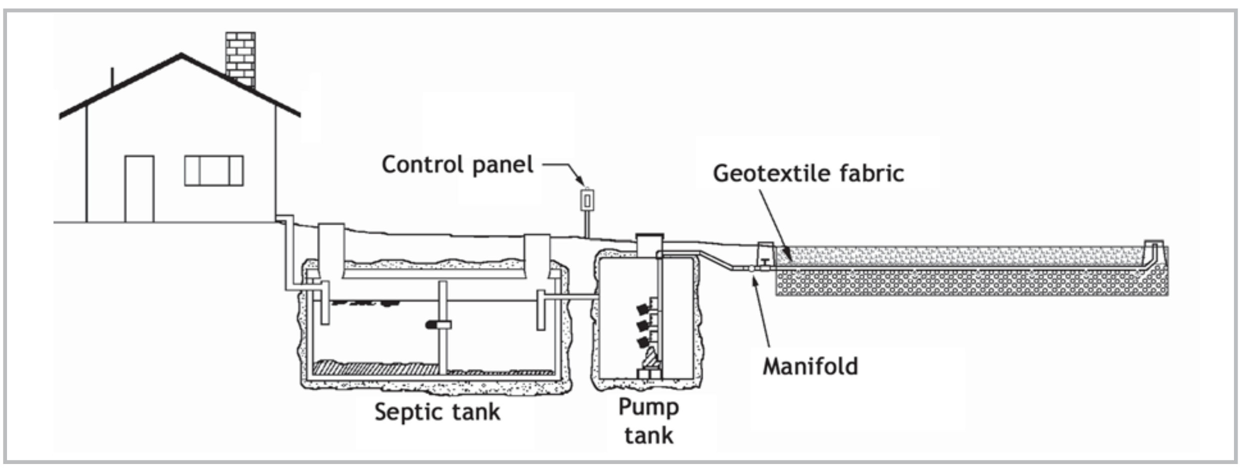
Low-pressure pipe (LPP)

LPP drainfields have 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 8-10).

The typical LPP drainfield consists of a pressure manifold and trenches (although a bed-type configuration may be used). The laterals, usually 11/4- to 2-inch diameter PVC pipes, are surrounded by washed stone, gravel, plastic chambers, slotted irrigation pipe, or synthetic media placed in the trench. Pressure-regulating valves are normally placed at the beginning of each lateral to allow for distal head pressure adjustment (Figure 8-11 (a)). Lateral orifices (1/8 to 1/4 inch in diameter) are generally oriented in a six o'clock position and spaced every 5 to 10 feet along the lateral depending on soil type. Cleanouts are placed at the lateral ends in access ports 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 (Figure 8-11 (b)). 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 (Figure 8-12 (c)).

Because straight septic tank effluent is being dosed, the development of a biomat at the trench infiltrative surface is to be expected. However, a fully developed biomat is not required for distribution of the effluent as is needed in gravity distribution trenches. The pipe network with orifices distributes the effluent. The dose volume and resting period between doses controls the quantity of ponding and distribution of the



8-10. Low-pressure pipe drainfield (profile view).

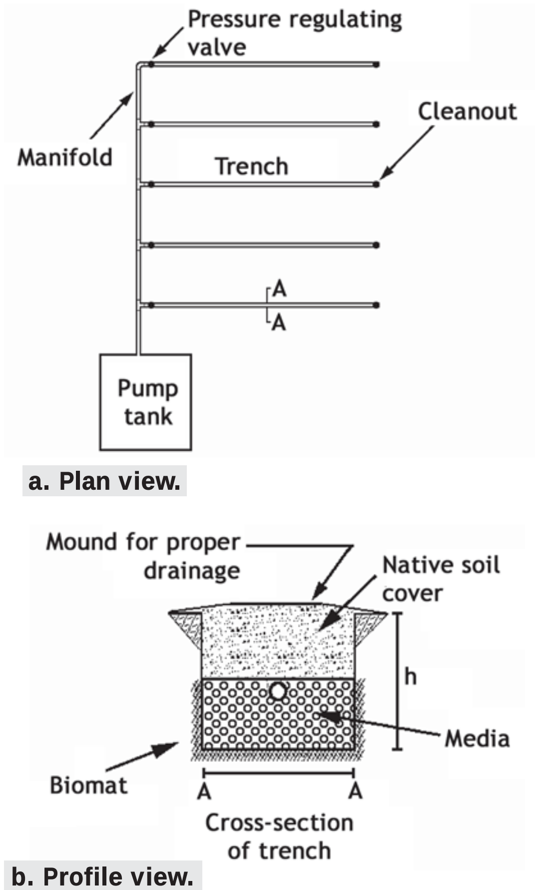


Figure 8-11. Low-pressure pipe drainfield.

effluent. LPP systems can be either time dosed (promoting flow equalization) or demand dosed.

Shallow narrow pressurized drainfield

Shallow narrow pressure-dosed drainfields are used to disperse wastewater from innovative systems. Typically, this drainfield type is used for wastewater that meets a minimum treatment level of 30 mg/L of both BOD_5 and TSS. Shallow narrow drainfields are placed in the upper soil layers (6 to 12 inches from the ground surface) for maximum wastewater treatment by natural soil processes. Shallow placement maximizes vertical separation distance from the drainfield base to the groundwater.

A shallow narrow drainfield works by pressure-dosing treated effluent into a small PVC drainfield lateral, which is typically 3/4 to 2 inches in diameter (Figure 8-12 (a)). The drainfield lateral pipe usually has 1/8- to 3/16-inch orifices drilled every 18 to 24 inches. The pressurized effluent squirts up against a cover made of a 12-inch PVC pipe cut lengthwise (Figure 8-12 (b)).

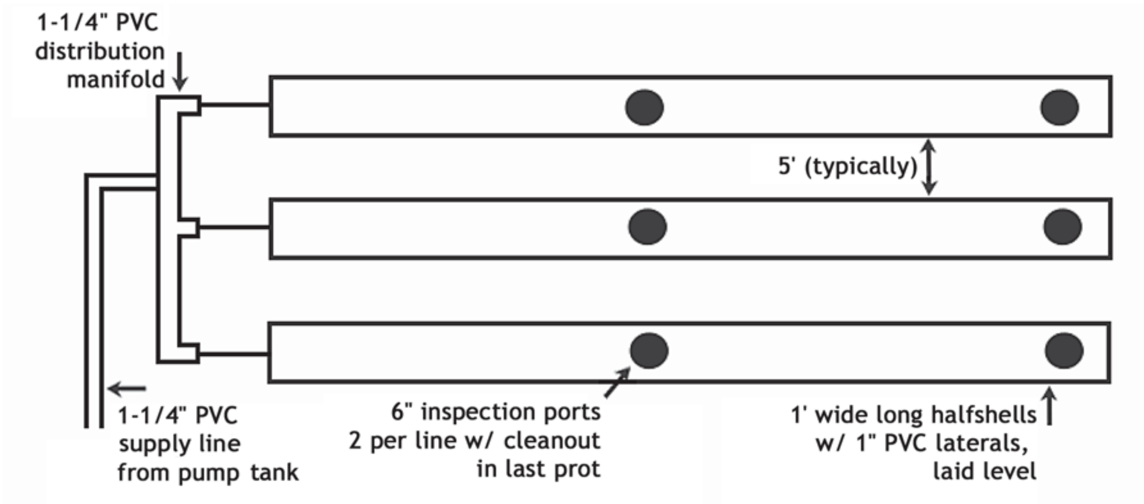
This half-pipe protects the trench and helps distribute the effluent evenly over the trench bottom just below the ground surface where biological activity is greatest. Effluent infiltrates the native soil surface and percolates down through underlying soil where additional nutrient and pathogen removal occurs.

Operation and maintenance

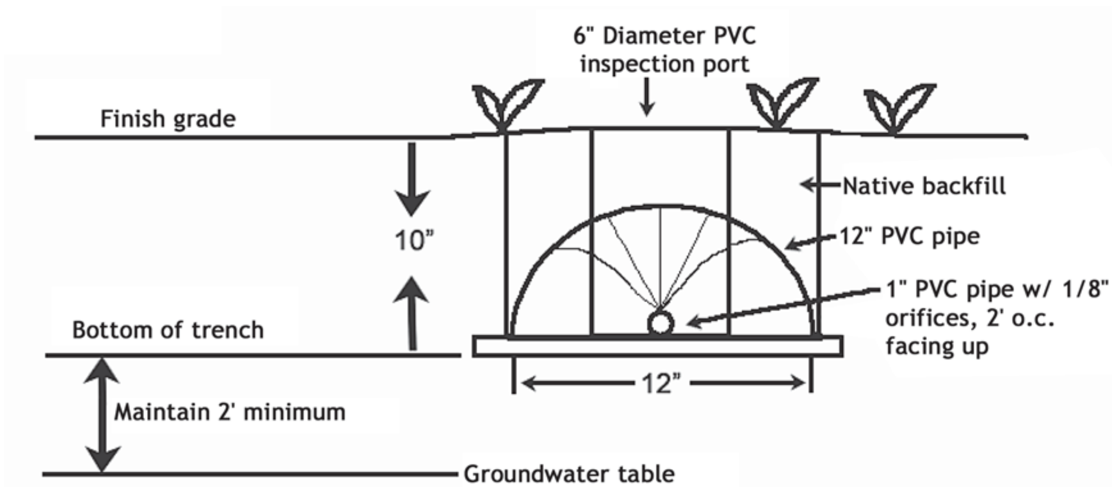
The proper care of LPDs can be accomplished through the following tasks (**Form 8-3. Low-pressure drainfield** (**LPD**)):

1. Determine if the effluent entering the system is aerobic or septic tank quality (anaerobic). Note the type of LPD—a low pressure pipe drainfield or a shallow narrow drainfield.

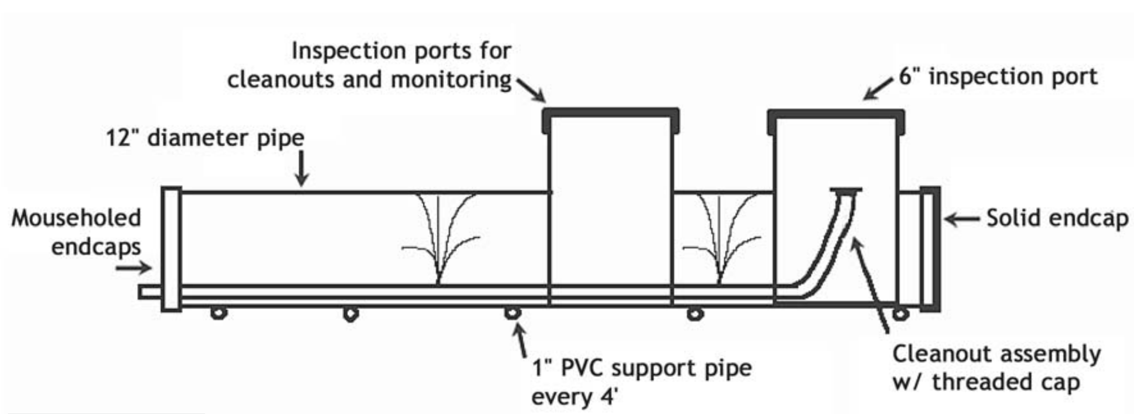
2. Evaluate the presence of odor as you approach the system. There should be no strong odors near the drainfield if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.



a. Plan view.



b. End profile view.



c. Profile view.

Figure 8-12. Shallow narrow pressurized drainfield.

Vegetation management on and around the drainfield is important for proper performance. Appropriate vegetation may be defined by local regulations. Typically, appropriate vegetation includes mowed grasses and/or short non-woody plants. During the growing season, grasses help remove moisture from the drainfield area. However, some water-loving plants with extensive root systems can cause problems with orifice clogging and water distribution in the system. Check for root intrusion into orifices in the lateral line (while snaking and flushing laterals).

3. Check supply line conditions. Check that the supply line drains freely after a dose. Check for any ponding or saturation along the supply line. Note if air relief valves are present and operating. Air relief valves should let the air in the line vent until the line is free of air. These valves allow for the line to pressurize faster and to avoid damage to pipe systems. Check valves are usually not necessary unless the static head is such that it will provoke backspin of the pump's impeller. Check valves are necessary for duplex pump systems. If using a check valve, a weep hole should be drilled just above it through the pipe to allow for drainback. If the pipe run is too long and pipe volume is a concern for the size of the chamber, the use of a check valve is warranted to keep supply line full. If keeping supply line full, an airvent hole is needed below check valve to prevent air-lock of the pump.

4. Check the function of the switching valves (if present). Record the type of switching valve, and record if any actions were taken for maintenance. Switching valves are used to automatically or manually divert the flow of effluent to another field or a different part of the field. Some switching valves are used to stop effluent from gaining access to part of the field (zone). Record which laterals/zone are in operation before leaving the site. Check that this has not been changed by the owner during the service interval.

5. Record soil treatment area information for each zone and lateral. Measure the distal head in inches (also known as squirt height) before and after cleaning. The distal head in the lateral line determines the flow rate of water leaving the orifices. Checking the distal head at the end of the lateral can be used to estimate how evenly the water is being distributed. If required, reset the lateral distal head pressure to the original value by adjusting the pressure-regulating valve located on the beginning of the lateral.

   View the drainfield base via inspection ports if present. LPP trenches are likely to have biomats present and some level of ponding and odor. The base of a shallow narrow drainfield should not have a biomat or have septic odors.

   Evaluate each lateral in the drainfield. An evaluation of the extent and depth of ponding can provide some indication about how much of the system is being utilized at the time of inspection and may also be a function of seasonal ground wetness. Check for surfacing effluent from the laterals, and measure the distance the effluent traveled. Look at the lateral ends for damage, and look for any root intrusion or obstruction to the system.

6. Record the positions of the orifices. If the orifices and laterals were cleaned, record the method used to clean them. The distribution lateral distal ends need to be accessible to allow for orifice cleaning. These laterals are periodically flushed to remove materials that have accumulated. This can be accomplished by jetting the lines with water or cleaning the system. Use a plumber's snake with a bottle brush attached, and/or vacuum the lines with a vacuum truck. Flush, snake, and reflush laterals (or use other method desired) to clear solids. Do this procedure one lateral at a time to maximize flushing pressure in each lateral.

7. Check to see if there is surfacing effluent anywhere else in an elevated system. If fill is used to elevate the system, then the natural soil/fill interface must be evaluated for leakage. Any leaks are a problem.

8. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, transport, and store samples using standard wastewater procedures. Record the chain of custody (COC) information, and deliver the sample to an authorized laboratory. Retain a signed COC from the testing laboratory to complete the system file. Report the sample analysis information to the proper entities.

Form 8-3. Operational checklist: Low-pressure drainfield (LPD).

Service provided on: Date:________ Time:____________ Reference #:____________________
Service provided by: Company: ____________________ Employee:____________________
Date of last service: ______________________________ By: ❑ You ❑ Other:____________
Date of last inspection: ____________________________

1. Effluent Quality: ❑ Aerobic ❑ Septic tank effluent (anaerobic)
   Type of low-pressure drainfield: ❑ Low-pressure pipe ❑ Shallow narrow drainfield
2. Conditions at the LPD
   a. Topography: ❑ Level ❑ Sloping: _________ % slope
   b. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   c. Source of odor, if present: ____________________________
   d. Indications of leaks around/above system. Yes_____No_____
   e. Vegetation appropriate. Yes_____No_____
   f. Excessive vegetative growth. Yes_____No_____
   g. Vegetation adequately maintained. Yes_____No_____
   h. Preventing accessibility for maintenance. Yes_____No_____
3. Supply line
   a. Line drains freely. Yes_____No_____
   b. Ponding or saturation present along parts of the supply line. N/A_____Yes_____No_____
   c. Air relief(s) valve operating. N/A_____Yes_____No_____
4. Switching valves
   a. Switching valve present. Yes_____No_____
   b. Type of valve:______________________________
   c. Operating properly. Yes_____No_____
   d. Action taken if not:____________________________
   e. Laterals/zones in operation: ______________________
5. Soil treatment area information:

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

Zone #	Lateral #	Distal head		Ponding Yes - No (in)	Surfacing effluent		Lateral ends			Root intrusion (Yes - No)	Other obstruction (specify)
		Operating at (in)	Adjusted to (in)		(Yes - No)	Distance traveled (ft)	Intact	Protected	Accessible		

Form 8-3 (continued). **Operational checklist: Low-pressure drainfield (LPD).**

Reference #:____________________

6. Orifices
   a. Position: ❑ 6 o'clock ❑ 12 o'clock
   b. Orifices cleaned. Yes_____No______
   c. Method: ❑ Hydrojetted ❑ Bottlebrushed
   ❑ Flushed ❑ Other:____________________
7. Elevated system: N/A_____________
   a. Surfacing effluent present. Yes_____No______
8. Lab samples collected for monitoring. Yes_____No______
   Types of analysis:____
   ____
   ____

6. ❑ Acceptable
   ❑ Unacceptable

7. ❑ Acceptable
   ❑ Unacceptable

Media filters used as drainfield options

Several types of media filters are used as drainfield options when they are configured in a bottomless fashion to allow treated wastewater to infiltrate directly into the soil beneath the unit. Essentially, their design looks quite similar to the single-pass media filter without the bottom liner or watertight sealed container. Media filters with an open bottom are specifically intended to disperse wastewater into the soil immediately under and adjacent to their footprint. Three media filters fall into this category: bottomless sand filters (BSFs), mounds, and bottomless peat filters.

The service provider should pay careful attention to verifying that these systems are hydraulically disconnected from the stormwater that may be generated on a site, that the filter footprint is kept as dry as possible, and, in the case of mounds, that vegetation is appropriate and adequately maintained.

Bottomless sand filter

BSFs are similar in several ways to the single-pass sand filter. However, BSF media may be finer textured and less uniform. Typically BSF sand media have an effective size of 0.33 mm and a uniformity coefficient of 2.5 to 4. In addition, they lack a bottom filter liner and underdrain. Some states allow straight septic tank effluent to be applied to BSFs; whereas, others require use with wastewater that has met a minimum 30 mg/L of both BOD_5 and TSS standard. The service provider is encouraged to check with local or state regulatory programs to determine what effluent discharge standards may apply to the BSF.

Wastewater is applied under low pressure to the top of a 2- to 3- foot deep bed of sand media through a distribution manifold and lateral system (Figure 8-13 (a)). The manifold and laterals are surrounded by pea gravel that extends to the filter surface (free access) (Figure 8-13 (b)). Wastewater trickles down in unsaturated thin-film flow through the sand media in a time-dosed mode. BSF effluent then percolates directly into the soil under the filter.

Because of a higher hydraulic loading rate and oxygen and gas exchange requirement, BSFs are usually not buried as are single-pass sand filters. BSFs can be designed at-grade, where just 6 to 10 inches of the filter projects above existing grade, or above grade, with the top 24 to 30 inches of the filter above the ground surface. The technology is usually used for residential systems where soil and site conditions exist that make the use of conventional or LPP drainfields impractical or not economical.

Mounds

A mound system for wastewater treatment is a soil absorption system placed above the natural surface of the ground. In pressure-dosed mounds, septic tank effluent is dispersed into carefully chosen fill of permeable, well-drained sands that contain a high volume of free air within the pore space. Because the effluent is distributed over a large area of sand, it moves slowly through the fill material and is in contact with air as it percolates downward. An elevated mound system is built above the native soil to achieve the required separation distance between the infiltrative surface and the limiting soil condition of the site. A mound has 1 to 2 feet of treatment media. The main goal is to preserve and use the natural soil conditions at the site. The wastewater must move into unsaturated soil in order for the microbes in the soil and in the biomat to feed on the waste and nutrients in the wastewater.

The components of the system include a septic tank for pretreatment, a pump with a small-diameter pipe network, and an absorption area. The mound itself is a layered structure consisting of a topsoil cap, a layer of sandy loam, a geotextile layer, a low-pressure distribution system, and an absorption area (Figure 8-14).

A topsoil cap, composed of 6 inches of soil, supports vegetation that prevents erosion and

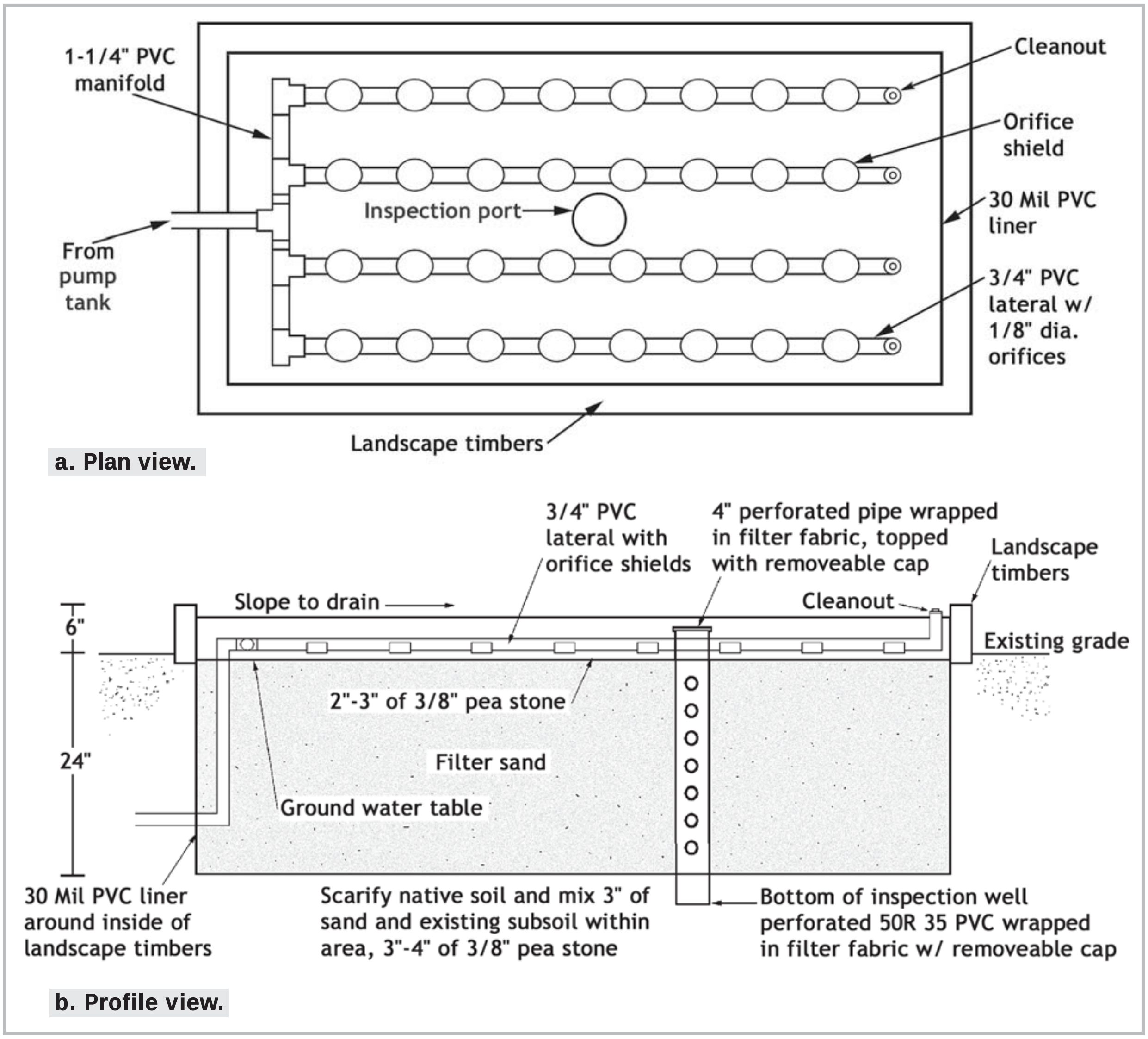


Figure 8-13. Bottomless sand filter.

gives off moisture through transpiration. This helps move treated wastewater into the free air. The topsoil cap is placed over a layer of sandy loam soil that covers the absorption area. This soil is used to retain some wastewater to be used by the vegetation in the topsoil cover. Geotextile fabric is placed over and around the trench media and distribution pipes to prevent soil from entering the pores of the sand media and clogging the absorption area.

A low-pressure distribution system of small-diameter pipes is used to distribute effluent evenly throughout the absorption area.

The absorption area stores the treated wastewater until it percolates down into the sand layer. A variety of materials can be used in the absorption area including gravel, washed stone, and leaching chambers. A sand layer is placed above the native soil to obtain the generally required 24 inches of separation between the infiltrative surface and the groundwater, or 18 inches of separation to impermeable soils or bedrock. These separation distances may differ among regulating jurisdictions. The total area of the mound is based on the ability of the native soil to accept wastewater.

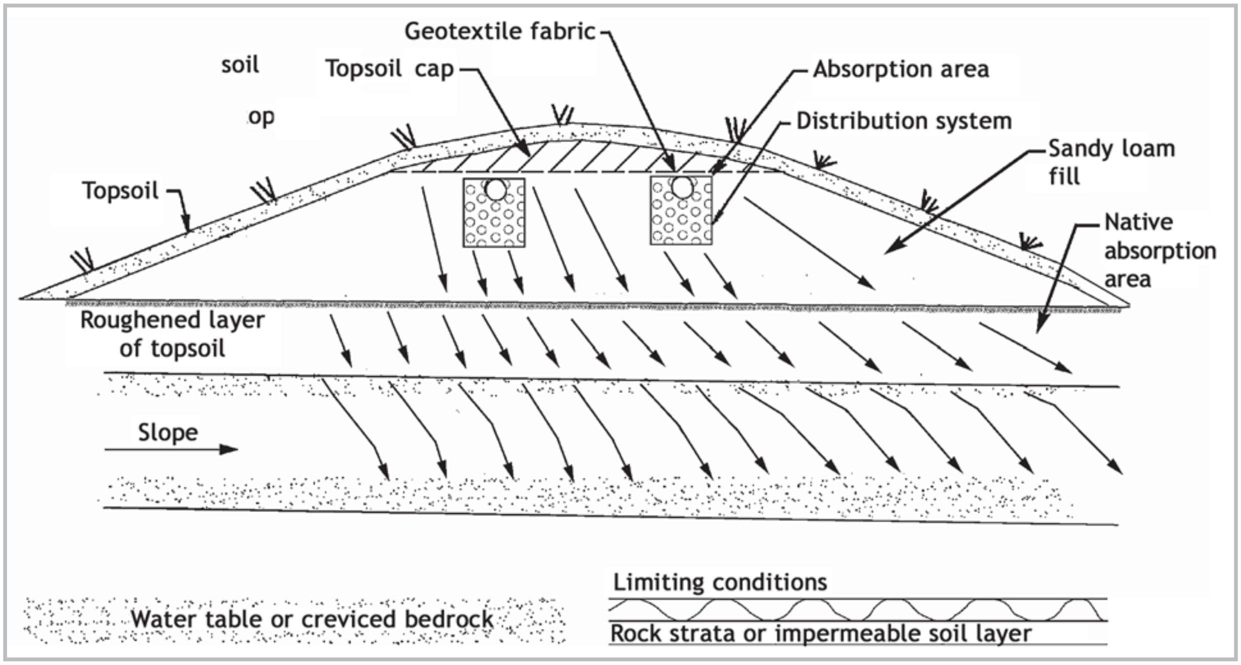


Figure 8-14. A mound system is placed above the natural surface of the ground (profile view).

Distribution laterals are placed in the absorption area. If leaching chambers are used, the distribution laterals are usually attached to the top of the chamber, and orifices are oriented in the 12 o'clock position, with one or two holes in the 6 o'clock position to allow the pipes to drain. The fill material is significantly coarse to provide the needed porosity for good air movement and yet provides enough gradation to limit the flow rate through the media and promote unsaturated flow. The area underneath the mound distribution system functions like a media filter (see Chapter 7).

There should be a minimum of 6 inches of topsoil covering the edges of the absorption area and 12 inches covering the center of the mound. The area up-grade of the mound should be landscaped to divert rainfall runoff around the mound and prevent ponding of stormwater behind it. Observation tubes are usually installed in the mound bed to monitor water infiltration and ponding in the mound.

Several variations of mounds are used in many locations. These include areal fill systems, Wisconsin mound systems, raised beds, and others. These options reflect substantial variations in requirements for dosing/gravity distribution, design, application rate, and construction methods. Despite the differences, these variants can be operated and maintained in a fashion similar to the mounds previously described.

Bottomless peat filters

Peat filters can also be used to treat septic tank effluent with a single-pass and bottomless method as a drainfield option. Prefabricated peat modules are typically placed on a prepared surface of washed stone or gravel. Wastewater is dosed to the top of the peat filter, trickles down through the media bed, and exits from the module through holes located in the filter base. Some peat filters can be installed without the bottom and installed directly on the soil surface. Other designs include stone or gravel at the module's base that spread the effluent provided by the module's holes.

Unlike sand media, peat tends to settle, decompose, and/or deteriorate over time and may need to be replenished or replaced entirely at some point during use. Replacement frequency is dependent upon the type of peat used and wastewater flow and characteristics, but typically peat needs to be completely replaced after 4 to 12 years of use. Additional peat material may need to be added to the module yearly to assure that distribution laterals are covered to prevent odor problems.

Operation and maintenance

Bottomless sand filter, mound, and bottomless peat filter maintenance requirements depend on the type of wastewater treatment needed. Generally, O&M can include the following evaluations (**Form 8-4a. Bottomless sand filters and mound systems** (BSF and MS) **and Form 8-4b. Bottomless peat filters** (BPF)):

1. Note the type of system being evaluated: a bottomless sand filter or a mound system.

2. Evaluate the presence of odor as you approach the system. There should be no strong odors near the filter if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

   Leaks around or on the system are not acceptable and are signs that the dispersal area is not operating properly.

   Vegetation management on and around the drainfield is important for proper performance. Appropriate vegetation may be defined by local regulations. Typically, appropriate vegetation includes mowed grasses and/or short non-woody plants. During the growing season, grasses help remove moisture from the drainfield area. However, some water-loving plants with extensive root systems can cause problems with orifice clogging and water distribution in the system. Check for root intrusion into orifices in the lateral line (while snaking and flushing laterals).

3. The media surface in the filter accepts wastewater and is the starting point for the wastewater treatment process. Vents and inspection ports to the media filter surface or underdrain system allow determination of the level of ponding. Ponding can indicate clogging of the media filter surface. Clogging in the media filter may occur due to physical and biological factors. Physical clogging is caused by the accumulation of solid material within or on the media surface. Biological clogging is due to excessive microbial growth within the filter. An accumulation of biological slime and a decrease in the rate of decomposition of entrapped wastewater contaminants within the filter accelerates clogging. The media filter can be allowed to rest to dry and break down the biological materials growing in the filter. A biomat is usually normal in mound systems as long as the effluent does not surface. However, it is not acceptable for BSFs or BPFs. Some free access media filters can be raked to break the inhibiting crust that has developed on top of the media filter due to the accumulation of fine materials. This will allow effluent to infiltrate into the media.

   Where applicable, the surface layer of media can be removed from the filter when it is clogged with fine particles.

Media can be replaced if the bed cannot be regenerated. Likewise, if repeated removals of the media surface layers have occurred, then partial replacement will be needed.

If the filter bed has an exposed surface, damage from any animal activities should be prevented.

4. Distribution systems should evenly distribute wastewater across the top of the filter. These laterals may need cleaning/flushing. Distal head in the laterals may be evaluated using squirt height or liquid height in a clear PVC tube. Distal head should be measured before and after lateral cleaning. Some bottomless peat filters use tipping buckets and/or holes to achieve even distribution.

5. Check for ponding and seepage at the toe of the mound or filter.

6. Inspection ports are the best method to evaluate the presence and depth of ponding. If they are not present, they should be recommended as an improvement. No heavy objects or obstructions of any kind (such as improper landscaping) should impede the service provider from accessing the drainfield.

7. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to the authorized laboratory. Retain signed COC from laboratory to complete system file. Use an authorized laboratory for sample analysis. Report information to the proper entities.

Form 8-4a. Operational checklist: Bottomless sand filters and mounds (BSF and MS).

Service provided on: Date:________ Time:_____________ Reference #:______________________
Service provided by: Company: ________________________ Employee:________________________
Date of last service: ________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: _____________________________

1. Type: ❑ Bottomless sand filter ❑ Mound system
2. Conditions at the drainfield site
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes____No_____
   d. Vegetation appropriate. Yes____No_____
   e. Excessive vegetative growth. Yes____No_____
   f. Vegetation adequately maintained. Yes____No_____
   g. Preventing accessibility for maintenance. Yes____No_____
3. Media surface
   a. Biomat on surface. Yes____No_____
   b. Uniform gravity distribution. N.A._____Yes____No_____
   c. Uniform spray pattern. N.A._____Yes____No_____
   d. Ponding in media. Yes____No_____
   e. Plugging/clogging of distribution components. Yes____No_____
   f. Media appears to be settling. Yes____No_____
   g. Appropriate maintenance performed. Yes____No_____
   h. Animal activity at surface. Yes____No_____
4. Pressure distribution: N.A. ___________
   a. Distal head before cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): _____________in
   b. Lateral condition
      i) Laterals in need of cleaning. Yes____No_____
      ii) Laterals cleaned. Yes____No_____
      iii) Method for cleaning laterals:_____________________
   c. Distal head after cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): _____________in
5. Additional requirements for mounds
   a. Ponding at toe/sides. Yes____No_____
   b. Seepage at toe/sides. Yes____No_____
6. Inspection ports
   a. Inspection ports present. Yes____No_____
   b. Inspection ports intact. Yes____No_____
7. Lab samples collected for monitoring. Yes____No_____
   Types of analysis:_____________________________________
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Form 8-4b. Operational checklist: Bottomless peat filter (BPF).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: _________________________ Employee:_________________________
Date of last service: ___________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _________________________________

1. Conditions at the drainfield site
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ___________________________________
2. Media surface
   a. Top of filter media in good condition. Yes____No_____
   b. Uniform distribution or spray pattern noticed. Yes____No_____
   c. Ponding in media. Yes____No_____
   d. Media in need of cleaning. Yes____No_____
   e. Additional media needed. Yes____No_____
   f. Date of last media replacement: _______________
   g. Media in need of replacement. Yes____No_____
   h. Appropriate maintenance performed. Yes____No_____
3. Pressure distribution: N.A. ___________
   a. Distal head before cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): ______________in
   b. Lateral condition
      i) Laterals in need of cleaning. Yes____No_____
      ii) Laterals cleaned. Yes____No_____
      iii) Method for cleaning laterals:__________________________
   c. Distal head after cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): ______________in
4. Manufacturer's required maintenance performed. Yes____No_____
   (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
5. Lab samples collected for monitoring. Yes____No_____
   Types of analysis:____
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Drip field

Overview

A drip distribution system distributes wastewater through a system of tubing with flow regulating emitters. The tubing can be installed at various depths below the ground surface (Figure 8-15). It generally consists of six main components:

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

The minimum treatment required is a septic tank to settle the solids (Figure 8-16). Some systems utilizing drip distribution for final treatment and dispersal require aerobic treatment (Figure 8-17). The service provider is encouraged to check with local and state regulations.

The pump tank stores the treated wastewater until it is dosed. A high-head pump delivers the water from the pump tank through the filtering device to the drip distribution system.

A control system regulates dosing to the drip fields. Most systems utilize a control panel to implement time-dosing to the fields. This allows effluent to be distributed throughout the day in even doses. Control panels can also control automatic filter backwashing and field flushing. Some systems use demand-dosing to the drip fields with a manual filter and field flushing, but this is not recommended.

The filtering device can be a sand filter, disk filter, or screen filter. Its main purpose is to remove larger particles from the wastewater so they do not plug the drip emitters. Depending on the system design, the filter may have an automatic backwash for the filter devices that can be activated by pressure differentials before and after the filter or on a predetermined frequency. The system can also have automatic, manual, and continuous field flushing.

Flow metering incorporated into the system facilitates monitoring of total hydraulic loading to the drip fields. This flow metering can be accomplished through use of a flow meter, elapsed time meter, or cycle/event counters. Flow meters provide a direct measure of flow. Elapsed time meters and cycle/event counters require the dose volume or pump delivery rate for calculating the flow to the fields. Flow meters can also be used to measure flow rate to the drip fields by recording the volume dosed during a given period of time.

The drip distribution system is made of drip tubing approved by the manufacturer for use with wastewater. The tubing is generally 1/2-inch in diameter with an emitter in the tubing wall. The pressure inside the tubing is

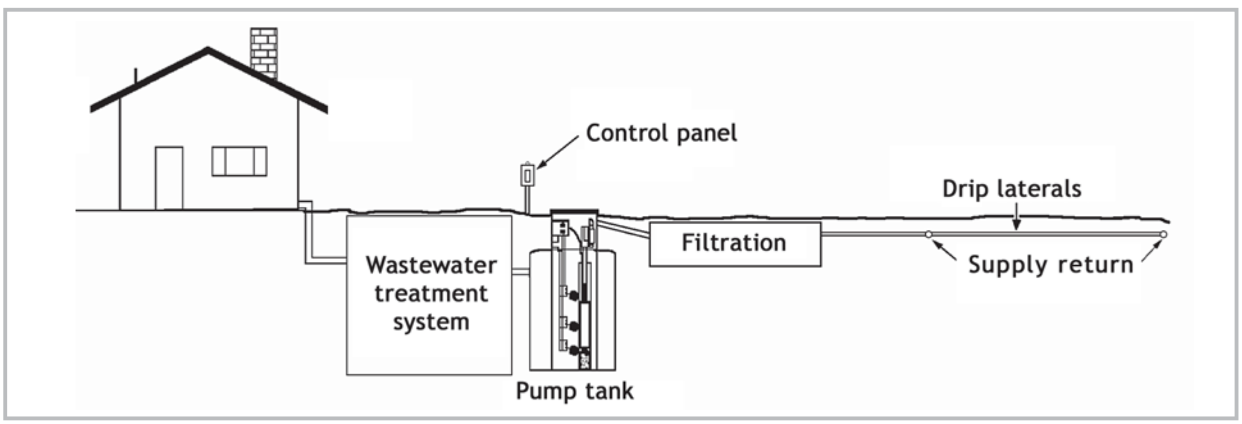


Figure 8-15. Subsurface drip distribution system (profile view).

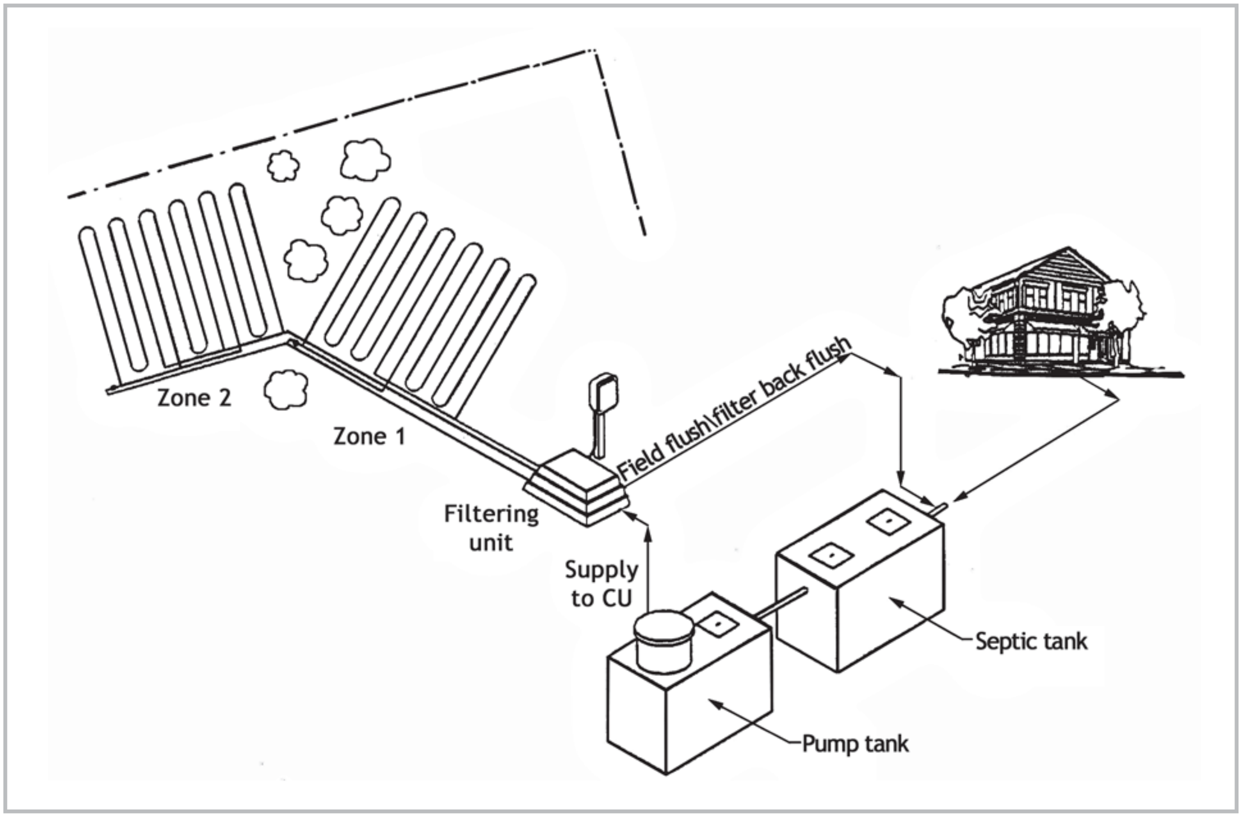


Figure 8-16. Drip distribution system utilizing a mechanical filter showing two zones. (*Source: American Manufacturing, 1999*)

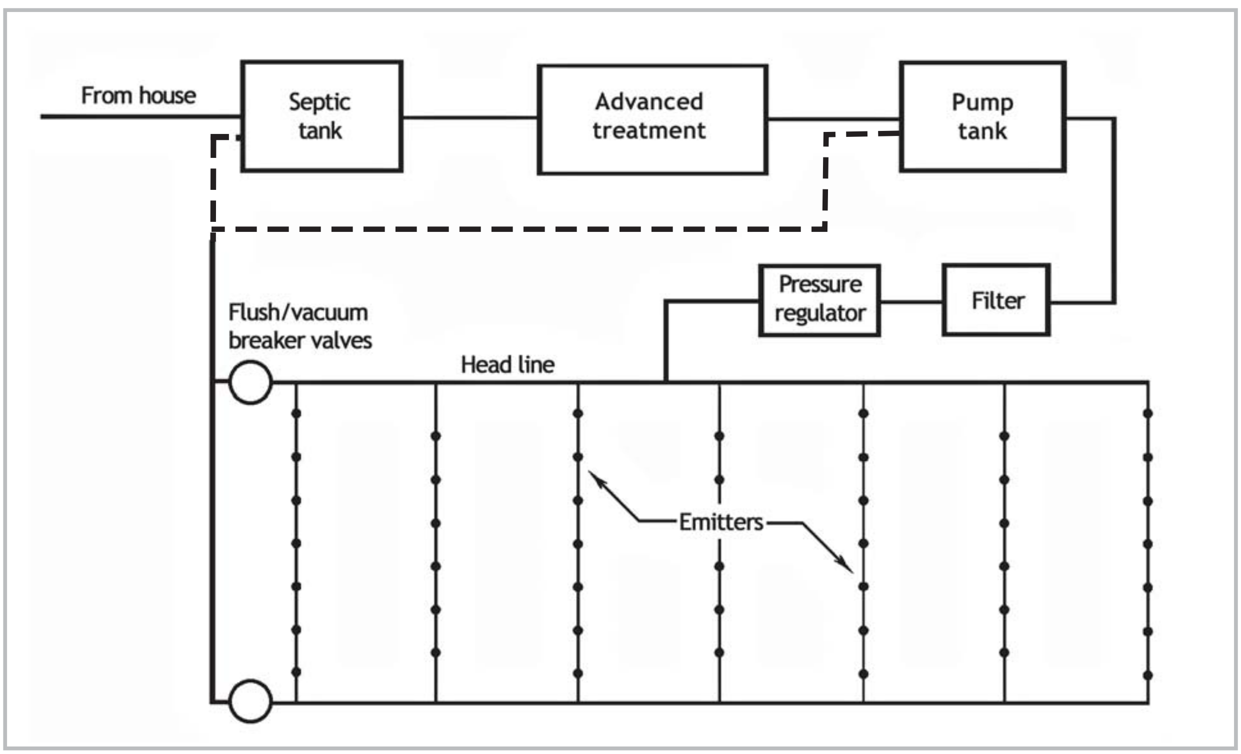
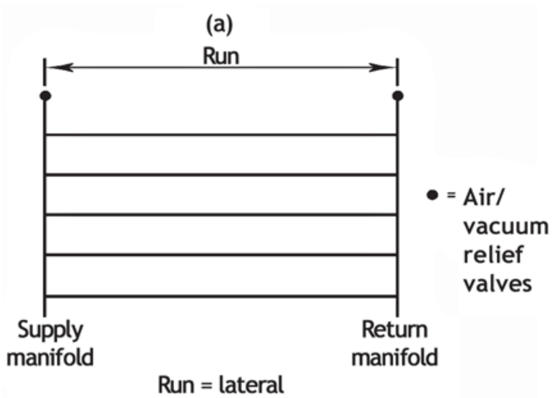


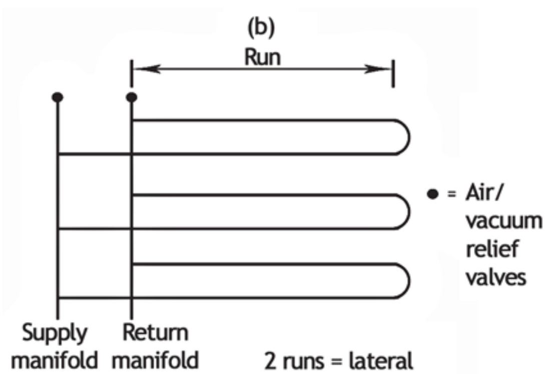
Figure 8-17. Drip dispersal system utilizing aerobically treated effluent (plan view). (*Source: Geoflow, 1999*)

generally operated at 15 to 60 pounds per square inch (psi), with the water exiting the emitter at 0 psi.

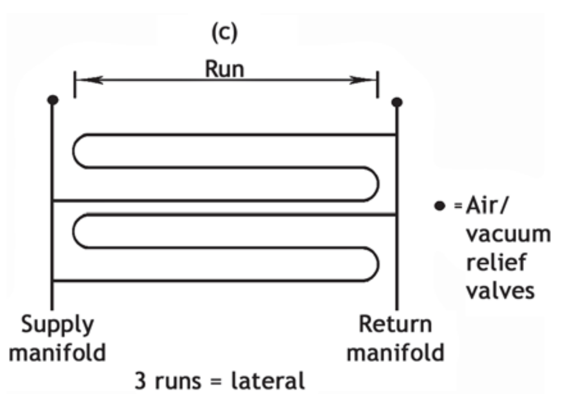
A drip field consists of drip tubing placed along the contour to form a run of tubing (Figure 8-18). These runs can be connected directly to the supply and return manifold forming a "ladder type" drip zone. The individual runs can be looped together to form a lateral. These laterals can then be connected to the supply and return manifold on the same end or opposite ends of the zones. A run is identified as one drip line along the length of the zone while a lateral is defined as one drip line from the supply manifold to the return manifold. There can be multiple runs per lateral (Figures 8-18 (b-c)).



a. The run is equal to the lateral (plan view).



b. Two runs make up one lateral (plan view).



c. Three runs makeup one lateral (plan view).

Figure 8-18. Drip field run layouts.

The supply and return manifolds run up and down the slope to facilitate the placement of the drip runs along the contour. Some methods are utilized to minimize "draindown" during depressurization of the drip zone. Bottom loading of the supply manifold with check valves after connection to each drip lateral and top exiting return manifolds can control draindown. Top loading short supply and return manifolds with small-diameter feeders to the individual drip laterals in the zone can also control draindown.

A given site may require multiple drip zones to have sufficient drip field for loading to the soil. Figure 8-19 is an example of a subsurface drip system layout with two zones on a flat site. A switching device is used to direct flow to the fields. Switching devices can be activated through hydraulic pressure or electrical current. Hydraulic switching valves switch to the next zone at the initiation of a dose. An electric switching valve needs a control panel to select the zone to be dosed. Isolation of the individual zones is accomplished with check valves placed at the end of the return manifold as it connects to the return line.

A single return line will collect field flush effluent from the individual zones. The return flush line needs to be connected to a tank for settling. This allows solids collecting inside the drip tubing to be flushed out.

Air/vacuum relief valves allow the air in the lines to purge, which speeds up the pressurization of the distribution network. After the pump cycles off, the air/vacuum relief valves open automatically to allow air to enter the piping.

Air/vacuum relief valves must be placed on all zones at the highest point. These devices must maintain an ability to exchange air during a dosing event. They must also be protected from damage and freezing. Valve boxes are generally placed around the device to protect them and develop a void space for air exchange.

Treatment

Drip fields distribute small doses of effluent to the soil. The soil that accepts the effluent provides final treatment of wastewater through removal of contaminants.

Operation and maintenance

The proper O&M of the subsurface drip field can be accomplished through the following tasks (**Form 8-5. Drip field** (DF)):

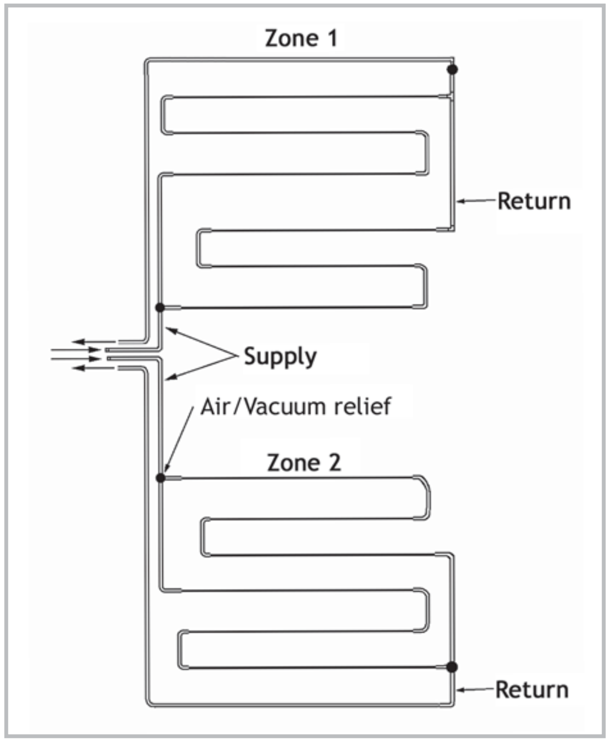


Figure 8-19. Subsurface drip field layout with looped lines (plan view).

1. Evaluate the presence of odor as you approach the system. There should be no strong odors near the filter if the venting system is operating properly and there are no breakouts. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, septic (rotten eggs), chemical, or sour in nature.

   Vegetation management on and around the drainfield is important for proper performance. Appropriate vegetation may be defined by local regulations. Typically, appropriate vegetation includes mowed grasses and woody plants. Drip fields can be used in areas with trees and other woody vegetation. During the growing season, grasses help remove moisture from the drainfield area.

   Evaluate vegetation in the field for uniformity of growth. The growth pattern of the vegetation can give indications of water and nutrient distribution. Changes in the vegetation patterns can indicate problems within the fields.

2. Evaluate the filters. Filtration can be accomplished with a variety of filters: sand, screen, and disk. Note which type of filter is being used. For disk filters and screens, make sure they are in the filter holder and have not been removed. Check the operating pressure before and after the filter(s) to determine the level of plugging on the filter. The filters should be removed and cleaned manually during each maintenance visit or as indicated by

the manufacturer's specifications. This can be accomplished by washing the filter with water or water containing a disinfectant. Some service providers carry replacement filters that are exchanged with the current filters. The dirty filters are then placed in water containing disinfectant or a plastic bag for transport to their shop, and are later cleaned when the filter has been disinfected. Automatic cleaning operations backwash the filters to remove debris. The system should be cycled to verify operation of the automatic backwashing filter. Manually cleaned filter systems usually have a bypass valve on the bottom of the filter to remove the larger solids. Check the valve after the filter is cleaned to make sure it is adjusted correctly.

3. Check flow meters and flow rates. Flow metering can assist in evaluating the drip fields. A flow meter recording the total volume of flow entering the drip fields allows estimation of loading which is compared to design loading rates. Evaluating the flow rate going to each drip zone can assist in determining the potential of emitter plugging. Elapsed time meter and cycle/event counter readings at the time of the visit can be compared with previous readings to determine number of doses and total pump run time.

4. Check the function of the switching valves (if present). Record the type of switching valve, and record if any actions were taken for maintenance. Switching valves are used to automatically divert the flow of effluent to another field (zone) or a different part of the field.

5. Evaluate the operation of the flushing system. Field flushing can be accomplished manually, automatically, or continuously. The operation of the flushing system should be evaluated. Check the operating pressure in the drip fields to provide an estimate of hydraulic conditions. A field flushing event should be conducted while at the site. Using either an elapsed time meter (ETM) or a cycle counter (CC), record the present and last flushing time reading (PFTR/LFTR) or the present and last flushing cycle reading (PFCR/LFCR).

6. Evaluate the drip field zones for proper operation. The flow should be evaluated for the total flow and flow rate entering the drip field. Air/vacuum relief valve should be evaluated to ensure operation. Make sure air/vacuum relief valves do not leak effluent once the system pressurizes. If they do, they will need to be replaced or serviced. Check for excess water or wet areas in the field indicating surfacing effluent. Drip tubing can be cut by poking metal objects into the soil. A cut in the tubing will allow excess water to be emitted.

7. Perform any additional maintenance that manufacturers may recommend for their specific units. Document these activities in the comments section.

Form 8-5. Operational checklist: Drip field (DF).

Service provided on: Date:_________ Time:______________ Reference #:______________________
Service provided by: Company: _________________________ Employee:______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ____________________________

1. Conditions at the drip distribution zone
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
2. Drip filter
   a. Type of filter:
      ❑ Sand ❑ Screen ❑ Disk ❑ Other:___________
   b. Filter in place. Yes_____No_____
   c. Pre-filter pressure: ____________ PSI
   d. Post-filter pressure: ____________ PSI
   e. Filter: ❑ Cleaned ❑ Replaced
   f. Automatic cleaning operational. N.A.____Yes_____No_____
   g. By-pass flow operating. N.A.____ Yes_____No_____
   h. Boxes insulated. N.A. ___Yes_____No_____
   i. Heater pad operational. N.A. ___Yes_____No_____
3. Effluent flow metering
   a. Flow meter:
      Current (PFR): ______ gal Date:_________
      Previous (LFR): ______gal Date:_________
      Differential ([PFR - LFR] / days):
      ______gpd Days: ________
4. Switching valves
   a. Switching valve present. Yes_____No_____
   b. Type of valve:______________________________
   c. Operating properly. Yes_____No_____
   d. Action taken if not:______________________________
5. Field flushing: ❑ None ❑ Manual ❑ Automatic ❑ Continuous
   a. Operational. Yes_____No_____
   b. Field flushing operation:

Notes

1. ❑ Acceptable
   ❑ Unacceptable

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

Zone	Manually flushed zones	Operating pressure (PSI)		Zone flushing				Field dosing			
				ETM		CC		ETM		CC	
		Dosing	Flushing	PFTR	LFTR	PFCR	LFCR	PFTR	LFTR	PFCR	LFCR

Form 8-5 (continued). **Operational checklist: Drip field (DF).**

Reference #:_______________________

6. Zone operation:

Zone	Flow rate (gpm)	Total flow (gal) *(since last visit)*	Air/Vacuum relief operating	Surfacing effluent

7. Manufacturer's required maintenance performed. Yes_____No______
(If 'Yes', attach Manufacturer Inspection form to this report, if supplied)

CC- cycle counter
ETM- elapsed time meter
GPM- gallons per minute
LFCR- last flushing cycle reading
LFR- last flow meter reading
LFTR- last flushing time reading
PFCR- present flushing cycle reading
PFR- present flow meter reading
PFTR- present flushing time reading
PSI- pounds per square inch
TT- total time

Spray field

Overview

Spray fields for wastewater treatment are much like a lawn sprinkler system. They spray treated wastewater over the surface of a yard. Unlike a subsurface distribution system, a spray field requires the greatest level of wastewater pretreatment because of the risk of human contact. This in turn increases the cost of the pretreatment system, because it must produce a high quality effluent and includes a disinfection component. Spray systems may incorporate an element of landscape irrigation.

Spray distribution systems have four main components (Figure 8-20):

- A **wastewater treatment system**, which is an advanced process that purifies wastewater by removing solids and organic matter.
- A **disinfection system**, which removes pathogens (disease-causing organisms) from the wastewater.
- A **pump tank**, which collects and holds the water until it is distributed over the landscape. The pump in the pump tank must meet the flow and pressure requirements of the distribution system. The controls on spray distribution systems can be operated in a demand-dosed or timer-dosed method. Local regulations may establish additional restrictions on demand dosed systems.
- A **spray field**, which is placed in the landscape to distribute the water uniformly on the ground surface.

The spray field carries the effluent from the pump tank to the distribution heads (Figure 8-21). The spray field has five components:

- **Supply line/main line,** which carries effluent from the pump discharge assembly to the manifold. In systems with multiple zones, a switching valve is placed at the end of the main supply line and diverts flow to multiple submains.
- **Manifold**, which carries effluent from the main supply line or submain to laterals.
- **Laterals**, which are connected to the manifold and convey a component of the flow to distribution heads.
- **Risers**, which connect the lateral to the distribution heads.
- **Distribution heads**, which connect to the riser and distribute effluent over the ground surface.

The components of the distribution field should be properly sized to uniformly distribute effluent on the ground surface. The main supply line, submains, manifold, laterals, and risers are generally constructed of PVC pipe. The PVC

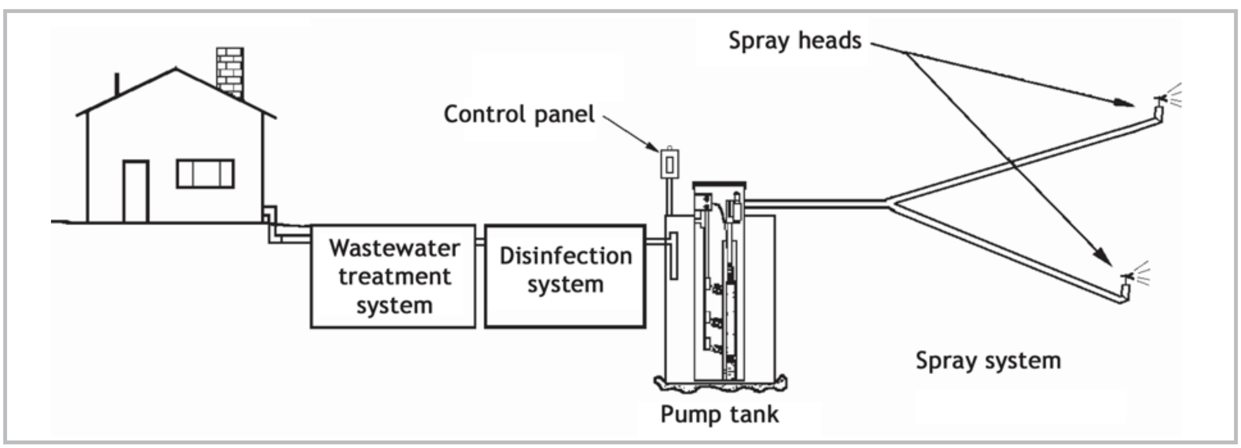


Figure 8-20. Spray distribution system (profile view).

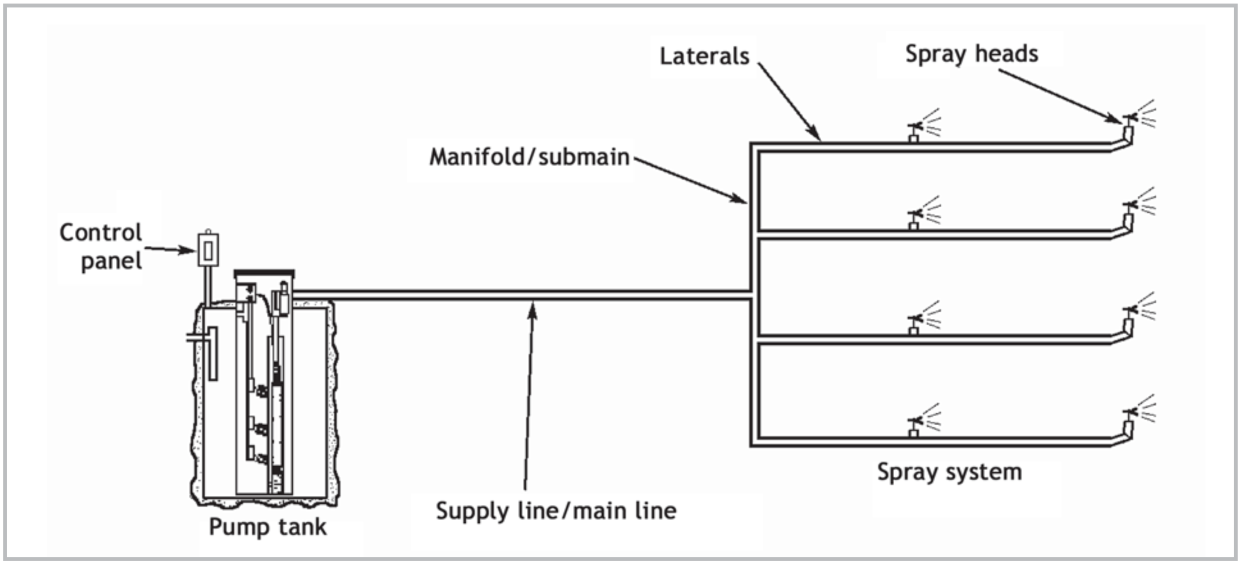


Figure 8-21. Identification of distribution system components.

pipe should have a purple color to denote conveyance of reclaimed water. Non-residential systems can have these components constructed of steel or aluminum piping. Several types of distribution heads are used to apply water and include rotor heads, impact heads, and spray heads. Designers will specify a specific type of head for use in the system. These distribution heads can be a solid set device or constructed with a retractable distribution head and thus operate in a pop-up mode.

The distribution heads are connected to the lateral using a riser. The riser can be a solid rigid pipe extending from the lateral to the distribution head located above grade. The riser can also be constructed in a flexible manner to allow greater ability to set the distribution head location and ease of repair (Figure 8-22). A swing joint uses rigid PVC piping and connections to set the location of the head. A flexible nipple has multiple threaded sections that can be selected and cut to the appropriate length that places the distribution head at the soil surface. A flexible pipe connection uses flexible pipe as a riser. This flexible pipe can assist in locating the distribution head at the ground surface and at a good location with respect to the lateral.

These flexible riser options can reduce the time and effort associated with repairs. A distribution head and riser can be broken due to landscape maintenance. Lawn mowers, people, and animals can move distribution heads and break nonflexible components. The repair of broken risers can be difficult if the lateral fitting is broken. These flexible risers will generally break before the lateral and its fittings are damaged.

Treatment

Because of the potential for human contact with wastewater, a spray distribution system must treat the wastewater to a very high quality before spraying it onto the landscape. This system must treat the wastewater to a "secondary-quality effluent," which generally means that it must remove 85-98 percent of the solids and organic matter. It also must disinfect the wastewater to remove pathogens.

Wastewater must be treated to lower its BOD_5 to less than 20 parts per million (ppm) and its TSS concentration to less than 30 ppm (depending on local and state regulations). To make sure the pathogens are destroyed, a chlorine residual level can be measured in the pump tank, or a microbial test can be used to

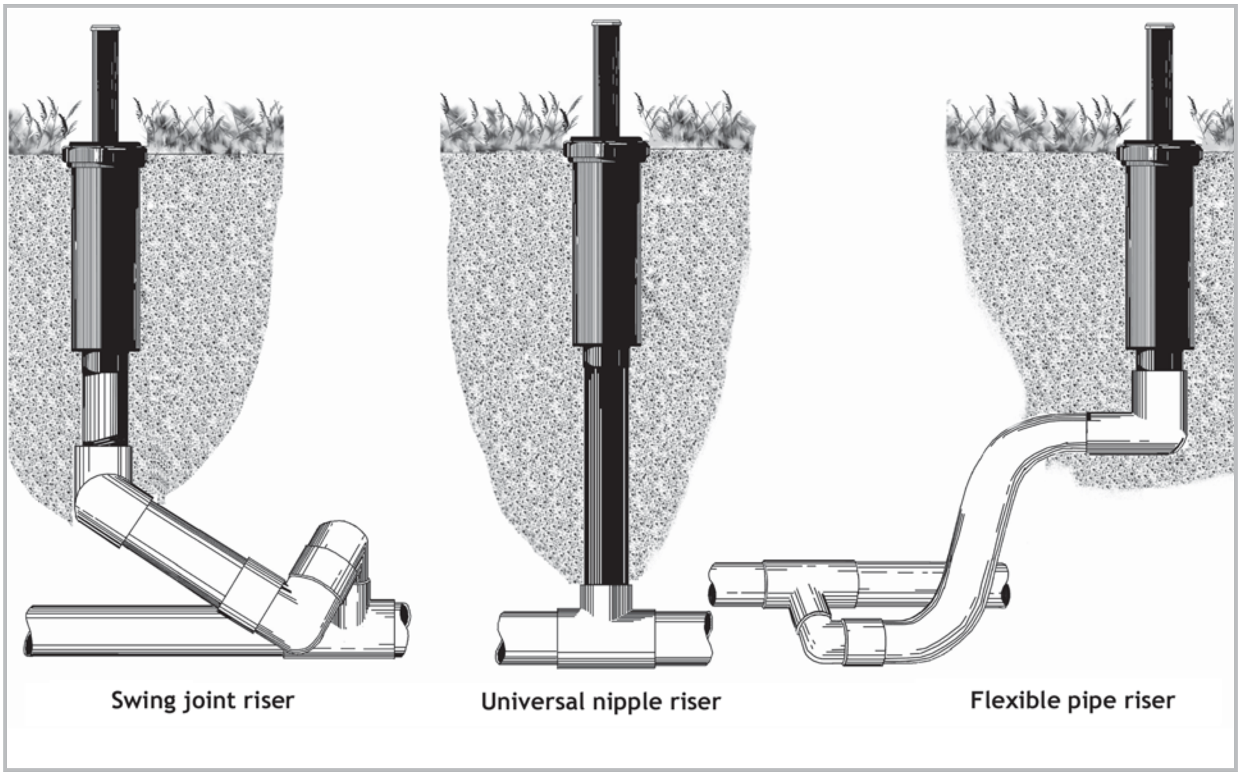


Figure 8-22. Riser options for connecting distribution head to lateral (Profile View).

make sure concentrations of the indicator organisms are below regulated levels. Although the wastewater is relatively clean when it meets these standards, it can still contain nutrients such as nitrogen and phosphorus. Some advanced treatment systems may also remove these nutrients.

Spray distribution systems rely on the soil for final wastewater treatment. The soil must be able to support vegetation that uses the nutrients in the wastewater. Plants use the nitrogen and phosphorus in the wastewater, preventing those nutrients from leaching to groundwater or flowing into surface water supplies.

Regulations may require that the system be designed to handle the greatest amount of wastewater expected, even during the wettest season of the year, without it flowing onto neighboring properties. Therefore, in the driest times of the year, there may not be enough wastewater to meet all the water requirements of the vegetation. Landscapes that require a lot of water will need supplemental watering.

Operation and maintenance

A spray field requires the following items be checked for O&M to continue to function properly (**Form 8-6. Spray fields (SF)**):

1. Evaluate the presence of odor as you approach the system. If odors are detected, determine the source by checking for missing caps on inspection ports or damaged lids or risers. Check for any indication of leaks around or above the system. Also check the roof vent location, prevailing winds, and atmospheric pressure, as these factors can contribute to odor issues. Note whether odors are strong, mild, chemical, or sour in nature. Vegetation management on and around the drainfield is important for proper

performance. Appropriate vegetation may be defined by local regulations. Typically, appropriate vegetation includes mowed grasses and/or short non-woody plants. Tall plants near the distribution heads can obstruct the spray pattern and cause problems with effluent distribution. During the growing season, grasses help remove moisture from the drainfield area.

2. Distribution approach can be accomplished with single or multiple zones. The number of zones should be recorded for future reference.

3. Check the function of the switching valves (if present). Record the type of switching valve, and record if any actions were taken for maintenance. Switching valves are used to automatically divert the flow of effluent to another field or a different part of the field.

4. Check the conditions at the spray distribution site. Purple color coding of the components identifies them as components distributing reclaimed water. Purple components should be noted on the distribution heads, valve boxes, and piping. Some jurisdictions may require signage or fencing to raise awareness regarding reclaimed water distribution or limiting access. If the jurisdiction requires these items, verify their presence.

5. Operating pressure of the distribution system should be recorded. This information can be recorded at the discharge assembly of the pump or at the distribution heads. However, due to the risk of contact with the effluent, the operating pressure is generally measured at the discharge assembly. Note the location of the operating pressure reading.

   Distribution heads generally have a droplet size and operating pressure relationship. Greater operating pressures generally result in smaller droplet sizes. These smaller droplets can easily drift outside the dispersal field on wind currents. An operating pressure of less than 40 psi will generally prevent the water droplets from becoming too small and subsequently reducing the risk of spray drift.

6. If the system uses a control panel, make sure all components are operating properly. If a timer, photocell, or rainfall shutoff are present, manually test the components to assess proper operation.

7. Distribution heads have operational components that need to be evaluated. Some distribution heads have low-pressure shutoff valves to prevent lateral line drainage from exiting the lowest head. In-line filters can be located in the distribution heads to prevent solids from clogging the nozzle. These filters may need to be cleaned to remove debris. The distribution heads may need to be adjusted to have the proper distribution pattern, or the head may be worn-out and need to be replaced. Pop-up heads need to have a clear area around the distribution head to prevent debris from catching in the head as it retracts.

   Verify that all distribution heads are operating. Verify if the heads are on single zone or multiple zones. Verify the number of heads and whether they are operating in a low angle mode. The distribution pattern should be verified with respect to the design. Distribution heads are operated in either a full circle or partial circle pattern. This pattern is generally noted by the degrees of a circle with 360º, 180º, and 90º being a full circle, half circle, and quarter circle, respectively. The type of distribution head should also be noted. Distribution heads used for effluent distribution usually operate as a rotor, impact, or spray head. Low pressure drains are usually only needed in colder climatic regions to prevent static water in the risers. Lines can be drained back to the pump tank, or individual risers may have a localized drain. The riser must remain intact to convey effluent to the distribution head. Some systems will have protective devices placed around the riser to limit access to the riser and distribution head. Note the status of the riser.

8. Evaluate the operational conditions in each zone of the dispersal field. Erosion on the dispersal field can be an indicator of concentrated water flow across the field. Soil erosion should be noted in the zone. Look for areas where effluent is ponding on the ground surface or signs of runoff. Vegetation must be present to use the water and nutrients. Presence of excessive vegetation around the distribution heads can cause uneven distribution. Wet areas around distribution heads could be caused by tall vegetation or slow drainage after the system turns off. Presence of trees or shrubs within 10 feet of the distribution heads can also cause uneven distribution. Gardens are generally not allowed in the dispersal area.

9. Manufacturers of specific units may recommend additional maintenance for their product. These activities should be performed, and the completion of these activities should be documented in the comments section.

Form 8-6. Operational checklist: Spray field (SF).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: ________________________ Employee:________________________
Date of last service: __________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ______________________________

1. Conditions at the spray distribution field
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ____________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
2. Distribution approach
   a. Zones: ❑ Single ❑ Multiple: #______________________
3. Switching valves
   a. Switching valve present. Yes_____No_____
   b. Type of valve:______________________________
   c. Operating properly. N.A.______Yes_____No_____
   d. Action taken if not:______________________________
4. Site conditions
   a. Color coding. Yes ____ No ____
   b. Signage. N.A.______Yes ____ No ____
   c. Fencing. N.A.______Yes ____ No ____
5. System operating pressure: ____________ PSI
   a. Location of pressure reading: ______________________________
6. Control panel
   a. Timer operating properly. N.A.______Yes_____No_____
      i) Timer settings: ON ____________________min
         OFF____________________min
   b. Photocell functioning. N.A.______Yes_____No_____
   c. Rainfall shutoff functioning. N.A.______Yes_____No_____
7. Distribution head operation
   a. Low-pressure shutoff valve. N.A.______Yes_____No_____
   b. In-line filter cleaned. N.A.______Yes_____No_____
   c. Heads in proper adjustment. Yes_____No_____
   d. Pop-up heads retracting. N.A.______Yes_____No_____
   e. Distribution head operation summary:

Notes

1. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable

Zone	Low angle nozzle	Pattern		Operation (impact, rotor, spray)	Low-pressure drain	Riser intact
		Current pattern	Designed pattern			

Form 8-6 (continued)**. Operational checklist: Spray field (SF).**

Reference #:___________________

8. Zone operational conditions:

Zone	Erosion	Wastewater runoff	Ponding	Vegetation	
				Clear of distribution pattern	Type

9. Manufacturer's required maintenance performed. Yes_____No______
(If 'Yes', attach Manufacturer Inspection form to this report, if supplied)

PSI- pounds per square inch

Outfalls

Overview

Outfalls are used after highly treated effluent has been generated by advanced treatment systems. These systems utilize a discharge pipe delivering the wastewater directly to a waterway, road ditch, or ground surface on the property.

Operation and maintenance

Discharging system outfalls require the following items be checked during O&M to ensure that they continue to function properly (**Form 8-7. Outfalls** (**OS**)):

1. Note the source of water exiting the outfall. Some pretreatment components have a built-in overflow to protect the structure, such as a lagoon. Other pretreatment systems have an outfall for final treatment and dispersal. Subsurface drainage systems are used to remove shallow groundwater. Interceptor drains collect water entering a site from upslope. Perimeter drains remove water from around a system.

   The flow exiting the outfall can gravity flow from the component or be collected in a dosing tank and be pumped to the outfall. Note the type of flow delivery.

2. There should be no strong odors near the outfall. If there is an odor present, note whether the odor is strong, mild, septic (rotten eggs), chemical, or sour in nature, and determine the source of that odor.

   Effluent exiting the outfall should be noted. Some outfalls only discharge during wetter weather conditions. Indicate the rate of discharge, whether it is dripping, trickling, or flowing. A visual inspection of the discharging effluent should be conducted to evaluate the presence of residual solids in the effluent. The discharged effluent may be a location for animals and/or vectors to gather or grow. A visual inspection of the condition of the discharged effluent should be conducted. The presence of animal activity or the identification of vectors living and growing in the discharged effluent should be noted.

3. The outfall structure outlet should be free of obstructions. There should be no vegetation blocking the outlet, which could cause plugging and backing up of the system. There should be no erosion around the outlet pipe. If erosion is present, an erosion control plan should be considered. The pipe should not be crushed or broken. Record if any maintenance on the outfall structure was needed and when it was completed. If there is groundwater flowing, estimate or measure the flowrate.

4. If sampling is needed to satisfy regulatory, manufacturer, or designer O&M requirements, collect, preserve, transport, and store samples using standard wastewater procedures. Record chain of custody (COC) information for delivery with the sample to the authorized laboratory. Retain signed COC from laboratory to complete system file. Use an authorized laboratory for sample analysis. Report information to the proper entities.

Form 8-7. Operational checklist: Outfalls (OS).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: ________________________ Employee:__________________________
Date of last service: ___________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _________________________________

1. Type of outfall:
   a. Treatment component:
      ❑ Lagoon ❑ Media filter ❑ Aerobic Treatment Unit
   b. Subsurface drainage: ❑ Interceptor ❑ Perimeter
   c. Flow delivery: ❑ Gravity flow ❑ Pumped flow
2. Discharge effluent condition
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ____________________________________
   c. Evidence of discharge. Yes_____No______
   d. If evidence of discharge, describe status: ❑ Current ❑ Previous
   e. If current discharge, describe rate of discharge:
      ❑ Dripping ❑ Trickling ❑ Flowing
   f. Residuals in discharging effluent. Yes_____No______
   g. Animal or vector activity in discharged effluent. Yes_____No______
3. Outfall structure condition
   a. Outlet unobstructed. Yes_____No______
   b. Vegetation maintenance necessary. Yes_____No______
   c. Erosion around outlet pipe. Yes_____No______
   d. Outlet protected from animal activity. Yes_____No______
   e. Discharge pipe in good condition. Yes_____No______
   f. If maintenance needed, maintenance completed. Yes_____No______
   g. If groundwater is present, flow rate of discharge: ____________ GPM
4. Lab samples collected for monitoring. Yes_____No______
   Types of analysis:____
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

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Appendix A

Math Review

Learning objectives

Upon completion of this chapter, you should be able to:

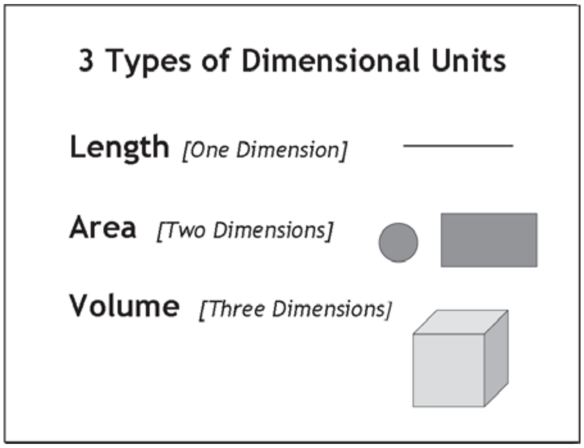
1. Given tank dimensions, calculate the liquid volume or operating volume.
2. Given the length and diameter of a pipe, calculate the liquid volume.
3. Describe the difference between the terms flow rate and flow velocity.
4. Describe and calculate flow in gallons per day (GPD) or other appropriate units of measure.
5. Define and calculate:
   - Pump delivery rate (PDR)
   - Detention time
   - Hydraulic loading rate

Preface

Appendix A discusses and illustrates the necessary formulae and math principles used to solve basic problems associated with operation of onsite wastewater treatment systems.

Math review

In order to effectively measure system performance, it is necessary to understand some basic math and be able to work through specific equations. This section begins with a review of some basic mathematical terms and proceeds with the presentation of important equations.



Length [One Dimension]

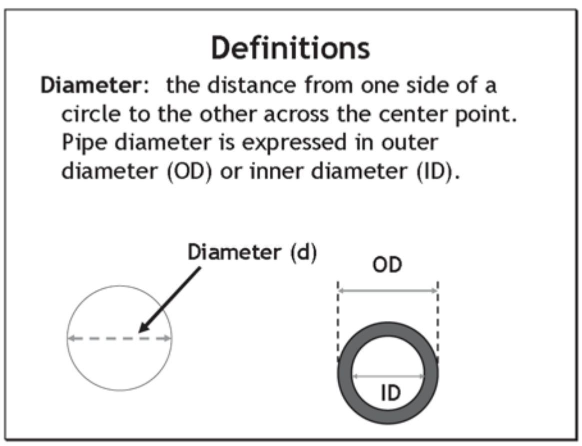
- Inches
- Feet
- Yards
- Miles
- Meters

Area : [Two Dimensions]
the measurement of a surface in square units.
Expressed in:

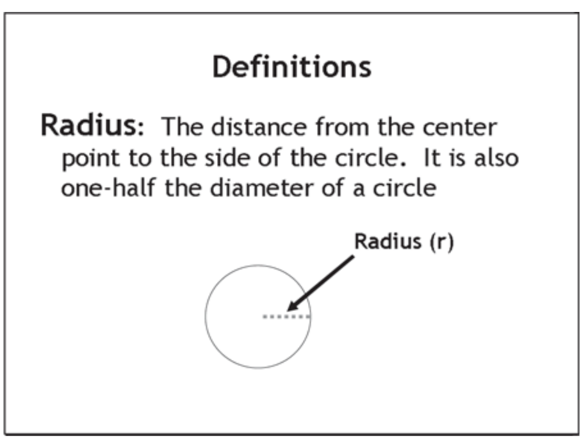
- $Inches^2$ or square inches
- $Feet^2$ or square feet
- $Yards^2$ or square yards
- Acres

Volume: [Three Dimensions]
the capacity of a container such as a pipe or a tank. Expressed in:

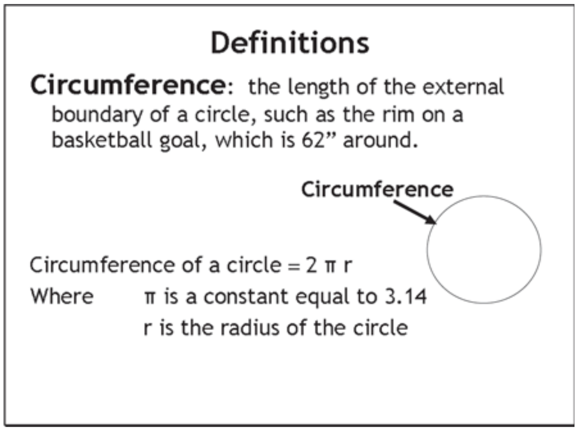
- $Inches^3$ or cubic inches
- $Feet^3$ or cubic feet,
- $Yards^3$ or cubic yards
- Gallons, liters



Note the difference between ID (inside diameter) and OD (outside diameter) of a pipe. The abbreviation for diameter is d.



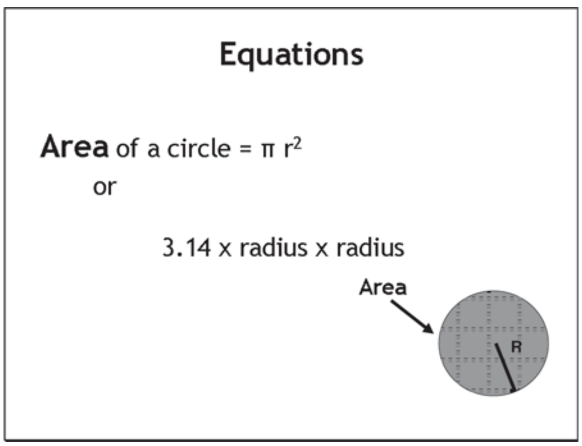
The radius (one-half the diameter) of a circle is an important term. It will be used later to calculate the area of a circle. The symbol for radius is r.



This term is seldom used in Wastewater Systems, but to differentiate from area and for a quick review…

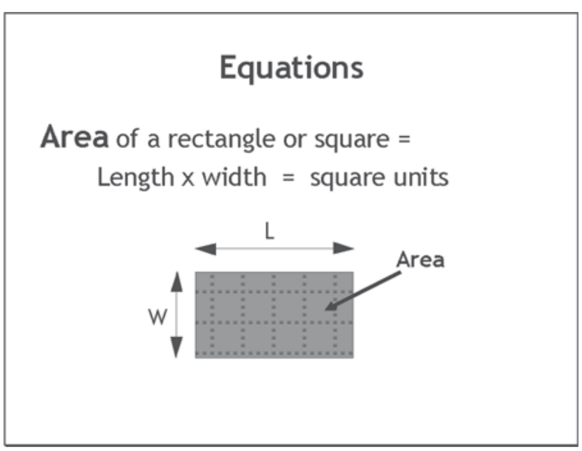
For example a pipe with a diameter of 3-inch OD, would have a circumference of:

2 x 3.14 x 1.5" = 9.42"



The area of a circle with a diameter of 3 inches would then be:

$3.14 \times (1.5 \text{ in.} \times 1.5 \text{ in.}) = 7.07 \text{ in}^2$



The area of squares and rectangles is the application of the simple formula L x W. One could count all the little units in this example, or just multiply the two dimensions to arrive at the same answer.

Converting units

- Tank is 4 ft wide and 102 in long

$$102 \text{ in} \div 12 \text{ in/ft} = 8.5 \text{ ft}$$

$$4 \text{ ft} \times 8.5 \text{ ft} = 34 \text{ ft}^2$$

or

$$48 \text{ in} \times 102 \text{ in} = 4896 \text{ in}^2$$

$$4896 \text{ in}^2 \div 144 \text{ in}^2/\text{ft}^2 = 34 \text{ ft}^2$$

Always remember to keep track of the units when applying formulas. You can not multiply Width in inches x Length in feet and get any meaningful numbers.

For example, if a tank is 4 feet wide and 102 inches long, you must first convert length to feet or width to inches before multiplying. As in:

$$4' \times 8.5' = 34 \text{ ft}^2 \quad \text{or}$$
$$48'' \times 102'' = 4896 \text{ in}^2$$

Both answers are right – just in different units.

To convert square inches to square feet, divide by 144 or $(12)^2$.

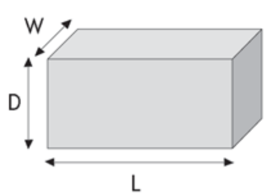
To convert square feet to square inches multiply by 144.

Equations

Volume of a rectangular tank:

length x width x depth = units^3

$$8 \text{ ft} \times 4 \text{ ft} \times 5 \text{ ft} = 160 \text{ ft}^3$$

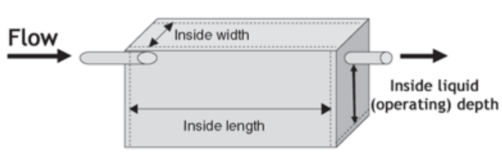


A tank is 4 feet wide, 5 feet deep, and 8 feet long. What is the volume in cubic feet?

Again, the units have to all be the same.

$$8 \text{ ft} \times 4 \text{ ft} \times 5 \text{ ft} = 160 \text{ ft}^3$$

Septic tank operating volume



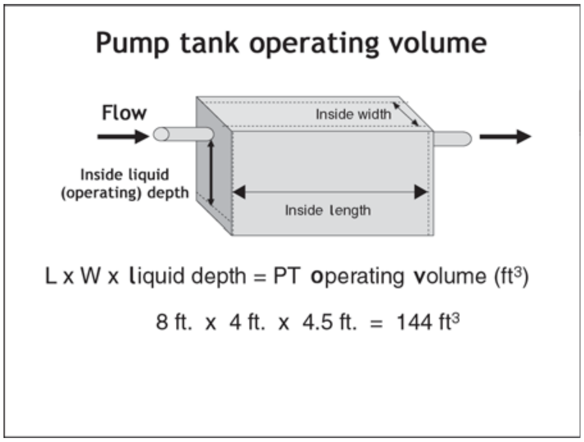
L x W x liquid depth = ST operating volume (ft^3)

$$8 \text{ ft} \times 4 \text{ ft} \times 4.25 \text{ ft} = 136 \text{ ft}^3$$

A more useful calculation is the operating volume of a tank. For a septic tank, the operating volume is the volume calculated using the depth from the invert of the OUTLET to the bottom of the tank.

L x W x liquid depth = ST operating volume (ft^3)

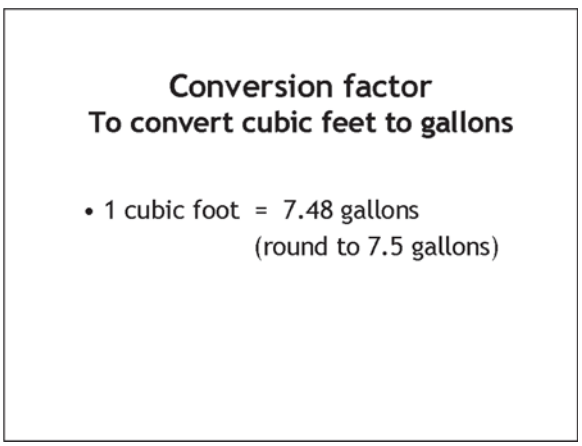
Note that liquid depth is measured INSIDE the tank. If this is not possible, use outside measurements and estimate a wall thickness of about 2 inches. Another option is to contact the manufacturer for dimensions.



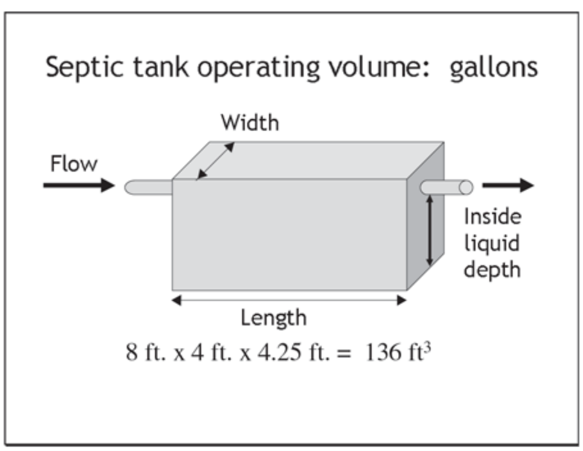
For a pump tank, the operating volume is the volume calculated using the depth from the invert of the INLET to the bottom of the tank.

L x W x liquid depth = PT operating volume (ft^3)

Note that liquid depth is measured INSIDE the tank. If this is not possible, use outside measurements and estimate a wall thickness of about 2 inches. Another option is to contact the manufacturer for dimensions.

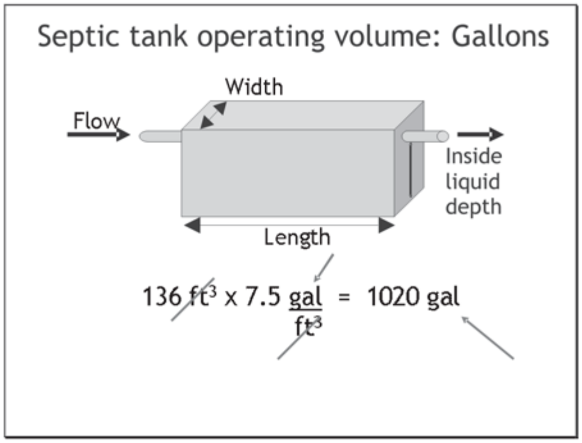


To express tank operating volume in gallons, we use a *Conversion Factor.* One cubic foot (1 ft^3) holds 7.48 gallons of water or effluent. This is a number that is used repeatedly in operation and maintenance and is worth remembering. For residential systems, it is reasonable to round 7.48 to 7.5 gallons per cubic foot. However, rounding 7.48 to 7.5 may affect the accuracy of calculations related to larger capacity systems.



So, first we calculate the volume in cubic feet.

Note that liquid depth is measured INSIDE the tank. If this is not possible, use outside measurements and estimate a wall thickness of about 2 inches. Another option is to contact the manufacturer for dimensions.

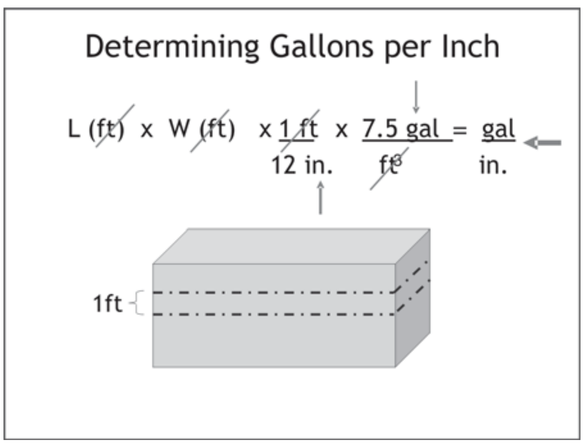


Then convert cubic feet into gallons using the conversion factor:

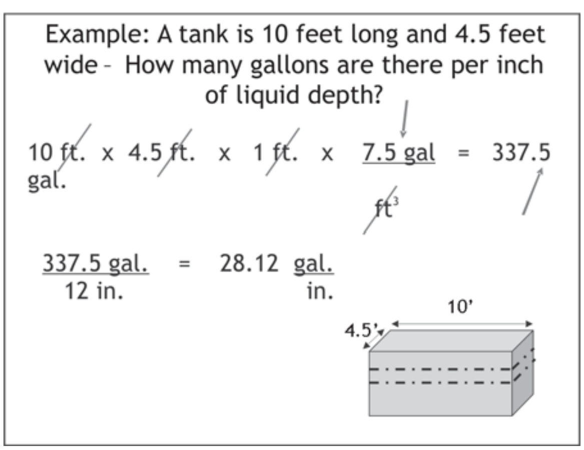
$136\ ft^3 \times 7.5\ gal/ft^3 = 1020$ gallons

Notice how the units cancel out to give the appropriate answer: We want the capacity expressed in gallons.

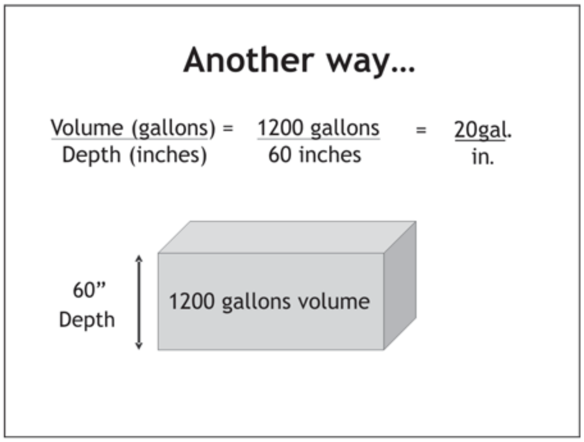
Note that liquid depth is measured INSIDE the tank. If this is not possible, use outside measurements and estimate a wall thickness of about 2 inches. Another option is to contact the manufacturer for dimensions.



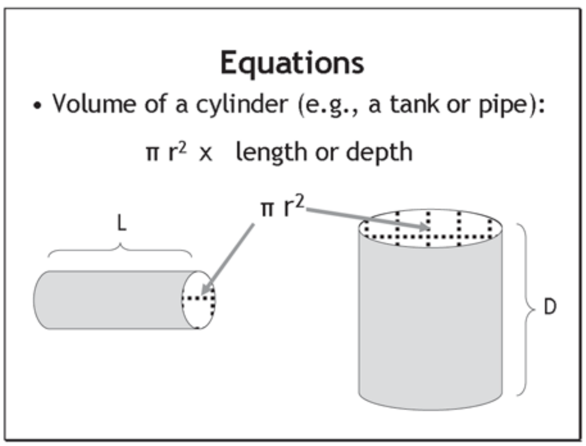
If you know the tank length and width, you can determine how many gallons per inch of liquid depth. The units cancel out to leave Gallons per Inch.



To think about it another way, we essentially calculate the volume of 1 foot of tank depth in gallons and then divide by 12 to get gallons per inch.



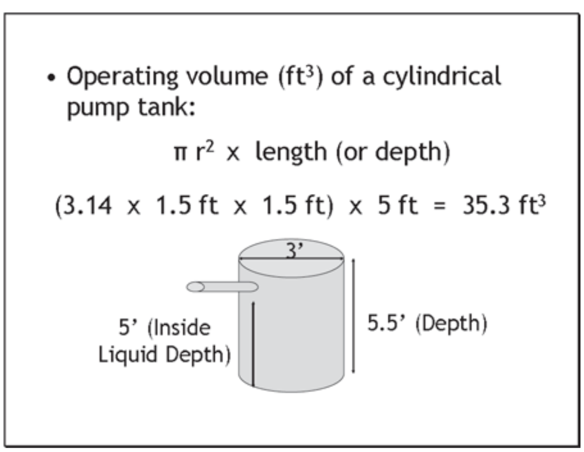
To look at it still another way, if you know the total tank volume in gallons and the total tank depth in inches, just divide to get gallons per inch.



To figure volume in a cylindrical tank or in a pipe (which is just a long cylinder), this is the formula that applies:

$(\pi r^2) \times$ length

Remember the formula for the area of a circle? Calculate that and then multiply times the length or height of the cylinder.



Here is an example of a pump basin that is 3 feet in diameter and 5.5 feet tall. The invert of the inlet to the tank is 5 ft above the bottom.

Remember that the radius equals ½ of the diameter. This gives us the answer in cu ft. which can be converted to gallons in one more step.

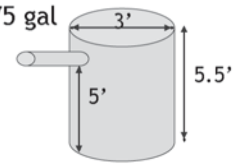
Note that liquid depth is measured INSIDE the tank. If this is not possible, use outside measurements and estimate a wall thickness of about 2 inches. Another option is to contact the manufacturer for dimensions.

Example

- Operating volume (gal) of a cylindrical pump tank:

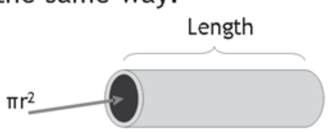
$$\text{Volume (ft}^3) \times \frac{7.5\text{ gal}}{\text{ft}^3} = \text{gallons}$$

$$35.3\text{ ft}^3 \times \frac{7.5\text{ gal}}{\text{ft}^3} = 264.75\text{ gal}$$



To convert the previous answer to gallons, just multiply by the conversion factor of 7.5 gal/ft^3. Note that the units cancel out to leave the answer in gallons.

- Volume of a pipe can be calculated the same way:



$$\pi r^2 \times \text{length} \times 7.5 \text{ gal/cu ft}$$

This calculation can be important if the volume of effluent in the supply line drains to the field after the pump turns off. For extremely long supply lines, the volume can be significant.

Remember, though that nominal pipe does not measure exactly as named. For instance, 2-inch Sch 40 pipe has a diameter of 2.067 inches while 2-inch Sch. 80 measures 1.939 inches inside.

Pipeline Volume

(Gallons per 100 feet)

	PVC Rigid Pipe		PVC Flexible Pressure Pipe		
Nominal Size (inches)	Schedule 40	Schedule 80	SDR 26 (160 psi)	SDR 21 (200 psi)	Corrugated tubing
¾	2.8	2.2			
1	4.5	3.7	5.8	5.5	
1 ¼	7.8	6.7	9.6	9.2	
1 ½	10.6	9.2	12.6	12.1	
2	17.4	15.3	19.6	18.8	
3	38.4	34.3	42.6	40.9	
4	66.1	59.7	70.4	67.7	65.3
6	150	135	153	147	147

Fortunately, there are tables available that provide the calculated values for pipes of various materials to save us from doing endless calculations like these. They are provided in your manual.

Units of Measure and Calculations

Percent (%)

- Latin for "parts of a hundred"

Percent is an important calculation.

Calculating percent

First, divide one number into another:

A ÷ B = quotient

The quotient expresses how many time a quantity is contained in another.

A = 20 ; B = 30

20 ÷ 30 = 0.67

So, A is: 0.67 the size of B

Calculating percent

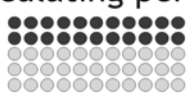
When we multiply the quotient by 100 we obtain how many times a number is contained in 100 of another (percent).

Using the same example:

0.67 x 100 = 67

So, A is: 67% the size of B

Calculating percent



There are 50 dots above and 20 of them are black. What percent of the dots are black?

20 ÷ 50 = 0.4	Divide # black by # white
0.4 x 100 = 40%	Convert to percent

It gives us an idea of the ratio or proportion of one thing to another.

Calculating percent solids in a septic tank

- Liquid depth = 60”
- Scum depth = 6”
- Sludge depth = 18”

18”+ 6” = 24	Add amount of scum and sludge
24 ÷ 60” = 0.4	Divide by tank liquid depth
0.4 x 100 = 40 %	Convert to percent

This is particularly useful for determining whether a tank needs to be pumped out but is useful for other things as well.

Converting percent to a fraction

20% = 20/100 = 1/5
33% = 33/100 = 1/3
25% = 25/100 = 1/4
50% = 50/100 = 1/2
75% = 75/100 = 3/4

Tanks should be pumped when the depth of scum and sludge equal 1/4 to 1/3 of the liquid depth of the tank.

Sometimes it is helpful to express percent as a fraction.

Units

Pressure: Force applied to a unit area. Expressed in:

- **pounds per square inch (psi)**
  ex./ Pressure of water in a force main that is 60 psi.
- **Feet of head**
  An alternative expression of water pressure
  psi x 2.31 = Head (ft)
- **pounds per square foot (psf)**
  ex./ A tank lid that is designed to support 150 psf.

Additional terms related to operation and maintenance of wastewater systems.

PSI can be converted to pressure head and vice-versa.

Units

Concentration

- Milligrams per liter (mg/l)
- Parts per Million (ppm)

Ex./ A system may have a requirement for the effluent not to exceed 10 mg/l (or ppm) of nitrate nitrogen.

mg/l is the same as ppm for water. Remember that wastewater effluent is 99.9% water.

% Reduction in concentration

is a reflection of the treatment efficiency of a system component.

$$\% \text{ reduction} = \frac{\text{influent} - \text{effluent}}{\text{influent}} \times 100$$

Percent reduction in concentration is an important concept in wastewater treatment.

% Reduction in Concentration

The influent concentration to a sand filter is 300 ppm BOD. The effluent concentration is 30 ppm BOD. What is the % reduction in concentration?

$$\% \text{ reduction} = \frac{\text{influent} - \text{effluent}}{\text{influent}} \times 100$$

$$\% \text{ reduction} = \frac{300 - 30}{300} \times 100 = 90\%$$

Units

Flow rate is volume per unit time

- Gallons per minute (gpm)
- Gallons per day (gpd)
- Cubic feet per sec (cfs)

Flow rate is important for calculating pump delivery rates or daily flow to a system. It is a measure of volume per unit of time. The concept of ***FLOW*** to a system may be one of the most important measurements that a service provider can make in the course of a visit. We will have several examples of flow rate to work on later.

Units

Flow Velocity is distance per unit time

- Feet per sec (fps)

Flow velocity refers to distance per unit of time, such as the flow through a pipe.

Flow velocity

- Should be at least 2 fps for good scour
- Minimum flow rate is needed to achieve this
- Equation to calculate minimum flow rate:

$$4.896 \times [\text{pipe diameter (in)}]^2 = \text{gpm required}$$

It is often specified that flow through a pipe should be at least 2 fps in order to scour excess solids that accumulate on the walls of the pipe.

Flow rate in gallons per minute to achieve a velocity of 2 feet per second in PVC pipe

Schedule 40 PVC		Schedule 80 PVC	
Nominal Dia. (inches)	Flow Rate (gpm)	Nominal Dia. (inches)	Flow Rate (gpm)
1	5.4	1	4.5
1 ¼	9.3	1 ¼	8.0
1 ½	14.2	1 ½	12.4
2	20.9	2	18.4
2 ½	29.8	2 ½	26.4
3	46.1	3	41.2
4	79.4	4	71.7
6	180	6	162.5

Minimum flow needed to achieve 2 fps in Schedule 40 and 80 rigid pipe.

Flow rate in gallons per minute to achieve a velocity of 2 feet per second in PVC pipe

SDR 21		SDR 26	
Nominal Dia. (inches)	Flow Rate (gpm)	Nominal Dia. (inches)	Flow Rate (gpm)
1	7.2	1	7.0
1 ¼	11.1	1 ¼	11.5
1 ½	14.5	1 ½	15.1
2	22.6	2	23.5
2 ½	33.1	2 ½	39.9
3	49.1	3	51.1
4	82.2	4	84.5
6	175.8	6	183.1

Minimum flow needed to achieve 2 fps in SDR 21 and 26 flexible pipe.

Definitions

Pump Delivery Rate (PDR): the rate at which wastewater is pumped to the drainfield or treatment unit in gallons per minute **(gpm)**

$$\text{PDR} = \frac{\text{gallons of water pumped (gal)}}{\text{pump run time (min)}}$$

$$\frac{\text{40 gallons}}{\text{5 minutes}} = \text{8 gal/min}$$

As an operation and maintenance service provider, it is essential to be able to accurately calculate ***Pump Delivery Rate (PDR).***

Equations

Detention Time – This term is used in design and operation of grease traps, septic tanks, lagoons, and contact chambers.
Expressed in hours or days.

$$\frac{\text{Tank Volume (gal)} \times \text{24 hrs/day}}{\text{Flow in gpd}} = \text{Hours}$$

$$\frac{\text{Tank Volume}}{\text{Flow in gal/day}} = \text{Days}$$

Detention Time: As flow in GPD goes up, the contact time in the fixed volume will go down. This is known as an inverse relationship. Detention time can be calculated in hours or days.

Example is on the next slide:

What is the **Detention time** of a 1000 gallon tank with a flow of 360 gpd:

$$= \frac{\text{Tank Volume} \times 24 \text{ hrs/day}}{\text{Flow in gpd}}$$

$$= \frac{1000 \text{ gal.} \times 24 \text{ hrs/day}}{360 \text{ gpd}}$$

$$= \frac{24{,}000 \text{ gal / hr / day}}{360 \text{ gal/day}} = 66.66 \text{ hrs}$$

For Example, a 1000 gallon septic tank receives a flow of 360 gallons each day (24 hours). What is the detention time? (Assume no sludge or scum has accumulated.)

Note that the units cancel out.

What is the Detention time (in days) of a 1000 gallon tank with a flow of 360 gpd:

$$= \frac{\text{Tank Volume}}{\text{Flow in gpd}}$$

$$= \frac{1000 \text{ gal.}}{360 \text{ gal/day}} = 2.78 \text{ days}$$

The calculation can also be done to provide a solution in days.

Definitions

Hydraulic loading rate: the amount of wastewater applied per day to a given area of trench bottom or sand filter surface expressed as:

gallons per day per square foot

or

gpd / ft^2

It is important to understand the concept of ***hydraulic loading rate*** to system components. This is a measure of flow per unit of area.

Calculate the Hydraulic Loading Rate to a sand filter surface, given:

3 Bedroom home: 360 gpd

Sand Filter is 18' x 10'

$$HLR = \frac{\text{gal. applied per day (gpd)}}{\text{area (ft}^2\text{)}}$$

$$= \frac{360 \text{ gpd}}{180 \text{ ft}^2} = 2.0 \frac{\text{gpd}}{\text{ft}^2}$$

For example, a sand filter measures 18 ft. by 10 ft. and serves a house with a design flow of 360 gpd. What is the hydraulic loading rate? The calculation is relatively straightforward and the result is expressed in gallons per day per square foot or gpd/ft^2.

$$HLR = \frac{\text{(gpd)}}{\text{area (ft}^2\text{)}}$$

$$\text{area (ft}^2\text{)} \times HLR = \frac{\text{(gpd)}}{\text{area (ft}^2\text{)}} \times \text{area (ft}^2\text{)}$$

$$\text{area (ft}^2\text{)} \times HLR = \text{gpd}$$

Let's look at ***hydraulic loading rate*** from a different angle. This is an example of how much wastewater can be applied to a system without exceeding the design flow rate. In order to use the information in this equation, we have to manipulate it a bit. What are we looking for: "How many gallons per day?"

$$HLR = \frac{\text{(gpd)}}{\text{area (ft}^2\text{)}}$$

$$\text{area (ft}^2\text{)} \times HLR = \frac{\text{(gpd)}}{\text{area (ft}^2\text{)}} \times \text{area (ft}^2\text{)}$$

$$\text{area (ft}^2\text{)} \times HLR = \text{gpd}$$

If we multiply both sides of the equation by the same item, we preserve the overall relationship between the elements here. To wind up with GPD alone on one side of the equation multiply both sides of the equation by AREA and cancel out the units where appropriate.

An LPP Drainfield is 30' x 90' or 2700 ft^2.
How many gallons per day can be dosed to the drainfield without exceeding the permit limit of 0.2 gpd / ft^2?

area (ft^2) x HLR = gpd

$$2700\ \cancel{ft^2} \times \frac{0.2\ gpd}{\cancel{ft^2}} = 540\ gpd$$

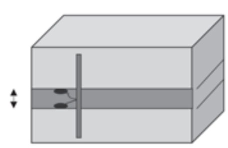
This is an example of how much wastewater can be applied to a system without exceeding the design flow rate. Note that units cancel out.

Determining Pump Drawdown

If you know gallons per inch, the drawdown determines the volume of effluent delivered per dose.

Drawdown (in.) = $\frac{\textit{Gal per Dose}}{\textit{Gal per inch}}$

Example: A tank with 31.2 gpi has a design requirement of delivering 290 gallons per dose. What should the drawdown be set at?



Gallons per inch will also allow the float to be adjusted properly to deliver the correct volume of effluent to a drainfield per dose.

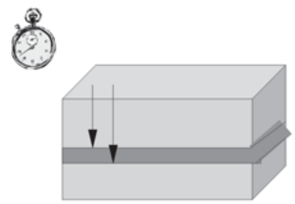
$$\frac{290\ gal/dose}{31.2\ gal/inch} = 9.3\ \text{inches dosed}$$

Figuring Pump Delivery Rate (PDR)

If you know the gpi in a tank, the pump delivery rate to the field can be measured.

$$PDR = \frac{\text{inches of liquid drop} \times \text{gpi}}{\text{minutes pumped}}$$

Ex. The pump is run for 5 minutes and the liquid level drops from 78' to 84". The tank's gpi is 31.2 What is the PDR?



$$PDR = \frac{(84-78)" \times 31.2\text{gpi}}{5 \text{ min}} = 37.5 \text{ gpm}$$

Figuring Daily Flow (GPD) from Elapsed Time Meter Readings

If you measure the PDR of the system, the gallons per day can be determined from the elapsed time meters.

Ex. The elapsed time meter readings were recorded as follows:

March 1 - 125.1 hours

May 30 - 140.5 hours

The PDR is 37.5 gpm.

What is the average daily flow from the facility?

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

The pump ran 140.5 – 125.1 or 15.4 hrs

15.4 hours x 60 min/hour = 924 minutes

$$\frac{924 \text{ min} \times 37.5 \text{ gal/min}}{90 \text{ days}} = 385 \text{ gal/day (GPD)}$$

Figuring Daily Flow (GPD) from Event (Cycle) Counters

If you know the gallons delivered per dose, the gallons per day can be determined from the event counters.

$$GPD = \frac{\#\ events \times gallons/event}{\#\ days}$$

Ex. The event counter readings were recorded as follows:

March 1 - 105 events
May 30 - 192 events

The pump delivers 344 gal/event.

What is the average daily flow from the facility?

11 inches/dose x 31.25 gal/inch = 343.75 gal/dose

Figuring Daily Flow (GPD) from Event (Cycle) Counters

If you know the gallons delivered per dose, the gallons per day can be determined from the event counters.

$$GPD = \frac{\#\ events \times gallons/event}{\#\ days}$$

Ex. The event counter readings were recorded as follows:

March 1 - 105 events
May 30 - 192 events

The pump delivers 344 gal/event.

What is the average daily flow from the facility?

The pump cycled 192 – 105 = 87 times

$$\frac{87 \text{ events} \times 344 \text{ gal/event}}{90 \text{ days}} = 332 \text{ GPD}$$

Figuring Gallons per Event from the Pump Timer Setting

(timer dose system)

If you know the pump run-time setting and the PDR, the gallons per dose can be determined.

$$\frac{\text{minutes}}{\text{dose}} \times \frac{\text{gallons}}{\text{min.}} = \frac{\text{gallons}}{\text{dose}}$$

Ex. A pump in a timer controlled setting runs for 6.5 minutes per dose. The pump delivers 37.5 gpm. How many gallons are delivered at each dose?

6.5min/dose x 37.5 gpm = 243.7 gal/dose

To Set up a Dosing Regime for a Timer Dosed Panel

System design flow is 720 GPD

PDR is 37.5 GPM

System is designed to dose 4 times per day*

Step 1: Calculate the dosing volume:

Design daily flow ÷ # Doses desired

* Per design - specific to the system

$$\frac{\text{Design daily flow}}{\text{\# Doses desired}} = \frac{720}{4} = 180 \text{ gal/dose}$$

To Set up a Dosing Regime for a Timer Dosed Panel

System design flow is 720 GPD

PDR is 37.5 GPM

System is designed to dose 4 times per day

Step 2: Calculate the pump-run time:

Dosing volume = 180 gal/dose

$$\text{Run-time} = \frac{\text{Dosing Volume}}{\text{Pump Delivery Rate}}$$

$$\frac{180 \text{ gal/dose}}{37.5\text{gpm}} = 4.8 \text{ minutes run time}$$

To Set up a dosing regime for a timer dosed panel

System design flow is 720 GPD

PDR is 37.5 GPM

System is designed to dose 4 times per day.

ON cycle is 4.8 minutes

Step 3: Calculate the Pump-Rest Time:

$$\text{Pump Off time} = \frac{24 \text{ hours}}{\text{\# Rest cycles}} - \text{Min. ON}$$

$$\frac{24 \text{ Hr/day}}{4 \text{ rest cycles}} - \text{Min. ON}$$

= 6 hrs OFF time – 4.8 min ON

= 5 hrs. 55.2 min.

A pump delivery rate is measured at 37 gpm. The pump runs an average of 16 minutes per day as indicated by the elapsed time meter. Is this system within the design flow for a 3 bedroom home?

A. GPD(actual) = gpm x runtime (min)

B. GPD (design) = 3 Br X 120 GPD/Br
= 360 GPD

A. 37 gpm x 16 min/day= 592 GPD

B. Therefore:
The system is not adequately sized for the actual flow.
(Example assumes 120 gpd/Br)

A pump delivers effluent to a drainfield at a rate of 36 gpm. The pump runs 8 minutes per day. The system is designed for 360 gpd.

A. Is this facility within the permit limits?

Flow (gpm) x Daily runtime (Min) = gpd

B. If this house has only 3 occupants, should the owner and/or operator be concerned?

(Residential Design flow is 60 gpd/person)

A. 36 gpm x 8 min/day = 288 GPD

Yes, the facility is not exceeding design flow of 360 gpd and is thus within permit limits.

B. 3 people x 60 gpd/person = 180 GPD

Yes, the flow is over 50% higher than what should be generated by 3 people (based upon 60 gal/person/day). Look for plumbing problems, excess water use, leaks into the tanks.

A pump in an LPP system delivers 50 gpm. The ETM in the control panel has the following readings:

- **March 1: 378.0 (h)**
- **April 1: 380.0 (h)**

A. How many gallons did it pump between those dates?

Volume (gal) = gpm x runtime (min)

B. What is the average gallons per day for this time period?

GPD (avg) = Volume (gal) / Interval (days)

A. 50 GPM x 120 Minutes = 6000 Gallons

B. 6000 Gallons / 30 days = 200 GPD

Calculating recirculation ratios

Recirculation tank data:

Previous pump counter:	5698
Current pump counter:	7453
Pump delivery rate (PDR)	28.6 gal/min
Timer on:	30 sec
Discharge diameter:	1.25 inch
Discharge length:	8 feet
Transport pipe diameter:	1.00 inch
Transport pipe length:	12 feet

Final treatment and dispersal pump chamber data:

Previous pump counter:	1366
Current pump counter:	1895
PDR:	22.3 gal/min
Timer on:	40 sec
Discharge diameter:	1.25 inch
Discharge length:	8 feet
Transport pipe diameter:	1.00 inch
Transport pipe length:	60 feet

Recirculation volume

Recirculation tank calculations:

1. Pump volume delivered to pipe = PDR (gpm) x timer on (min)
   = 28.6 gal/min x 30 sec x (1/60 min/sec)
   = 14.3 gal (per dose)

2. No. of times pump on = current pump counter - previous pump counter
   = 7453 - 5698 = 1755

Pipe fill-up volume calculations:

1. Pipe volume = π x r^2 x length
   r (radius): half of diameter (in feet)
   π (pi): constant value (3.1415)
   length: length of pipe (in feet)

   = π x $[(1.25 \text{ inch} \div 2) \div 12 \text{ inch/feet}]^2$ x 8 feet
   = 0.068 cubic feet
   = 0.51 gal (using 7.48 gal per 1 cubic feet)

2. Pipe volume (transport) = π x $[(1.00 \text{ inch} \div 2) \div 12 \text{ inch/feet}]^2$ x 12 feet
   = 0.065 cubic feet
   = 0.50 gal (using 7.48 gal per 1 cubic feet)

3. Total pipe volume = 0.51 gal + 0.50 gal = 1.01 gal

Calculate recirculation volume:

1. Volume delivered to unit (per dose) = Volume delivered to pipe - Total pipe volume
   = 14.3 gal - 1.01 gal = 13.29 gal

2. Total volume delivered to unit from previous pump count (Total volume):

   Total volume = # of times pump on x Volume delivered to unit (per dose)
   = 1755 x 13.29 gal = 23324 gal (recirculation)

Forward flow

Final treatment and dispersal calculations:

1. Pump volume delivered to pipe = PDR (gpm) x timer on (min)
   = 22.3 gal/min x 40 sec x (1/60 min/sec)
   = 14.86 gal (per dose)

2. No. times pump on = current pump counter - previous pump counter
   = 1895 - 1366 = 529

3. Pipe volume (transport) = π x $[(1.00 \text{ inch} \div 2) \div 12 \text{ inch/feet}]^2$ x 60 feet
   = 0.33 cubic feet
   = 2.45 gal (using 7.48 gal per 1 cubic feet)

Pipe fill-up volume calculations:

1. Pipe volume = π x r^2 x length
   r (radius): half of diameter (in feet)
   π (pi): constant value (3.1415)
   length: length of pipe (in feet)

2. Pipe volume (discharge) = π x $[(1.25 \text{ inch} \div 2) \div 12 \text{ inch/feet}]^2$ x 8 feet
   = 0.068 cubic feet
   = 0.51 gal (using 7.48 gal per 1 cubic feet)

3. Total pipe volume = 0.51 gal + 2.45 gal = 2.96 gal

Calculate forward flow

1. Volume delivered to unit (per dose) = Volume delivered to pipe - Total pipe volume
   = 14.86 gal - 2.96 gal = 11.9 gal

2. Total volume delivered to dispersal from previous pump count (Total volume):

   Total volume = # of times pump on x Volume delivered to unit (per dose)
   = 529 x 11.9 gal = 6295 gal (forward flow)

Calculate recirculation ratio

Recirculation ratio = Recirculation volume ÷ Forward flow
= 23324 ÷ 6295 = 3.71 or 3.71 : 1

The data can be also calculated in a similar manner using the previous and current elapsed time meter readings.

Table A-1. Conversion factors.

Multiply	By	To obtain
Acres	43560	Square feet
Atmospheres	33.9	Feet of water
Centimeters	0.3937	Inches
Cubic feet	7.48052	Gallons
Cubic feet	28.32	Liters
Cubic feet/sec.	449	Gallons/min.
Cubic meters	35.31	Cubic feet
Cubic meters	264.2	Gallons
Cubic meters	10^3	Liters
Cubic yards	27	Cubic feet
Cubic yards	202	Gallons
Feet	30.48	Centimeters
Feet	0.3048	Meters
Feet of water	62.43	Lbs/sq. ft.
Feet of water	0.434	PSI (lbs/sq. in.)
Gallons	3785	Cubic centimeters
Gallons	0.1337	Cubic feet
Gallons	3.785	Liters
Gallons water	8.3453	Pounds of water
Gallons/min.	2.228×10^{-3}	Cubic feet/sec.
Gallons/min.	1440	Gallons/day
Gallons/min.	0.06308	Liters/sec.
Gallons/day	6.944×10^{-4}	Gallons/min.
Gallons/day/sq.ft.	1.604	Inches/day
Grams	2.205×10^{-3}	Pounds
Grams/liter	1000	Parts/million
Hectares	2.471	Acres
Horsepower	33,000	Foot-lbs/min.
Horsepower	0.7457	Kilowatts
Inches	2.54	Centimeters
Inches/day	0.6234	Gallons/day/sq.ft.
Kilograms	2.205	Lbs.
Kilowatts	1.341	Horsepower
Kilowatt-hours	2.655×10^6	Foot-lbs.
Liters	103	Cubic centimeters
Liters	0.03531	Cubic feet
Liters	0.2642	Gallons
Meters	3.281	Feet
Milligrams/liters	1	Parts/million
Million gals./day	1.54723	Cubic ft./sec.
Parts/million	8.345	Lbs/million gal.
Pounds	453.5024	Grams
Pounds of water	0.1198	Gallons
psi (lbs/sq.in.)	2.31	Feet of water
Square feet	2.296×10^{-5}	Acres
Temp. (°C) + 17.78	1.8	Temp. (°F)
Temp. (°F) - 32	5/9	Temp. (°C)

Table A-2. Friction loss (feet per 100 foot).

	Pipe size (inches)					
Flow (GPM)	1 (1.049)	1-1/4 (1.38)	1-1/2 (1.61)	2 (2.067)	3 (3.068)	4 (4.026)
1	0.09					
2	0.32	0.09				
3	0.68	0.18	0.08			
4	1.17	0.31	0.14			
5	1.76	0.46	0.22	0.06		
6	2.47	0.65	0.31	0.09		
7	3.28	0.86	0.41	0.12		
8	4.2	1.1	0.52	0.15		
9	5.22	1.37	0.65	0.19		
10	6.35	1.67	0.79	0.23		
11	7.57	1.99	0.94	0.28		
12		2.34	1.1	0.33		
13		2.71	1.28	0.38		
14		3.11	1.47	0.43	0.06	
15		3.54	1.67	0.49	0.07	
16		3.98	1.88	0.56	0.08	
17		4.46	2.1	0.62	0.09	
19		5.47	2.58	0.77	0.11	
20		6.02	2.84	0.84	0.12	
25			4.29	1.27	0.19	
30			6.02	1.78	0.26	0.07
35				2.37	0.35	0.09
45				3.77	0.55	0.15
50				4.58	0.67	0.25
60				6.42	0.94	0.33
70					1.25	0.43
80					1.6	0.53
90					1.99	0.64
100					2.41	0.97
125					3.65	1.36
150					5.11	1.81
175					6.8	2.32
200						2.88
225						3.5
250						4.18
275						4.91
300						5.69
350						6.53
375						7.41

*Assumed to be Sch 40 PVC, C=140

$H_f=(0.00113 \times L \times Q^{1.85})/d^{4.87}$

Where Hf=head loss (feet)

L=pipe length (feet)

Q=flow (gpm)

d=pipe inside diameter (inches)

Table A-3. Allowance in equivalent length of pipe for friction loss in valves and threaded fittings (ASA A40.8- 1955).

Diameter of fitting	90 deg. standard ell	45 deg standard ell	90 deg. standard tee	Coupling or str. run of tee	Gate valve	Glove valve	Angle valve	Check valve
Inches	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
3/8	1	0.6	1.5	0.3	0.2	8	4	3
1/2	2	1.2	3	0.6	0.4	15	8	5
3/4	2.5	1.5	4	0.8	0.5	20	12	7
1	3	1.8	5	0.9	0.6	25	15	8
1 1/4	4	2.4	6	1.2	0.8	35	18	11
1 1/2	5	3	7	1.5	1	45	22	14
2	7	4	10	2	1.3	55	28	19
2 1/2	8	5	12	2.5	1.6	65	34	22
3	10	6	15	3	2	80	40	27
3 1/2	12	7	18	3.6	2.4	100	50	32
4	14	8	21	4	2.7	125	55	38
5	17	10	25	5	3.3	140	70	46
6	20	12	30	6	4	165	80	54

Table A-4a Pipeline volume (gallons per 100 feet of pipe).

Pipe	PVC flexible	Pressure pipe	PVC rigid pipe		Corrugated tubing
Size (inches)	SDR 26 (160 psi)	SDR 21 (200 psi)	Sch 40	Sch 80	
3/4			2.80	2.20	
1	5.80	5.80	4.50	3.70	
1 1/4	9.60	9.20	7.80	6.70	
1 1/2	12.60	12.10	10.60	9.20	
2	19.60	18.80	17.40	15.30	
3	42.60	40.90	38.40	34.30	
4	70.40	67.70	66.00	59.70	65.30
6	153.00	147.00	150.00	135.00	147.00
8	259.00	249.00	260.00	237.00	

Table A-4b. Pipeline volume (gallons per foot).

Pipe	PVC flexible	Pressure pipe	PVC rigid pipe		Corrugated tubing
Size (inches)	SDR 26 (160 psi)	SDR 21 (200 psi)	Sch 40	Sch 80	
3/4			0.03	0.02	
1	0.06	0.06	0.05	0.04	
1 1/4	0.10	0.09	0.08	0.07	
1 1/2	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	
4	0.70	0.68	0.66	0.60	0.65
6	1.53	1.47	1.50	1.35	1.47
8	2.59	2.49	2.60	2.37	

Table A-5a. Flow velocities: Flow rate in gallons per minute to achieve a flow velocity of 2 feet per second in rigid PVC pipe.

SDR 21		SDR 26	
Nominal dia. (inches)	Flow rate (gpm)	Nominal dia. (inches)	Flow rate (gpm)
1	5.4	1	4.5
1 ¼	9.3	1 ¼	8.0
1 ½	14.2	1 ½	12.4
2	20.9	2	18.4
2 ½	29.8	2 ½	26.4
3	46.1	3	41.2
4	79.4	4	71.7
6	180	6	162.5

Table A-5b. Flow velocities: Flow rate in gallons per minute to achieve a flow velocity of 2 feet per second in flexible PVC pipe.

SDR 21		SDR 26	
Nominal dia. (inches)	Flow rate (gpm)	Nominal dia. (inches)	Flow rate (gpm)
1	7.2	1	7.0
1 ¼	11.1	1 ¼	11.5
1 ½	14.5	1 ½	15.1
2	22.6	2	23.5
2 ½	33.1	2 ½	39.9
3	49.1	3	51.1
4	82.2	4	84.5
6	175.8	6	183.1

Table A-6. Orifice flow for various orifice sizes and pressure heads.

Orifice	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	9/32"	5/16"	11/32"	3/8"
Size	0.094	0.125	0.156	0.188	0.219	0.25	0.281	0.313	0.344	0.375
Press. head										
2.0	0.15	0.26	0.41	0.59	0.80	1.04	1.32	1.63	1.97	2.34
2.1	0.15	0.27	0.42	0.60	0.82	1.07	1.35	1.67	2.02	2.40
2.2	0.15	0.27	0.43	0.61	0.84	1.09	1.38	1.71	2.07	2.46
2.3	0.16	0.28	0.44	0.63	0.86	1.12	1.41	1.75	2.11	2.51
2.4	0.16	0.29	0.45	0.64	0.87	1.14	1.44	1.78	2.16	2.57
2.5	0.16	0.29	0.46	0.66	0.89	1.17	1.47	1.82	2.20	2.62
2.6	0.17	0.30	0.46	0.67	0.91	1.19	1.50	1.86	2.25	2.67
2.7	0.17	0.30	0.47	0.68	0.93	1.21	1.53	1.89	2.29	2.72
2.8	0.17	0.31	0.48	0.69	0.94	1.23	1.56	1.93	2.33	2.77
2.9	0.18	0.31	0.49	0.71	0.96	1.25	1.59	1.96	2.37	2.82
3.0	0.18	0.32	0.50	0.72	0.98	1.28	1.62	1.99	2.41	2.87
3.1	0.18	0.32	0.51	0.73	0.99	1.30	1.64	2.03	2.45	2.92
3.2	0.19	0.33	0.51	0.74	1.01	1.32	1.67	2.06	2.49	2.97
3.3	0.19	0.33	0.52	0.75	1.02	1.34	1.69	2.09	2.53	3.01
3.4	0.19	0.34	0.53	0.76	1.04	1.36	1.72	2.12	2.57	3.06
3.5	0.19	0.34	0.54	0.78	1.06	1.38	1.74	2.15	2.61	3.10
3.6	0.20	0.35	0.55	0.79	1.07	1.40	1.77	2.18	2.64	3.15
3.7	0.20	0.35	0.55	0.80	1.09	1.42	1.79	2.21	2.68	3.19
3.8	0.20	0.36	0.56	0.81	1.10	1.44	1.82	2.24	2.72	3.23
3.9	0.20	0.36	0.57	0.82	1.11	1.46	1.84	2.27	2.75	3.27
4.0	0.21	0.37	0.58	0.83	1.13	1.47	1.87	2.30	2.79	3.32
4.1	0.21	0.37	0.58	0.84	1.14	1.49	1.89	2.33	2.82	3.36
4.2	0.21	0.38	0.59	0.85	1.16	1.51	1.91	2.36	2.86	3.40
4.3	0.21	0.38	0.60	0.86	1.17	1.53	1.93	2.39	2.89	3.44
4.4	0.22	0.39	0.60	0.87	1.18	1.55	1.96	2.42	2.92	3.48
4.5	0.22	0.39	0.61	0.88	1.20	1.56	1.98	2.44	2.96	3.52
4.6	0.22	0.40	0.62	0.89	1.21	1.58	2.00	2.47	2.99	3.56
4.7	0.22	0.40	0.62	0.90	1.22	1.60	2.02	2.50	3.02	3.59
4.8	0.23	0.40	0.63	0.91	1.24	1.61	2.04	2.52	3.05	3.63
4.9	0.23	0.41	0.64	0.92	1.25	1.63	2.06	2.55	3.08	3.67
5.0	0.23	0.41	0.64	0.93	1.26	1.65	2.09	2.57	3.12	3.71

Notes:

1. Figures Based on Orifice Equation $Q=11.79d^2h^{0.5}$
2. Orifice Sizes in Inches
3. Pressure Heads in Feet
4. Flows in Gallons per Minute

Table A-7a. Flow through orifices, pressure manifolds schedule 40 taps.

	Hole size					
Head (ft)	1/2-inch	3/4-inch	1-inch	1-1/4 inch	1-1/2 inch	2-inch
	(.622)	(.824)	(1.049)	(1.38)	(1.61)	(2.067)
1.5	6.16	10.8	17.5	30.3	41.3	68
2	7.11	12.5	20.2	35	47.7	78.5
2.5	7.95	14	22.6	39.1	53.3	87.8
3	8.71	15.3	24.8	42.9	58.4	96.2
3.5	9.41	16.5	26.8	46.3	63	104
4	10.1	17.7	28.6	49.5	67.4	111

Table A-7b. Flow through orifices, pressure manifolds schedule 80 taps.

	Hole size					
Head (ft)	1/2-inch	3/4-inch	1-inch	1-1/4 inch	1-1/2 inch	2-inch
	(.546)	(.742)	(.957)	(1.278)	(1.50)	(1.939)
1.5	4.75	8.77	14.6	26	35.8	59.9
2	5.48	10.1	16.8	30	41.4	69.1
2.5	6.13	11.3	18.8	33.6	46.2	77.3
3	6.71	12.4	20.6	36.8	50.7	84.7
3.5	7.25	13.4	22.3	39.7	54.7	91.4
4	7.75	14.3	23.8	42.5	58.5	97.8

$Q=13d^2h^{1/2}$

Where Q = flow per orifice (gpm)
d = diameter of orifice (inches)
h = pressure head (feet)

Table A-8. Flow through orifices, LPP (gallons per minute).

	Drilled hole diameter (inches)				
Head (ft)	1/8	5/32	3/16	7/32	1/4
2	0.26	0.41	0.59	0.8	1.04
2.5	0.29	0.46	0.66	0.89	1.17
3	0.32	0.5	0.72	0.98	1.28
3.5	0.34	0.54	0.78	1.06	1.38
4	0.37	0.58	0.83	1.13	1.48
4.5	0.39	0.61	0.88	1.2	1.56
5	0.41	0.64	0.93	1.26	1.65

$Q= 11.79\ d^2h^{1/2}$

Where Q = flow per orifice (gpm)
d = diameter of orifice (inches)
h = pressure head (feet)

Appendix B

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Form 1-1. System description (SD).

(This form is used for the initial system evaluation for the facility and the site. It should be kept on file, and a copy should accompany the service provider at each O&M service visit. Any changes to the system facility should be recorded on the form, along with the date the change was noted.)

System ref. #:________________

A. Client contact information

Name of owner:____

Phone:______________________________ T:____R:____Sec:____No.:______

Cell:______________________________ E-mail:______________________________

Site address/county:____

____

Mailing address/county (if different):____

____

Directions to site:____

B. System documentation available (If no documentation, fill out Section D.)

Date installed:_________________

Installer:____ License #:________________

Phone:_________________ Cell:_________________________ Fax:_____________________

E-mail:____

Designer:____ License #:________________

Phone:_________________ Cell:_________________________ Fax:_____________________

E-mail:____

Previous service provider:____________________________ License #:________________

Phone:_________________ Cell:_________________________ Fax:_____________________

E-mail:____

Design flow: _________________Gal per day

C. Operational checklists:

Identify operational checklists for components included in system. Number the components of the treatment train in order in the spaces provided after the titles.

Form 4.1 Site assessment on File. ❑ Yes ❑ No

Tanks and advanced treatment component operational checklists (Chapters 5, 6 and 7):

- ❑ Pump: Demand-dosed system: ______
- ❑ Pump: Timer-dosed system: ______
- ❑ Holding tank: ______
- ❑ Septic/trash/processing (tank): ______
- ❑ Pump tank(s): ______
- ❑ Media filter: ______
- ❑ Aerobic treatment unit: ______
- ❑ Constructed wetland: ______
- ❑ Lagoon: ______
- ❑ Disinfection unit –chlorine: ______
- ❑ Disinfection unit –ultraviolet light: ______
- ❑ Disinfection unit –ozone: ______

Final treatment and dispersal component operational checklists (Chapter 8):

- ❑ Gravity distribution: ______
- ❑ Evapotranspiration bed: ______
- ❑ Mound system: ______
- ❑ Bottomless sand filter: ______
- ❑ Bottomless peat filter: ______
- ❑ Low-pressure drainfield: ______
- ❑ Drip field: ______
- ❑ Spray field: ______
- ❑ Outfalls: ______

Form 1-1 (continued). **System description (SD).**

System ref. #:____________________

D. No system documentation available

Complete the remaining information if it is not available in the permit or as-built drawings.

Facility details

1. Number of bedrooms: ____________
2. Square footage of facility: ____________sq ft
3. Number of current occupants: ____________
4. Design flow: ____________gpd
5. Design strength: ____________ BOD (mg/L) ____________TSS (mg/L) ____________ FOG (mg/L)
6. Water supply:
   - ❑ Private water supply
   - ❑ Public water supply
7. Water source (if private supply): Lateral distance to water supply
   - ❑ Groundwater well: ____________ft
   - ❑ Spring: ____________ft
   - ❑ Surface water (e.g. creek, lake, etc.): ____________ft
8. Garbage disposal present. Yes_____No______
9. Are any water softener or water treatment chemicals used. Yes_____No______
   - ❑ Softener backwash drains to system: Yes_____No______
   - ❑ Softener backwash does not drain to system: Yes_____No______
10. Has facility been remodeled since original construction. Yes_____No______

System Details

1. Site

a. Landscape position: ____

b. Drainage: ❑ Surface/gravity ❑ Subsurface/gravity ❑ Subsurface/pump

c. Monitoring well present. Yes_____No______

2. Pretreatment components - Tanks

a. Holding tank

1) Capacity: ____________gal

2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic ❑ Other

i) Manufacturer:____

3) Access to surface. Yes_____No______

4) Location (GIS): ________/_______

b. Septic tank /trash tank

1) Capacity (total): ____________gal

i) Compartmented. Yes____No______

ii) Capacities for compartmented system: 1)____gal 2)___gal

2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic ❑ Other

i) Manufacturer:____

3) Access to surface. Yes_____No______

4) Location (GIS): ________/_______

5) Effluent screen. Yes_____No______

i) Manufacturer:____________________________ Model: ____________________

Form 1-1 (continued). **System description (SD).**

System ref. #:________________

c. Flow equalization tank (surge, etc.)
   1) Capacity: __________gal/in
   2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   3) Access to surface. Yes____No_____
   4) Location (GIS): ________/_______
   5) Pump tank: ____________N.A.
      i) Manufacturer:________________________________
   6) Pump: ____________N.A.
      i) Manufacturer:____________________ Model:____________ HP:_____
   7) Pump operating condition
      i) Discharge Rate: _________gal/min
      ii) Operating pressure: ______________ft
   8) Control method
      i) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
      ii) Description:________________________________
   9) Pump dose settings
      i) Frequency _________doses/day
      ii) Interval _________ sec/dose
      iii) Volume __________ gal/dose
   10) Control panel
      i) Manufacturer:____________________ Model:____________________
   11) Electrical
      i) Separate circuits (pump, alarm). Yes____No_____
      ii) Breaker size: ________________
   12) Alarm
      i) Manufacturer: ________________________________
      ii) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
      iii) Description:________________________________

d. Dosing tank
   1) Capacity: __________gal/in
   2) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   3) Access to surface. Yes____No_____
   4) Location (GIS): ________/_______
   5) Dosing tank: ____________N.A.
      i) Manufacturer:________________________________
   6) Pump: ____________N.A.
      i) Manufacturer:____________________ Model:____________ HP:_____
   7) Pump operating condition
      i) Discharge Rate: _________gal/min
      ii) Operating pressure: ______________ft
   8) Control method
      i) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
      ii) Description:________________________________
   9) Pump dose settings
      i) Frequency: ________doses/day
      ii) Interval: _________ sec/dose
      iii) Volume: __________gal/dose
   10) Panel for sensors
      i) Manufacturer:____________________ Model:____________________
   11) Electrical
      i) Separate circuits (pump, alarm). Yes____No_____
      ii) Breaker size: ________________

Form 1-1 (continued)**. System description (SD).**

System ref. #: ________________

12) Alarm
   i) Manufacturer: ________________
   ii) Sensors: ❑ Floats ❑ Pressure transducer ❑ Ultrasonic ❑ Other
   iii) Description: ________________

3. Pretreatment components – advanced

a. Aerobic treatment unit (ATU)
   1) Treatment method:
      ❑ Suspended growth ❑ Attached growth ❑ Rotating Biological Contactor
      ❑ Combination attached/suspended growth ❑ Sequencing Batch Reactor
      ❑ Other: ________________
   2) Capacity: __________gpd
   3) Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
      i) Manufacturer: ________________ Model #: ________________
      ii) Product serial #: ________________
   4) Access to surface. Yes____No_____
   5) Location (GIS): _______/_______
   6) Effluent screen / Tertiary filter __________N.A.
      i) Manufacturer: ________________
   7) Air supply
      i) Air supply method: ❑ Aspirator ❑ Compressor ❑ Blower ❑ Free Air
      ii) Manufacturer: ________________ Model #: ________________
   8) Sludge return method: ________________

b. Single pass filter
   1) Media: ❑ Sand ❑ Glass ❑ Foam ❑ Peat ❑ Other: ________________
      i) Media depth: ____________in
      ii) Liner material: ________________
   2) Filter size: ___________sq ft
      i) Dimensions: ______ft x ____ft
      ii) Accessibility: ❑ Buried ❑ Free Access ❑ Covered
      iii) Cover material: ________________
      iv) Lid insulated. Yes____No_____
   3) Distribution method: ❑ Pressure ❑ Gravity
      i) Pipe diameter: ____________in
      ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ________________
         Orifice orientation: ________________
      iii) Flow control diameter: ____________in
      iv) Number of flow controls (orifices, nozzles, etc.): ____________
      v) Squirt height/Operating pressure: ____________in
      vi) Clean outs/Inspection ports: Number________Yes____No_____
      vii) Clean out access to surface. Yes____No_____
   4) Filtrate collection system: ____________

c. Recirculating Filter
   1) Media: ❑ Sand ❑ Gravel ❑ Bottom Ash ❑ Foam ❑ Other: ____________
      ❑ Polystyrene ❑ Textile
      i) Media depth: ____________in
      ii) Liner material: ____________
      iii) Recirculation method: ____________

Form 1-1 (continued). **System description (SD)**

System ref. #: ___________

2) Filter size: ____________sq ft
   i) Dimensions: ______ft x ____ft
   ii) Accessibility: ❑ Buried ❑ Free access
   iii) Cover material: ______________________________
   iv) Lid insulated. Yes_____No_____
3) Distribution method
   i) Pipe diameter: ______________in
   ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________________
   Orifice position: ______________________________
   iii) Flow control diameter: ______________in
   iv) Number of flow controls (orifices, nozzles, etc.): ______________
   v) Squirt height/Operating pressure: ______________in
   vi) Clean outs/Inspection ports: Number_________Yes_____No_____
   vii) Clean out access to surface. Yes_____No_____
4) Filtrate collection system: ______________
5) Forced aeration: ____________N.A.
   i) Description: ______________________________

d. Trickling filter
1) Media: ❑ Gravel ❑ Foam ❑ Textile ❑ Plastic ❑ Other: ____________________
   i) Media depth: ______________in
   ii) Liner material: ______________
2) Filter size: ______________________________sq ft
   i) Dimensions: ______ft x ____ft
3) Distribution method
   i) Pipe diameter: ______________in
   ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________________
   Orifice position: ______________________________
   iii) Flow control diameter: ______________in
   iv) Number of flow controls (orifices, nozzles, etc.): ______________
   v) Squirt height/Operating pressure: ______________in
   vi) Clean outs/Inspection ports: Number_________Yes_____No_____
   vii) Clean out access to surface. Yes_____No_____
4) Filtrate collection system: ______________
5) Forced aeration : ____________N.A.
   i) Description: ______________________________

e. Constructed wetland
1) Bed media: ❑ None ❑ Gravel ❑ Other: ______________________________
   i) Number of cells: ______________
   ii) Media depth: ______________in
   iii) Water depth: ______________in
   iv) Liner material: ______________
   v) Border material: ______________
2) Size: ____________sq ft
   i) Dimensions: _____ft x _____ft
   ii) Length to width ratio: ________:_______

Form 1-1 (continued). **System description (SD).**

System ref. #: __________

3) Distribution method
   - i) Pipe diameter: ______________in
   - ii) Flow control: ❑ Orifice ❑ Spray nozzle ❑ Other: ____________________
     Orifice position: ____
   - iii) Flow control diameter: ______________in
   - iv) Number of flow controls (orifices, nozzles, etc.): ______________
   - v) Squirt height/Operating pressure: ______________in
   - vi) Clean outs/Inspection ports: Number________Yes____No_____
   - vii) Clean out access to surface. Yes____No_____
4) Surface loading rate: _______gpd/sq ft
5) Filtrate collection system: ______________
6) Monitoring location: ______________
7) Vegetation: ___________N.A.
   - i) Description:____
8) Water level control: ___________N.A.
   - i) Description:____

f. Lagoon system
1) Type: ❑ Aerobic ❑ Facultative ❑ Partial-mixed aerated ❑ Anaerobic
   - i) Water depth: ______________ft
   - ii) Liner material: ______________
2) Lagoon size: ___________sq ft
   - i) Dimensions: _____ft x ___ft
   - ii) Length to width ratio: ________:_____
3) Inlet to lagoon
   - i) Pipe description:____
   - ii) Pipe diameter: ______________in
   - iii) Clean outs. Yes____No_____
4) Surface loading rate: _______gpd/sq ft
5) Monitoring location: ______________
6) Vegetation: ___________N.A.
   - i) Description:____
7) Water level control: ___________N.A.
   - i) Description:____

g. Disinfection unit
1) Chlorine – tablet
   - i) Manufacturer:____________________ Model:________________
2) Chorine – liquid
   - i) Manufacturer:____________________ Model:________________
3) Ultraviolet light
   - i) Manufacturer:____________________ Model:________________
4) Ozone
   - i) Manufacturer:____________________ Model:________________
5) Other:____
6) Disinfection monitoring location:________________________________
7) Dechlorination
   - i) Type: ____
   - ii) Manufacturer:____________________ Model:________________
8) Dechlorination monitoring location: ______________________________

Form 1-1 (continued)**. System description (SD).**

System ref. #: ___________

4. Final treatment and dispersal

a. Gravity distribution

1) Type: ❑ Trench ❑ Bed ❑ ET bed

i) If lined ET bed, describe liner material:______________________________

2) Distribution method: ❑ Gravity-to-gravity ❑ Pressure-dosed gravity ❑ Siphon-to-gravity

3) Configuration: ❑ Parallel ❑ Serial ❑ Sequential

4) Distribution approach: ❑ Distribution box ❑ Solid header pipe ❑ Drop box ❑ Stepdown

5) Distribution media

i) Material: ❑ Gravelless ❑ Multi-pipe ❑ Chamber
❑ Washed rock ❑ Polystyrene ❑ Other:______________________

b. Pressure

1) Low-pressure distribution

i) Level. Yes_____No_____

ii) Number of zones: _______________

a) Switching method: ❑ Hydraulic valves ❑ Separate pumps
❑ Other:____

iii) Distribution method

a) Pipe diameter: ______________in

b) Orifice diameter: ______________in

c) Orifice orientation: _______________

d) Number of orifices: _______________

e) Squirt height/Operating pressure: ______________in

f) Clean outs/Inspection ports: Number_________Yes_____No_____

g) Clean out access to surface. Yes_____No_____

iv) Number of trenches/beds: _______________

v) Dimensions of trenches/beds: ______ft x _____ft

Pressure mound distribution

i) Distribution method: ❑ Trench ❑ Bed ❑ Other:______________________

a) Pipe diameter: ______________in

b) Orifice diameter: ______________in

c) Number of orifices: _______________

d) Squirt height/Operating head: ______________in

e) Clean outs/Inspection ports: Number_________Yes_____No_____

f) Clean out access to surface. Yes_____No_____

ii) Number of trenches/beds: _______________

iii) Dimensions of trenches/beds: ______ft x _____ft

2) Drip field

i) Distribution field: ❑ Surface ❑ Subsurface

ii) Drip tubing manufacturer:_____________________ Model:______________________

iii) Filtration: ❑ Screen ❑ Disk ❑ Sand
Manufacturer:____________________________ Model:______________________

iv) Filter cleaning: ❑ Automated ❑ Manual/Continuous flush

v) Number of zones: _______________

a) If multiple, switching device: _______________

b) Zone area(s): ______sq ft ________ sq ft ___________sq ft

vi) Field flushing: ❑ Automated ❑ Continuous ❑ Manual

vii) Air release/Vacuum breaker: ____________N.A.

a) Manufacturer:_____________________ Model:______________________

viii) Inspection ports. Yes_____No_____

a) Locations:____

Form 1-1 (continued). **System description (SD).**

System ref. #: ___________

4) Spray field
   i) Number of zones: ________________
      a) If multiple, switching device:________________
   ii) Distribution heads per zone: ________________
      a) Manufacturer:________________ Model(s):________________
      b) Pattern(s):________________
   iii) In-line filtration: ❑ None ❑ Screen ❑ Disk ❑ Sand
      a) Manufacturer:________________ Model:________________
   iv) Total area of spray distribution fields: ____________sq ft
   v) Gauging Device:________________
5) Outfalls
   i) Permit number:________________
   ii) Permit requirements:________________
   iii) Location:________________
   iv) Monitoring location:________________

Form 1-1 (continued). **System description (SD).**

System ref. #:__________________

E. Sketch of system

Scale 1 in = ________ ft

Form 1-2. System evaluation (SE).

(This form is used for identification of the system design flow and to gather the operational checklists needed for conducting an O&M service visit.)

A. Client contact information

Name of owner:______________________________ System ref. #:______________

Site address/county:____

____

Date of last service:____________________

B. System documentation *(See Form 1.1 System Description (SD) for complete documentation)*

Design flow: ____________Gal per day

C. Operational checklists *(from Form 1.1 System Description (SD) Section C)*

Form 4-1. Site assessment on File. ❑ Yes ❑ No

Tanks and advanced treatment component operational checklists (Chapters 5, 6 and 7):

- ❑ Pump: Demand-Dosed system: ____________
- ❑ Pump: Timer-Dosed system: ____________
- ❑ Holding tank: ____________
- ❑ Septic/Trash/Processing (tank): ____________
- ❑ Pump tank(s): ____________
- ❑ Media filter: ____________
- ❑ Aerobic treatment unit:____________
- ❑ Constructed wetland: ____________
- ❑ Lagoon: ____________
- ❑ Disinfection unit –Chlorine: ____________
- ❑ Disinfection unit –Ultraviolet light: ______
- ❑ Disinfection unit –Ozone: ____________

Final treatment and dispersal component operational checklists (Chapter 8):

- ❑ Gravity distribution: ______
- ❑ Evapotranspiration bed: ______
- ❑ Mound system: ______
- ❑ Bottomless sand filter: ______
- ❑ Bottomless peat filter: ______
- ❑ Low-pressure drainfield: ______
- ❑ Drip field: ______
- ❑ Spray field: ______
- ❑ Outfalls: ______

D. System Evaluation

1. O&M service provided on: Date:____________________ Time:__________________
2. Observation and assessment of the site (on lot and in neighborhood)
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
      i) Source of odor, if present: ______________________________
   b. Any surfacing or breakouts. Yes ___ No____
   c. Any construction, utility work, or changes in drainage patterns. Yes ___ No____
   d. Are all components present and not modified. Yes ___ No____
   e. Are all lids at grade or on risers present and secure. Yes ___ No____
   f. Traffic on onsite wastewater system. Yes ___ No____

Form 1-2. (continued)**. System evaluation (SE).**

System ref. #:__________________

3. Estimated system flow: ___________ gallons per day
   Indicate method used for estimate:
   - ❑ House water meter reading:

     This time: _________(gal) - Last time: ___________(gal) = Result: _____ gal

     Result: ___________(gal) / ____________________days = ___________GPD

   - ❑ Dosing tank control meter readings (indicate form used): PDD: ________ PTD: ________
   - ❑ Discharge line meter
   - ❑ Estimate based on number of occupants: ______People

4. Complete operational checklists for pretreatment components, pumps, pump tanks and controls (Chapters 5, 6 and 7).

5. Complete operational checklists for final treatment and dispersal components (Chapter 8).

6. Updates required on **Form 1-1. System description:**

   ____
   ____
   ____
   ____

7. Site status at conclusion of O&M service visit:
   - ❑ Verify that controls are set on the appropriate mode.
   - ❑ Power is on to all components.
   - ❑ Revisit all components to verify lids are secure.
   - ❑ Gather all tools for removal from the site.
   - ❑ Verify that no sewage is on the ground surface.
   - ❑ Service notification.

8. Comments:

   ____
   ____
   ____

9. Overall system condition:
   - ❑ Acceptable
   - ❑ Unacceptable
   - ❑ Maintenance needed
   - ❑ Maintenance performed
   - ❑ Mitigation required

Company name: ____

Agreement period from: ______________________to ______________________

This report indicates the condition of the above onsite wastewater treatment system at the time of the O&M service visit. It does not guarantee that it will continue to function satisfactorily.

Signature of service provider: ______________________________Date:__________________

Form 4-1. Operational checklist: Site Assessment (SA)
(This form is to be filled out one time at the initial site assessment and used as a reference for all other O&M service visits.)

Service provided on: Date:_________ Time:___________ Reference #:______________________
Service provided by: Company:__________________________ Employee: ___________________________
Date of last service: ____________________ by: ❑ You ❑ Other:___________________________

1. Surface water management
   a. Is surface water effectively managed/diverted away from the site. Yes ____ No____
   b. Is surface water effectively diverted away from system and components. Yes ____ No____
   c. Evaluate the presence of odor within 10 ft of perimeter of the system:
      ❑ None ❑ Mild ❑ Strong ❑ Sour ❑ Chemical
   d. Source of odor, if present: ____
   e. Are the system components free from settling or erosion. Yes ____ No____
2. Subsurface water management
   a. Type: ❑ Gravity ❑ Pump ❑ Not present
   b. Outlet open to drainage. Yes ____ No____
   c. Rodent guard on outlet. Yes ____ No____
   d. Sump pump working. Yes ____ No____
   e. Outlet for sump pump discharge. Yes ____ No____
3. System encroachment
   a. Is the system free from encroachment. Yes ____ No____
   ❑ Driveways ❑ Utility easements ❑ Patios ❑ Decks ❑ Livestock
   ❑ Gardening ❑ Vehicular traffic ❑ Construction ❑ Pets ❑ Other:_______
   b. Is the reserve area free from encroachment. Yes_____ No____
   ❑ Driveways ❑ Utility easements ❑ Patios ❑ Decks ❑ Livestock
   ❑ Gardening ❑ Vehicular traffic ❑ Construction ❑ Pets ❑ Other:_______
4. Vegetation and soils
   a. Trees in distribution field. Yes ____ No____
      Type(s): ____
      Location(s): ____
   b. Excessive vegetation. Yes ____ No____
      Location(s): ____
   c. Uneven vegetation. Yes ____ No____
      Location(s): ____
   d. Poor vegetation. Yes ____ No____
      Location(s): ____
   Soil fertility and salinity sampling (if required). Yes ____ No____
5. Groundwater monitoring wells (if applicable)
   a. Present. Yes ____ No____
   b. Wells accessible. Yes ____ No____
   c. Wells intact. Yes ____ No____
   d. Wells properly protected. Yes ____ No____
   e. Labels and tags in place. Yes ____ No____
   Groundwater sampling (if required). Yes ____ No____
6. Additional comments:____
   ____

Attach any photographs of the site to this form.

Notes

1. ❑ Acceptable
   ❑ Unacceptable
2. ❑ Acceptable
   ❑ Unacceptable
3. ❑ Acceptable
   ❑ Unacceptable
4. ❑ Acceptable
   ❑ Unacceptable
5. ❑ Acceptable
   ❑ Unacceptable

Form 5-1. Operational checklist: Holding tank (HT)

Reference #:____________________

Service provided on: Date:________ Time:____________

Service provided by: Company: ______________________ Employee:______________________

Date of last service: ______________________________ By: ❑ You ❑ Other:______________

Date of last inspection: ______________________________

1. Conditions at the tank
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
2. Tank description
   a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   b. Capacity: ____________gal
3. Tank access
   a. Access location: ❑ Inlet ❑ Center
   b. Located at grade. Yes_____No_____
   c. If 'No', how deep is lid buried. ____________
   d. Risers on tank. Yes_____No_____
   e. Evidence of infiltration in risers. Yes_____No_____
   f. Lids securely fastened. Yes_____No_____
   g. Lid in operable condition. Yes_____No_____
4. Alarm(s)
   a. Alarm(s) present. Yes_____No_____
   b. Audio alarm operational. N.A.____Yes_____No_____
   c. Visual alarm operational. N.A.____Yes_____No_____
   d. Remote telemetry operational. N.A.____Yes_____No_____
   e. Electronic monitoring operational. N.A.____Yes_____No_____
5. Current tank operating conditions
   a. Liquid level relative to inlet: ___________in
      At ❑ Above ❑ Below
   b. Maximum liquid level of tank (invert of inlet pipe):___________in
   c. Height at which alarm is activated as measured from invert of inlet: ____________in
   d. Evidence liquid level has been higher. Yes_____No_____
   e. Evidence liquid level dropped without pumping. Yes_____No_____
   f. Evidence of continuous inflow. Yes_____No_____
   g. Date of last pumpout:______________________________
6. Tank structural condition (evaluate if tank pumped): N.A.___________
   a. Appears to be watertight (no visual leaks). Yes_____No_____
   b. Rebar exposed. Yes_____No_____
   c. Corrosion present. Yes_____No_____
   d. Spalling present. Yes_____No_____
   e. Cracks present. Yes_____No_____
   f. Root intrusion. Yes_____No_____
   g. Deflection noted. N.A.____Yes_____No_____
7. Holding tank pumping recommended. Yes_____No_____
8. Contractor responsible for pumping: ____________
   a. Gal removed:________________Date:____________________

Notes

1. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

5. ❑ Acceptable ❑ Unacceptable

6. ❑ Acceptable ❑ Unacceptable

Form 5-2. Operational checklist: Septic, trash, and processing tanks (STPT).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: _________________________ Employee:_________________________
Date of last service: ______________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ______________________________

1. Type:
   ❑ Septic tank ❑ Trash tank
   ❑ Processing tank ❑ Pump vault present
2. Conditions at the tank
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ________________________________
3. Tank description
   a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   b. Capacity: _____________gal
   c. Compartmented? Yes ____No_____
   d. Capacities for compartmented system: 1)______ gal 2) ______ gal
4. Tank access
   a. Access location: ❑ Inlet ❑ Outlet ❑ Center
   b. Located at grade. Yes_____No_____
   c. If 'No', how deep is lid buried. _______________
   d. Risers on tank. Yes_____No_____
   e. Evidence of infiltration in risers. Yes_____No_____
   f. Lids securely fastened. Yes_____No_____
   g. Lid in operable condition. Yes_____No_____
5. Alarm(s)
   a. Alarm(s) present. Yes_____No_____
   b. Audio alarm operational. N.A.____Yes_____No_____
   c. Visual alarm operational. N.A.____Yes_____No_____
   d. Remote telemetry operational. N.A.____Yes_____No_____
   e. Electronic monitoring operational. N.A.____Yes_____No_____
6. Current tank operating conditions
   a. Liquid level relative to outlet: ______________in
      ❑ At ❑ Above ❑ Below
   b. Maximum liquid level of tank (invert of outlet pipe):__________in
   c. Height at which alarm is activated as measured from invert of outlet: ______________in
   d. Evidence liquid level has been higher. Yes_____No_____
   e. Evidence liquid level dropped without pumping. Yes_____No_____
   f. Evidence of continuous inflow. Yes_____No_____
   g. Date of last pumpout:____
   h. Presence of flocculant in clear zone. Yes_____No____
   i. Evaluation of layers in tank:

Compartment Number	Scum (in)		Clear Zone (in)		Sludge (in)		Odor	Other
	Depth	Color*	Depth	Color	Depth	Color		
1								
2								

*Color Choices: ❑ Clear ❑ Flocced ❑ Milky ❑ Muddy ❑ Grainy
❑ Black ❑ Brown ❑ Mustard ❑ Gray ❑ White

7. Tank pumping recommended. Yes_____No_____

NOTES

2. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Form 5-2 (continued). **Operational checklist: Septic, trash, and processing tanks (STPT)**

Reference #:______________________

8. Baffles currently structurally sound. Yes____No_____
   a. Inlet baffle in place. Yes____No_____
   b. Outlet baffle in place. Yes____No_____
   c. Compartment baffle in place. N.A. ______ Yes____No_____
   d. Effluent screen. N.A. ______ Yes____No_____
      Manufacturer:____________________Model:______________
   e. Is screen accessible from ground surface. N.A. __ Yes____No_____
   f. If screened, percent plugged: ______________%
   g. Was screen cleaned. Yes____No_____
9. Tank structural condition (evaluate if tank pumped): N.A.___________
   a. Appears to be watertight (no visual leaks). Yes____No_____
   b. Rebar exposed. Yes____No_____
   c. Corrosion present. Yes____No_____
   d. Spalling present. Yes____No_____
   e. Cracks present. Yes____No_____
   f. Root intrusion. Yes____No_____
   g. Deflection noted. N.A. ______ Yes____No_____
10. Contractor responsible for pumping: _______________
   a. Gal removed:_______________ Date:____________________
11. Lab samples collected for monitoring. Yes____No_____
   Types of analysis:____
   ____
   ____

8. ❑ Acceptable
   ❑ Unacceptable

9. ❑ Acceptable
   ❑ Unacceptable

Form 6-1. Operational checklist: Dosing tank (DT).

Service provided on: Date:_________ Time:______________ Reference #:_______________________
Service provided by: Company: _______________________ Employee:________________________
Date of last service: ________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: ______________________________

1. Type:
   - ❑ Pump tank ❑ Siphon tank ❑ Surge/Flow equalization tank
   - ❑ Processing tank ❑ Recirculation tank ❑ Internal pump basin sump
   - a. Pump intake depth: ______________
2. Conditions at the pump tank
   - a. Evaluate presence of odor within 10 feet of perimeter of system:
     ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   - b. Source of odor, if present: ________________________________
3. Tank description
   - a. Material: ❑ Concrete ❑ Fiberglass ❑ Plastic
   - b. Capacity: ____________gal
   - c. Surface area: ___________sq ft
   - d. Operational depth: ____________in
   - e. Gallons per inch (GPI): __________gal/in
4. Tank access
   - a. Access location: ❑ Inlet ❑ Outlet ❑ Center
   - b. Located at grade. Yes_____No_____
   - c. If 'No', how deep is lid buried. ______________
   - d. Risers on tank. Yes_____No_____
   - e. Evidence of infiltration in risers. Yes_____No_____
   - f. Lids securely fastened. Yes_____No_____
   - g. Lid in operable condition. Yes_____No_____
5. Current tank operating conditions
   - a. Liquid level relative to inlet: ____________in
     ❑ At ❑ Above ❑ Below
   - b. Maximum liquid level of tank (invert of inlet pipe):___________in.
   - c. Height at which alarm is activated as measured from top of maximum liquid level: ____________in
   - d. Evidence liquid level has been higher. Yes_____No_____
   - e. Evidence liquid level dropped without pumping. Yes_____No_____
   - f. Evidence of continuous inflow. Yes_____No_____
   - g. Date of last pumpout: ______________________________
6. Pump/Siphon
   - a. Pump/Siphon under access. Yes_____No_____
   - b. Pull chain or rope present. N.A.___ Yes_____No_____
7. Discharge assembly: N.A. ___________
   - a. Anti siphon/air release device. Yes_____No_____
   - b. Backflow prevention (check valve) present. Yes_____No_____
   - c. Air release located below check valve. Yes_____No_____
   - d. Drain back device present. Yes_____No_____
   - e. Quick disconnect present. Yes_____No_____
   - f. Isolation valve present. Yes_____No_____
   - g. Inline filters present. Yes_____No_____
8. Electrical components sealed and watertight. N.A.____Yes_____No_____

Notes

2. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

5. ❑ Acceptable ❑ Unacceptable

6. ❑ Acceptable ❑ Unacceptable

7. ❑ Acceptable ❑ Unacceptable

8. ❑ Acceptable ❑ Unacceptable

Form 6-1 (continued)**. Operational checklist: Dosing tank (DT).**

Reference #:______________________

9. Tank structural condition (evaluate if tank pumped): N.A.____________
   a. Appears to be watertight (no visual leaks). Yes_____No______
   b. Rebar exposed. Yes_____No______
   c. Corrosion present. Yes_____No______
   d. Spalling present. Yes_____No______
   e. Cracks present. Yes_____No______
   f. Root intrusion. Yes_____No______

9. ❑ Acceptable
   ❑ Unacceptable

10. Solids accumulation:

Scum (in)	Sludge (in)	Odor	Color	Other

11. Tank pumping recommended. Yes_____No______
12. Contractor responsible for pumping: ________________
    a. Gal removed:___________________Date:____________________
13. Screen(s)
    a. Type of screen: ❑ Vault with basket ❑ Vault with filter ❑ In-line screen
    b. Was screen cleaned. Yes_____No______
14. Lab samples collected for monitoring. Yes_____No______
    Types of analysis:____
    ____
    ____

Form 6-2. Operational checklist: Pump: Demand-dosed system (PDD) (including siphons).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: __________________________ Employee:________________________
Date of last service: ____________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _________________________________

System type: ❑ Pump ❑ Siphon

1. Controls
   a. Type: ❑ Piggy back ❑ Control panel
   b. Controls operating properly. Yes _____ No______
   c. Is enclosure watertight. Yes ______No______
   d. Alarm test switch working properly. Yes ______No______
   e. At time of inspection, control switch (HAND-OFF-AUTO) was set at:
      "Hand/Manual"_____________
      "Auto"________________
      "Off"_________________
   f. Electrical meter readings:

		Reading (this)	Reading (last)	Difference	N.A.
i)	ETM			min	
ii)	Cycles/events			Events (NC)	

Calculate cycles/day: _____ [NC] / [Days] = _______ [CPD]

   g. Telemetry operational. N.A.: _______Yes ______ No_____
      Type:________________________

2. Pump/Siphon
   a. Siphon operating properly. N.A.: ________Yes ______ No_____
   b. Pump operating properly. Yes ______ No_____
   c. Type of pump: ❑ Multi-stage ❑ Single-stage
   d. Amps measured: ______________amps
   e. Voltage measured: _______________volts
   f. Pump turns on/turns off. Yes _____No______
3. Water level sensors
   a. Type of water level sensor: ❑ Floats ❑ Pressure transducers
      ❑ Ultrasonic ❑ Other: _____________
   b. Pump floats/sensors functioning properly. Yes _____No______
   c. Alarm float/sensor operating both audible and visible. Yes _____ No______
4. Sensor settings:

Sensor Number*	Function	Operational	Set At**		Secured
			Inches	Datum	
1		Yes___ No___			Yes___ No___
2		Yes___ No___			Yes___ No___
3		Yes___ No___			Yes___ No___
4		Yes___ No___			Yes___ No___
5		Yes___ No___			Yes___ No___

**(Designate starting from bottom of tank)*
*** (Measurements are taken from a fixed point ("Datum") near the surface or bottom of float tree in inches)*

5. Dose volume (DV)
   a. Pump Off – Pump On = ________in pumped (dose)
   b. GPI: _______ (Form 6.1 – Item 3.e)
      _______dose (in) x _______________GPI =____________ DV(gal)

Notes

1. ❑ Acceptable
   ❑ Unacceptable

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Form 6-2 (continued)**. Operational checklist: Pump: Demand-dosed system (PDD) (including siphons).**

Reference #:____________________

6. Pump delivery rate (PDR)
   a. Dose volume (from Item 5): __________ gal
   b. Verified pump run time "On": __________ min
   ____________ gal pumped ÷ __________ min = _________________ GPM
7. Total gallons
   a. Method to activate pump: ❑ Water added ❑ Lifted float
   b. Total gallons (from elapsed time meter)
   [_____(PTR) - _____(LTR)] x _____(GPM) = _______Total Gal
   OR Total gallons (from event/cycle counter)
   [_____(PCR) - _____(LCR)] x _____(DV) = _______Total Gal
8. Gallons per day (GPD)
   a. _____Total gal ÷ _____No. of days = ________Gal/day (GPD)

CPD: cycles per day
DV: dose volume
ETM: elapsed time meter
GPI: gallons per inch
GPM: gallons per minute
GPD: gallons per day
HAND-OFF-AUTO: Hand-off-auto switch
LCR: last cycle reading
LTR: last time reading
PCR: present cycle reading
PDR: pump delivery rate
PTR: present time reading

Form 6-3. Operational checklist: Pump: Time-dosed system (PTD)

Service provided on: Date:_________ Time:_______________ Reference #:_________________________
Service provided by: Company: ____________________________ Employee:__________________________
Date of last service: ____ By: ❑ You ❑ Other:_________________
Date of last inspection: ________________________________

1. Controls Timer manufacturer:____________________
   a. Is enclosure watertight. Yes_____No_____
   b. Alarm test switch working properly. Yes_____No_____
   c. At time of inspection, timer was set at: "On"____ Mode setting____ "Off"____ Mode setting____
   d. At time of inspection, control switch (HAND-OFF-AUTO) was set at: "Hand/Manual"_______ "Off" ________ "Auto" ________
   e. If timer was changed from above, new setting is: "On"____ Mode setting____ "Off"____ Mode setting____
   f. Electrical meter readings:

		Reading (this)	Reading (last)	Difference	N.A.
i)	ETM			min	
ii)	Cycles/events			Events (NC)	

Calculate cycles/day: _____ [NC] / [Days] = _______ [CPD]

   g. Telemetry operational. N.A._______Yes ____ No _____ Type: ______________________

2. Pump
   a. Pump operating properly. Yes_____No_____
   b. Type of pump: ❑ Multi-stage ❑ Single-stage
   c. Amps measured: ___________amps
   d. Voltage measured: ___________volts
   e. Pump turns on/turns off. Yes_____No_____
3. Water level sensors
   a. Type of water level sensor: ❑ Floats ❑ Pressure transducers ❑ Ultrasonic ❑ Other:________________
   b. Pump sensors functioning properly. Yes_____No_____
   c. Alarm sensor operating audible and visible alarms. Yes_____No_____
4. Sensor settings:

Sensor Number*	Function	Operational	Set At:		Secured
			Inches**	Datum	
1		Yes___ No___			Yes___ No___
2		Yes___ No___			Yes___ No___
3		Yes___ No___			Yes___ No___
4		Yes___ No___			Yes___ No___
5		Yes___ No___			Yes___ No___

(Designate starting from bottom of tank)
*** Measurements are taken from a fixed point ("Datum") near the surface or bottom of float tree in inches)*

5. Pump delivery rate (PDR) (measured)
   a. Pump Off_____________ – Pump On ________________ = ________in
   b. GPI: _______ (*From* Form 6.1 – Item 3 e)
   c. Verified pump run time: _____________min

(____________In x ________________________GPI) ÷ Pump run time (min) =_______(GPM)

Notes

1. ❑ Acceptable ❑ Unacceptable

2. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

Form 6-3. (continued). Operational checklist: Pump: Time-dosed system (PTD)

Reference #:____________________

6. Dose volume (DV) (from timer setting)
   a. Pump delivery rate: _______________ GPM (from Item 5)
   b. Verified pump run time: ________min
   _________ GPM x _________ min/cycle =___________(DV[Gal/ cycle])
7. Total gallons (from elapsed time meter)
   a. [_______(PTR) - _____(LTR)] x _____(GPM) = _______Total Gal
   OR Total gallons (from event/cycle counter)
   [_______(PCR) - ____ (LCR)] x _____(DV) =_______Total Gal
8. Gallons per day (GPD)
   _____Total gal ÷ _____No of days = _____Gal./Day (GPD)

CPD: cycles per day
DV: dose volume
ETM: elapsed time meter
GPD: gallons per day
GPI: gallons per inch
GPM: gallons per minute
HAND-OFF-AUTO: Hand-Off-Auto Switch
LCR: last cycle reading
LTR: last time reading
PCR: present cycle reading
PDR: pump delivery rate
PTR: present time reading

Form 7-1. Operational checklist: Media filter (MF).

Service provided on: Date:________ Time:______________ Reference #:_____________________
Service provided by: Company: ______________________ Employee: _____________________
Date of last service: ________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: ______________________________

1. Type of media filter:

Single pass: ❑ Sand ❑ Foam ❑ Peat ❑ Other: _______________
Recirculating: ❑ Sand/gravel ❑ Foam ❑ Textile ❑ Other: _______________
Trickling filter: ❑ Gravel ❑ Plastic ❑ Textile ❑ Other: _______________
Upflow filter: ❑ Gravel ❑ Plastic ❑ Wood chips ❑ Other: _______________

a. Manufacturer: ________________________ Model #: ________________________
b. Distribution method: ❑ Pressure distribution ❑ Gravity distribution

2. Conditions at media filter
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
3. Cover
   a. Type of cover: ❑ Free access ❑ Buried ❑ Lid
   b. Filter cover intact. Yes_____No_____
   c. Method of securing cover: ______________
   d. Distribution component accessible. Yes_____No_____
   e. Surface water/infiltration into components. Yes_____No_____
4. Venting/Air supply: ❑ Passive ❑ Active ❑ Not present
   a. Supply: ❑ Aspirator ❑ Compressor ❑ Blower ❑ Free air (go to 4.g)
   b. Operation: ❑ Continuous ❑ Timed (On______min, Off ______ min)
   c. Air supply unit operating properly. Yes_____No_____
   d. Pressure at air supply unit: ____________psi
   e. Air flow at air supply unit: ____________cfm
   f. Air filter/screen: ❑ Cleaned ❑ Replaced
   g. Venting appears operable. Yes ____No____
5. Media surface
   a. Biomat on surface. Yes_____No_____
   b. Uniform gravity distribution. N.A._____Yes_____No_____
   c. Uniform spray pattern. N.A._____Yes_____No_____
   d. Ponding in/on media. Yes_____No_____
   e. Plugging/clogging of distribution components. Yes_____No_____
   f. Media appears to be settling. Yes_____No_____
   g. Appropriate maintenance performed. Yes_____No_____
   h. Pest activity at surface. Yes_____No_____
6. Effluent quality
   a. Turbidity: ____________NTU
   b. Oily film on the surface of effluent. Yes_____No_____
   c. DO at outlet: ____________mg/L
   d. pH at outlet: ______________
   e. Temperature at outlet: ______________
   f. Bypass or overflow noticed. Yes_____No_____
   g. Effluent odor after passing through media filter:
      ❑ None ❑ Mild ❑ Strong
   h. Effluent color after passing through media filter:
      ❑ Clear ❑ Brown ❑ Black

Notes

2. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

5. ❑ Acceptable ❑ Unacceptable

6. ❑ Acceptable ❑ Unacceptable

Form 7-1 (continued). **Operational checklist: Media filter (MF)**

Reference #:____________________

7. Pressure distribution: N.A__________
    a. Distal head before cleaning
        i) Equal height. Yes____No_____
        ii) Height (inches): __________in
    b. Lateral condition
        i) Laterals in need of cleaning. Yes_____No_____
        ii) Laterals cleaned. Yes_____No_____
        iii) Method for cleaning laterals:____________________
    c. Distal head after cleaning
        i) Equal height. Yes_____No_____
        ii) Height (inches): __________in
8. Gravity distribution: N.A__________
    a. Device: __________
    b. Uniform distrubtion. Yes_____No_____
    c. Operating properly. Yes_____No_____
9. Filter drainage systems
    a. Ponding in media filter sump. Yes No
    b. Effluent level below filter media. Yes_____No_____
    c. Gravity drainage operational. N.A._____Yes_____No_____
    d. Solids buildup in sump area. N.A._____Yes_____No_____
    e. Underdrain vents present. Yes_____No_____
    f. Underdrain vents appear operable. Yes_____No_____
10. Additional tasks for recirculating filters
    a. DO in recirculation tank: __________mg/L
    b. Inspected recirculating device. N.A._____Yes_____No_____
    c. Cleaned recirculating device. N.A._____Yes_____No_____
    d. Design recirculation ratio: ________:_______
    e. Actual recirculation ratio: ________:_______
    f. Recirculation changed to: ________:_______
    *If dam configuration, recirculation device cannot be inspected or cleaned
11. Additional tasks for trickling filters
    11.1 Clarification chamber
    a. Solids blanket below recirculation pump inlet. Yes_____No_____*
    *If no, was system pumped out. Yes_____No_____
    b. If screened inlet, was screen cleaned. Yes_____No_____
    11.2 Sludge return
    a. Solids blanket slightly above return pump. Yes_____No_____
    b. Changed solids return rate. Yes_____No_____
        i) Pump: ❑ Off ❑ On
        ii) Changed from ____ min to ____min
12. Manufacturer's required maintenance performed. Yes_____No_____
    (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
13. Lab samples collected for monitoring. Yes_____No_____
    Types of analysis:______________________________
    ____
    ____

7. ❑ Acceptable ❑ Unacceptable

8. ❑ Acceptable ❑ Unacceptable

9. ❑ Acceptable ❑ Unacceptable

10. ❑ Acceptable ❑ Unacceptable

11.1. ❑ Acceptable ❑ Unacceptable

11.2. ❑ Acceptable ❑ Unacceptable

Form 7-2. Operational checklist: Aerobic treatment unit (ATU).

Service provided on: Date:_________ Time:_______________ Reference #:______________________
Service provided by: Company: ________________________ Employee: ______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ______________________________

1. Type of ATU:
   - ❑ Suspended-growth ❑ Attached-growth ❑ Sequencing batch reactor
   - ❑ Combination attached/suspended-growth
   - ❑ Rotating biological contactor ❑ Other:_______________
   - a. Manufacturer:___________________ Model #: ________________
2. Conditions at the ATU
   - a. Evaluate presence of odor within 10 ft of perimeter of system:
     ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   - b. Source of odor, if present: ______________________________
   - c. Was foam/residue observed outside the unit. Yes_____No_____
3. ATU access
   - a. Located at grade. Yes_____No_____
   - b. If 'No', how deep is tank buried. _______________
   - c. Risers on tank. Yes_____No_____
   - d. Evidence of infiltration in the risers. Yes_____No_____
   - e. Lids securely fastened. Yes_____No_____
   - f. Lids in operable condition. Yes_____No_____
4. Venting/Air supply
   - a. Air supply method:
     ❑ Aspirator ❑ Aerator ❑ Compressor ❑ Blower ❑ Free air (go to 4.g)
   - b. Operation: ❑ Continuous ❑ Timed (On: _____min, Off:_____ min)
   - c. Air supply unit operating properly. Yes_____No_____
   - d. Pressure at air supply unit: ____________psi
   - e. Air flow at air supply unit: ____________cfm
   - f. Air filter/screen: ❑ Cleaned ❑ Replaced
   - g. Venting appears operable. Yes ____No____
5. Aeration chamber
   - a. Mixing in aeration chamber. Yes_____No_____
   - b. DO in aeration chamber: ___________mg/L
   - c. pH in aeration chamber: _______________
   - d. Temperature in aeration chamber: _______________
   - e. Settlability test:
     Settled ___%, Floating ___% in _________ min
   - f. Biomass color in the aeration chamber:
     ❑ Brown ❑ Black
   - g. Sludge pumping recommended. Yes_____No_____
6. Additional tasks for attached-growth: media evaluation
   - a. Plugging. Yes_____No_____
   - b. Floating. Yes_____No_____
   - c. Media washed. Yes_____No_____
     If washed, indicate method used: ❑ Air ❑ Water
   - d. Media replaced. Yes_____No_____
7. Clarification chamber
   - a. Scum layer. Yes_____No_____
     If yes, thickness: _____________in
   - b. Clear zone depth below outlet: _____________in
   - c. Effluent screen/tertiary filter cleaned. N.A.___ Yes_____No_____

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable

Form 7-2 (continued)**. Operational checklist: Aerobic treatment unit (ATU)**

Reference #:___________________

d. DO in clarifier: ___________mg/L
e. pH in clarifier: _______________
f. Temperature in clarifier: _______________
g. Effluent odor after passing through unit:
❑ None ❑ Mild ❑ Strong
h. Effluent color after passing through unit:
❑ Clear ❑ Brown ❑ Black
i. Effluent turbidity: ___________NTU

8. Sludge return operating: ❑ Passive ❑ Active
a. If active, pump was checked manually. N.A.___ Yes_____No_____
b. If active, pump operating properly. N.A.___ Yes_____No_____

9. Control Panel: N.A.____________________
a. Controls operating properly. Yes_____No_____
b. Is enclosure watertight. Yes_____No_____
c. Alarm test switch operating properly. Yes_____No_____
d. At time of inspection, control switch was set to: N.A. ___________
"Hand/Manual" __
"Auto"__________
e. If auto, setting: Time On:_______ (min) Time Off:________ (min)

10. Alarm(s): N.A.___________
a. Types: ❑ Air pressure ❑ High water ❑ Remote
b. Alarms operating. Yes_____No_____
c. Alarm readings:

		Reading (present)	Reading (last)	Difference	N.A.
i.	ETM			hours	
ii.	Alarm Counter			Events (NC)	

Elapsed time in alarm status: _____(PTR) - _____(LTR) = ______Time (hours)
Number of alarm events: ______(PACR) - _____(LACR) = ______Events (number)
d. Battery backup charged. N.A.___Yes______No_____
e. Telemetry operable. N.A.___ Yes_____No_____

11. Manufacturer's required maintenance performed. Yes_____No_____
(If 'Yes', attach Manufacturers Inspection form to this report, if supplied)

12. Lab samples collected for monitoring. Yes_____No_____
Types of analysis:____
____
____

8. ❑ Acceptable ❑ Unacceptable

9. ❑ Acceptable ❑ Unacceptable

10. ❑ Acceptable ❑ Unacceptable

ETM: elapsed time meter
LACR: last alarm counter reading
LTR: last time reading
NC: number of cycles
PACR: present alarm counter reading
PTR: present time reading

Form 7-3. Operational checklist: Constructed wetland (CW).

Service provided on: Date:_________ Time:_______________ Reference #:_______________________
Service provided by: Company: _______________________ Employee: _______________________
Date of last service: _______________________ By: ❑ You ❑ Other:_______________
Date of last inspection: _______________________

1. Constructed wetland: Cell # : ________/ ________
    a. Media: ❑ None ❑ Gravel, average diameter: ____________in
       ❑ Other:_______________________
    b. Flow regime: ❑ Surface ❑ Subsurface ❑ Combination
    c. Distribution: ❑ Pressure ❑ Gravity
2. Conditions at the constructed wetland
    a. Evaluate presence of odor within 10 ft of perimeter of system:
       ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
    b. Source of odor, if present: _______________________
    c. Type of border material: _______________
    d. Border material in good repair. Yes_____No_____
    e. Evidence of water/soil entering wetland. Yes_____No_____
    f. Fence present and operable. N.A.____Yes_____No_____
    g. Animal activity at wetland surface. Yes_____No_____
3. Water level management
    a. Header distribution plugged. Yes_____No_____
    b. Water level control option available. Yes_____No_____
    c. Water level adjustment needed. Yes_____No_____
4. Vegetation
    a. Is species appropriate. Yes_____No_____
    b. Is vegetation alive. Yes_____No_____
    c. Replanting needed. Yes_____No_____
    d. Vegetation removal required. Yes_____No_____
5. Effluent quality
    a. Turbidity: ____________NTU
    b. Oily film on the surface of effluent. Yes_____No_____
    c. DO in outlet: ____________mg/l
    d. pH in outlet: _______________
    e. Temperature in outlet: _______________
    f. Bypass or overflow noticed. Yes_____No_____
    g. Effluent odor after passing through wetland:
       ❑ None ❑ Mild ❑ Strong
    h. Effluent color after passing through wetland:
       ❑ Clear ❑ Brown ❑ Black
6. Additional tasks for subsurface flow wetlands
    a. Media surface level. Yes_____No_____
    b. Water level below media surface: ____________in
7. Additional tasks for recirculating wetlands
    a. DO in recirculation tank: ____________mg/l
    b. Inspected recirculating device. N.A.____Yes_____No_____
    c. Cleaned recirculating device. N.A.____Yes_____No_____
    d. Design recirculation ratio: ________:_______
    e. Actual recirculation ratio: ________:_______
    f. Recirculation changed to: ________:_______
    *If dam configuration, recirculation device cannot be inspected or cleaned
8. Inspection ports
    a. Inspection ports present. Yes_____No_____
    b. Inspection ports intact. Yes_____No_____
9. Lab samples collected for monitoring. Yes_____No_____
    Types of analysis:_______________________

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

7. ❑ Acceptable
   ❑ Unacceptable

8. ❑ Acceptable
   ❑ Unacceptable

Form 7-4. Operational checklist: Lagoon maintenance (LM).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Lagoon: Cell #: _________ / ____________
   a. Type: ❑ Aerobic ❑ Facultative
2. Conditions at the lagoon
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Color of lagoon water:
      ❑ Clear ❑ Green ❑ Purple ❑ Other:____________
   d. Sludge pumping necessary. Yes_____No_____
   e. Animal activity at surface. Yes_____No_____
3. Border around lagoon
   a. Type of border material: _______________
   b. Border effective and in good repair. Yes_____No_____
   c. Evidence of water/soil entering lagoon. Yes_____No_____
   d. Berm free of burrowing animals. Yes_____No_____
   e. Berm protected from erosion. Yes_____No_____
   f. Trees present on the berm. Yes_____No_____
   g. Fencing is present and operable. Yes_____No_____
4. Vegetation in lagoon
   a. Floating vegetation present. Yes_____No_____
   b. If yes, vegetation removed. Yes_____No_____
   c. Vegetation at edges present. Yes_____No_____
5. Water level management
   a. Water level below freeboard: ______________ft
   b. Water level relative to: ❑ Outlet ❑ Berm ______________in
      ❑ Above ❑ Below
   c. Water level control option available Yes_____No_____
6. Effluent quality
   a. Turbidity: ___________NTU
   b. Oily film on the surface of effluent. Yes_____No_____
   c. DO at outlet or across from inlet: ___________mg/l
   d. pH at outlet or across from inlet: _______________
   e. Temperature in outlet: _______________
   f. Bypass or overflow noticed. Yes_____No_____
   g. Effluent odor after passing through lagoon (if discharging):
      ❑ None ❑ Mild ❑ Strong
   h. Effluent color after passing through lagoon (if discharging):
      ❑ Clear ❑ Brown ❑ Black
7. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable

Form 7-5. Operational checklist: Disinfection unit - chlorine (DUC).

Service provided on: Date:_________ Time:_______________ Reference #:_______________________
Service provided by: Company: _________________________ Employee: _______________________
Date of last service: ___________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: ________________________________

1. Operation of chlorination system
   a. Manufacturer: Chlorinator: ________ Dechlorinator:__________
   b. Model #: ____
   c. Method: ❑ Tablet ❑ Liquid
   d. Unit appears to be in good condition. Yes_____No_____
2. Tablet chlorination: N.A. ___________
   a. Chlorinator appears to be operable. Yes_____No_____
   b. Chlorine tablets in place. Yes_____No_____
      Type:____
   c. Tablets come in contact with effluent. Yes_____No_____
   d. If tablets added, how many: _______________
   e. Contact chamber appears operable. Yes_____No_____
   f. Contact chamber and stack feeder cleaned. Yes_____No_____
   g. Chlorine residual: ❑ Free ❑ Total ____________ppm
      Testing method:____
3. Liquid chlorinator: N.A. ___________
   a. Chlorine present in reservoir. Yes_____No_____
      Type:____
   b. Injection method operating correctly. Yes_____No_____
      Type:____
   c. Contact chamber appears operable. Yes_____No_____
   d. Proper mixing occurring. Yes_____No_____
   e. Chlorine residual: ❑ Free ❑ Total ____________ppm
      Testing method:____
4. Tablet dechlorination: ❑ Required ❑ Not required
   a. Dechlorination appears operable. Yes_____No_____
   b. Dechlorination tablets in place: Yes_____No_____
      Type:____
   c. Tablets come in contact with effluent. Yes_____No_____
   d. If tablets added, how many: _______________
   e. Contact chamber appears operable. Yes_____No_____
   f. Contact chamber and stack feeder cleaned. Yes_____No_____
   g. Chlorine residual: ❑ Free ❑ Total ____________ppm
      Testing method:____
5. Control panel: N.A.___________
   a. Controls operating properly. Yes_____No_____
   b. Is enclosure watertight. Yes_____No_____
   c. Alarm test switch operating properly. Yes_____No_____
   d. At time of inspection, control switch was set to: N.A.___________ "Hand/Manual"__ "Auto" __________
   e. If auto, setting: Time On:_______ (min) Time Off:________ (min)
6. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
7. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable

Form 7-6. Operational checklist: Disinfection unit - ultraviolet light (DUUL).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ____________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Power supply
   a. Dosing method: ❑ Pressure dosed ❑ Gravity fed
   b. Manufacturer:______________ Model #:________________
   c. Power supplied to the unit. Yes_____No_____
   d. UV lamp 'ON'. Yes_____No_____
   e. Electrical system is free of corrosion/damage. Yes_____No_____
   f. Ballast replaced during this visit. Yes_____No_____
   g. Last replacement date: ____ / ____ / ___
2. UV controls
   a. Unit equipped with a lamp intensity sensor. Yes_____No_____
   b. If so, what was intensity reading: __________
   c. Alarm present. Yes_____No_____
   d. Alarm operating properly. Yes_____No_____
3. Contact chamber, lamp, and sleeve conditions
   a. Evidence of damage or leakage. Yes_____No_____
   b. Contact chamber cleaned/flushed of solids. Yes_____No_____
   c. Type of protective sleeve: ❑ Quartz ❑ Teflon ❑ Other: ______
   d. Protective sleeve free of buildup. Yes_____No_____
   e. Protective sleeve cleaned. Yes_____No_____
   f. Protective sleeve replaced during this visit. Yes_____No_____
   g. Date last replaced: ____ / ____ / ___
   h. UV lamp replaced during this visit. Yes_____No_____
   i. Date last replaced: ____ / ____ / ___
4. Influent characteristics
   a. Turbidity: ___________ NTU
   b. Flow rate: ___________gpm
   c. Indicate wastewater characteristics that may compromise treatment:
   ____
   ____
5. Control panel: N.A. __________
   a. Controls operating properly. Yes_____No_____
   b. Is enclosure watertight. Yes_____No_____
   c. Alarm test switch operating properly. Yes_____No_____
   d. At time of inspection, control switch was set to: N.A. __________ "Hand/Manual" __ "Auto"__________
   e. If auto, setting: Time on:_______ (min) Time off:________ (min)
6. Housing unit: Location:________________
   a. Appears in good condition. Yes_____No_____
   b. Leaks/Cracks present. Yes_____No_____
   c. Excessive dust present. Yes_____No_____
7. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes', attach Manufacturers Inspection form to this report, if supplied)
8. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable

Form 7-7. Operational checklist: Disinfection unit – ozone (DUO).

Service provided on: Date:________ Time:______________ Reference #:____________________
Service provided by: Company: ______________________ Employee: ______________________
Date of last service: _________________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ______________________________

1. Ozone generator
   a. Manufacturer:________________ Model #:____________________
   b. Air supply: ❑ Free air ❑ Pure oxygen
   c. Ozone generator operating properly. Yes_____No_____
   d. Filter/Screen: ❑ Cleaned ❑ Replaced
2. Wastewater delivery system operating properly. Yes_____No_____
   a. Dosing method: ❑ Pressure-dosed ❑ Gravity-dosed
3. Contact chamber
   a. Proper mixing. Yes_____No_____
   b. Cracks/leaks present. Yes_____No_____
   c. DO concentration: __________ppm
4. Ventilation appears operable. Yes_____No_____
5. Housing unit: Location:________________
   a. Appears in good condition. Yes_____No_____
   b. Leaks/cracks present. Yes_____No_____
   c. Excessive dust present. Yes_____No_____
6. Ozone sensor
   a. Sensor functioning. Yes_____No_____
   b. If 'yes,' what was the reading: __________ppm
   c. Safety alarm present. Yes_____No_____
   d. Alarm operating properly. Yes_____No_____
7. Control panel: N.A. __________
   a. Controls operating properly. Yes_____No_____
   b. Is enclosure watertight. Yes_____No_____
   c. Alarm test switch operating properly. Yes_____No_____
   d. At time of inspection, control switch was set to: N.A. __________ "Hand/Manual" __ "Auto"__________
   e. If auto, setting: Time on:_______ (min) Time off:________ (min)
8. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes,' attach Manufacturers Inspection form to this report, if supplied)
9. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

1. ❑ Acceptable ❑ Unacceptable
2. ❑ Acceptable ❑ Unacceptable
3. ❑ Acceptable ❑ Unacceptable
4. ❑ Acceptable ❑ Unacceptable
5. ❑ Acceptable ❑ Unacceptable
6. ❑ Acceptable ❑ Unacceptable
7. ❑ Acceptable ❑ Unacceptable

Form 8-1. Operational checklist: Gravity distribution (including pump-to-gravity) (GD).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: ________________________ Employee:______________________
Date of last service: __________________________________ By: ❑ You ❑ Other:_______________
Date of last inspection: ________________________________

1. Type
    a. Method for dosing to field:
        ❑ Gravity-to-gravity ❑ Pump-to-gravity ❑ Siphon-to-gravity
    b. Method for distribution in the field:
        ❑ Above grade ❑ Bed ❑ Sequential trench
        ❑ Parallel trench ❑ Serial trench
2. Conditions at the drainfield site
    a. Evaluate presence of odor within 10 ft of perimeter of system:
        ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
    b. Source of odor, if present: ________________________________
    c. Indications of leaks around/above system. Yes_____No_____
    d. Vegetation appropriate. Yes_____No_____
    e. Excessive vegetative growth. Yes_____No_____
    f. Vegetation adequately maintained. Yes_____No_____
    g. Preventing accessibility for maintenance. Yes_____No_____
3. Distribution device
    a. Type: ❑ Distribution box ❑ Drop box ❑ Header
        ❑ Pressure manifold ❑ Other: ______________________
    b. If pressure manifold, distal head: ______________________
    c. Accessible. Yes_____No_____
    d. Intact, providing equal distribution. Yes_____No_____
    e. Free of solids. Yes_____No_____
    f. If 'No,' depth of solids below outlet: ______________in
    g. Root intrusion. Yes_____No_____
4. Distribution in field
    a. Soil treatment area information:

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Lateral #	Ponding		Surfacing Effluent		Distance Effluent Traveled (ft)	Lateral ends	Roots	Obstructions	Notes	Status
	Yes - No	Depth (in)	Yes	No						
1			☐	☐						❑ Acceptable ❑ Unacceptable
2			☐	☐						❑ Acceptable ❑ Unacceptable
3			☐	☐						❑ Acceptable ❑ Unacceptable
4			☐	☐						❑ Acceptable ❑ Unacceptable
5			☐	☐						❑ Acceptable ❑ Unacceptable
6			☐	☐						❑ Acceptable ❑ Unacceptable

Form 8-1(continued). **Operational checklist: Gravity distribution (including pump-to-gravity) (GD).**

Reference #:____________________

Other Areas where Effluent is surfacing.	☐	☐	Location:					❑ Acceptable ❑ Unacceptable

5. Inspection ports
   a. Inspection ports present. Yes_____No______
   b. Inspection ports intact. Yes_____No______
6. Switching valves
   a. Switching valve present. Yes_____No______
   b. Type of valve:____
   c. Operating properly. Yes_____No______
   d. Action taken if not:__________________________________
   e. Laterals in operation: ________________________________

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Form 8-2. Operational checklist: Evapotranspiration beds (ETB).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: _________________________ Employee:________________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ______________________________

1. Conditions at the ET bed
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
2. Distribution to ET bed
   a. Method for dosing:
      ❑ Gravity-to-gravity ❑ Pump-to-gravity
   b. Type: ❑ Distribution box ❑ Drop box ❑ Header
      ❑ Pressure manifold ❑ Other: ______________________
   c. If pressure manifold, distal head: ______________________
   d. Accessible. Yes_____No_____
   e. Intact, providing equal distribution. Yes_____No_____
   f. Free of solids. Yes_____No_____
   g. If 'No' depth of solids below outlet. ____________in
   h. Root intrusion. Yes_____No_____
3. Switching valve
   a. Switching valve present. Yes_____No_____
   b. Type of valve:______________________________
   c. Operating properly. Yes_____No_____
   d. Action taken if not:______________________________
   e. Bed in operation: ______________________________
4. ET bed:

Bed #	Status		Ponding		Surfacing Effluent (Yes - No)	ET Bed Surface Shedding Rainwater (Yes-No)
	Current	End of Service	Yes-No	Depth (in)		
1	❑ Active ❑ Resting	❑ Active ❑ Resting				
2	❑ Active ❑ Resting	❑ Active ❑ Resting				

5. Inspection ports
   a. Inspection ports present. Yes_____No_____
   b. Inspection ports intact. Yes_____No_____

Notes

1. ❑ Acceptable ❑ Unacceptable

2. ❑ Acceptable ❑ Unacceptable

3. ❑ Acceptable ❑ Unacceptable

4. ❑ Acceptable ❑ Unacceptable

Form 8-3. Operational checklist: Low-pressure drainfield (LPD).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: ______________________ Employee:______________________
Date of last service: ______________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ____________________________

1. Effluent Quality: ❑ Aerobic ❑ Septic tank effluent (anaerobic)
   Type of low-pressure drainfield: ❑ Low-pressure pipe ❑ Shallow narrow drainfield
2. Conditions at the LPD
   a. Topography: ❑ Level ❑ Sloping: _________ % slope
   b. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   c. Source of odor, if present: ______________________________
   d. Indications of leaks around/above system. Yes____No_____
   e. Vegetation appropriate. Yes____No_____
   f. Excessive vegetative growth. Yes____No_____
   g. Vegetation adequately maintained. Yes____No_____
   h. Preventing accessibility for maintenance. Yes____No_____
3. Supply line
   a. Line drains freely. Yes____No_____
   b. Ponding or saturation present along parts of the supply line. N/A____Yes____No_____
   c. Air relief(s) valve operating. N/A____Yes____No_____
4. Switching valves
   a. Switching valve present. Yes____No_____
   b. Type of valve:______________________________
   c. Operating properly. Yes____No_____
   d. Action taken if not:______________________________
   e. Laterals/zones in operation: ______________________________
5. Soil treatment area information:

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

Zone #	Lateral #	Distal head		Ponding Yes - No (in)	Surfacing effluent		Lateral ends			Root intrusion (Yes - No)	Other obstruction (specify)
		Operating at (in)	Adjusted to (in)		(Yes - No)	Distance traveled (ft)	Intact	Protected	Accessible		

Form 8-3 (continued)**. Operational checklist: Low-pressure drainfield (LPD).**

Reference #:____________________

6. Orifices
   a. Position: ❑ 6 o'clock ❑ 12 o'clock
   b. Orifices cleaned. Yes_____No______
   c. Method: ❑ Hydrojetted ❑ Bottlebrushed
   ❑ Flushed ❑ Other:____________________
7. Elevated system: N/A____________
   a. Surfacing effluent present. Yes_____No______
8. Lab samples collected for monitoring. Yes_____No______
   Types of analysis:____
   ____
   ____

6. ❑ Acceptable
   ❑ Unacceptable

7. ❑ Acceptable
   ❑ Unacceptable

Form 8-4a. Operational checklist: Bottomless sand filters and mounds (BSF and MS).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: _________________________ Employee:__________________________
Date of last service: ___________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _________________________________

1. Type: ❑ Bottomless sand filter ❑ Mound system
2. Conditions at the drainfield site
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
3. Media surface
   a. Biomat on surface. Yes_____No_____
   b. Uniform gravity distribution. N.A._____Yes_____No_____
   c. Uniform spray pattern. N.A._____Yes_____No_____
   d. Ponding in media. Yes_____No_____
   e. Plugging/clogging of distribution components. Yes_____No_____
   f. Media appears to be settling. Yes_____No_____
   g. Appropriate maintenance performed. Yes_____No_____
   h. Animal activity at surface. Yes_____No_____
4. Pressure distribution: N.A. ___________
   a. Distal head before cleaning
      i) Equal height. Yes_____No_____
      ii) Height (inches): ______________in
   b. Lateral condition
      i) Laterals in need of cleaning. Yes_____No_____
      ii) Laterals cleaned. Yes_____No_____
      iii) Method for cleaning laterals:__________________________
   c. Distal head after cleaning
      i) Equal height. Yes____No_____
      ii) Height (inches): ______________in
5. Additional requirements for mounds
   a. Ponding at toe/sides. Yes_____No_____
   b. Seepage at toe/sides. Yes_____No_____
6. Inspection ports
   a. Inspection ports present. Yes_____No_____
   b. Inspection ports intact. Yes_____No_____
7. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

5. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

Form 8-4b. Operational checklist: Bottomless peat filter (BPF).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: _________________________ Employee:_________________________
Date of last service: ___________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: ________________________________

1. Conditions at the drainfield site
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ___________________________________
2. Media surface
   a. Top of filter media in good condition. Yes_____No_____
   b. Uniform distribution or spray pattern noticed. Yes_____No_____
   c. Ponding in media. Yes_____No_____
   d. Media in need of cleaning. Yes_____No_____
   e. Additional media needed. Yes_____No_____
   f. Date of last media replacement: ________________
   g. Media in need of replacement. Yes_____No_____
   h. Appropriate maintenance performed. Yes_____No_____
3. Pressure distribution: N.A. ___________
   a. Distal head before cleaning
      i) Equal height. Yes_____No_____
      ii) Height (inches): ______________in
   b. Lateral condition
      i) Laterals in need of cleaning. Yes_____No_____
      ii) Laterals cleaned. Yes_____No_____
      iii) Method for cleaning laterals:__________________________
   c. Distal head after cleaning
      i) Equal height. Yes_____No_____
      ii) Height (inches): ______________in
4. Manufacturer's required maintenance performed. Yes_____No_____
   (If 'Yes', attach Manufacturer Inspection form to this report, if supplied)
5. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:____
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Form 8-5. Operational checklist: Drip field (DF).

Service provided on: Date:_________ Time:______________ Reference #:________________________
Service provided by: Company: __________________________ Employee:__________________________
Date of last service: _________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _______________________________

1. Conditions at the drip distribution zone
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ___________________________________
   c. Indications of leaks around/above system. Yes_____No_____
   d. Vegetation appropriate. Yes_____No_____
   e. Excessive vegetative growth. Yes_____No_____
   f. Vegetation adequately maintained. Yes_____No_____
   g. Preventing accessibility for maintenance. Yes_____No_____
2. Drip filter
   a. Type of filter:
      ❑ Sand ❑ Screen ❑ Disk ❑ Other:___________
   b. Filter in place. Yes_____No_____
   c. Pre-filter pressure: ____________ PSI
   d. Post-filter pressure: ____________ PSI
   e. Filter: ❑ Cleaned ❑ Replaced
   f. Automatic cleaning operational. N.A.____Yes_____No_____
   g. By-pass flow operating. N.A.___ Yes_____No_____
   h. Boxes insulated. N.A. ___Yes_____No_____
   i. Heater pad operational. N.A. ___Yes_____No_____
3. Effluent flow metering
   a. Flow meter:
      Current (PFR): ______ gal Date:__________
      Previous (LFR): ______gal Date:__________
      Differential ([PFR - LFR] / days):
      ______gpd Days: _________
4. Switching valves
   a. Switching valve present. Yes_____No_____
   b. Type of valve:___________________________________
   c. Operating properly. Yes_____No_____
   d. Action taken if not:______________________________
5. Field flushing: ❑ None ❑ Manual ❑ Automatic ❑ Continuous
   a. Operational. Yes_____No_____
   b. Field flushing operation:

Notes

1. ❑ Acceptable
   ❑ Unacceptable
2. ❑ Acceptable
   ❑ Unacceptable
3. ❑ Acceptable
   ❑ Unacceptable
4. ❑ Acceptable
   ❑ Unacceptable

Zone	Manually flushed zones	Operating pressure (PSI)		Zone flushing				Field dosing			
				ETM		CC		ETM		CC	
		Dosing	Flushing	PFTR	LFTR	PFCR	LFCR	PFTR	LFTR	PFCR	LFCR

Form 8-5 (continued). **Operational checklist: Drip field (DF).**

Reference #:____________________________

6. Zone operation:

Zone	Flow rate (gpm)	Total flow (gal) *(since last visit)*	Air/Vacuum relief operating	Surfacing effluent

7. Manufacturer's required maintenance performed. Yes_____No______
(If 'Yes', attach Manufacturer Inspection form to this report, if supplied)

CC- cycle counter
ETM- elapsed time meter
GPM- gallons per minute
LFCR- last flushing cycle reading
LFR- last flow meter reading
LFTR- last flushing time reading
PFCR- present flushing cycle reading
PFR- present flow meter reading
PFTR- present flushing time reading
PSI- pounds per square inch
TT- total time

Form 8-6. Operational checklist: Spray field (SF).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: ________________________ Employee:________________________
Date of last service: ________________________________ By: ❑ You ❑ Other:________________
Date of last inspection: _____________________________

1. Conditions at the spray distribution field
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Indications of leaks around/above system. Yes_____No______
   d. Vegetation appropriate. Yes_____No______
   e. Excessive vegetative growth. Yes_____No______
   f. Vegetation adequately maintained. Yes_____No______
   g. Preventing accessibility for maintenance. Yes_____No______
2. Distribution approach
   a. Zones: ❑ Single ❑ Multiple: #______________________________
3. Switching valves
   a. Switching valve present. Yes_____No______
   b. Type of valve:______________________________________
   c. Operating properly. N.A.______Yes_____No______
   d. Action taken if not:_________________________________
4. Site conditions
   a. Color coding. Yes ____ No ____
   b. Signage. N.A.______Yes ____ No ____
   c. Fencing. N.A.______Yes ____ No ____
5. System operating pressure: ____________ PSI
   a. Location of pressure reading: ____________________________
6. Control panel
   a. Timer operating properly. N.A.______Yes_____No______
      i) Timer settings: ON ___________________min
         OFF___________________min
   b. Photocell functioning. N.A.______Yes_____No______
   c. Rainfall shutoff functioning. N.A.______Yes_____No______
7. Distribution head operation
   a. Low-pressure shutoff valve. N.A.______Yes_____No______
   b. In-line filter cleaned. N.A.______Yes_____No______
   c. Heads in proper adjustment. Yes_____No______
   d. Pop-up heads retracting. N.A.______Yes_____No______
   e. Distribution head operation summary:

Zone	Low angle nozzle	Pattern		Operation (impact, rotor, spray)	Low-pressure drain	Riser intact
		Current pattern	Designed pattern			

Notes

1. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

4. ❑ Acceptable
   ❑ Unacceptable

6. ❑ Acceptable
   ❑ Unacceptable

7. ❑ Acceptable
   ❑ Unacceptable

Form 8-6 (continued)**. Operational checklist: Spray field (SF).**

Reference #:__________________

8. Zone operational conditions:

Zone	Erosion	Wastewater runoff	Ponding	Vegetation	
				Clear of distribution pattern	Type

9. Manufacturer's required maintenance performed. Yes_____No______
(If 'Yes', attach Manufacturer Inspection form to this report, if supplied)

PSI- pounds per square inch

Form 8-7. Operational checklist: Outfalls (OS).

Service provided on: Date:________ Time:______________ Reference #:______________________
Service provided by: Company: _________________________ Employee:______________________
Date of last service: ________________________________ By: ❑ You ❑ Other:______________
Date of last inspection: ______________________________

1. Type of outfall:
   a. Treatment component:
      ❑ Lagoon ❑ Media filter ❑ Aerobic Treatment Unit
   b. Subsurface drainage: ❑ Interceptor ❑ Perimeter
   c. Flow delivery: ❑ Gravity flow ❑ Pumped flow
2. Discharge effluent condition
   a. Evaluate presence of odor within 10 ft of perimeter of system:
      ❑ None ❑ Mild ❑ Strong ❑ Chemical ❑ Sour
   b. Source of odor, if present: ______________________________
   c. Evidence of discharge. Yes_____No_____
   d. If evidence of discharge, describe status: ❑ Current ❑ Previous
   e. If current discharge, describe rate of discharge:
      ❑ Dripping ❑ Trickling ❑ Flowing
   f. Residuals in discharging effluent. Yes_____No_____
   g. Animal or vector activity in discharged effluent. Yes_____No_____
3. Outfall structure condition
   a. Outlet unobstructed. Yes_____No_____
   b. Vegetation maintenance necessary. Yes_____No_____
   c. Erosion around outlet pipe. Yes_____No_____
   d. Outlet protected from animal activity. Yes_____No_____
   e. Discharge pipe in good condition. Yes_____No_____
   f. If maintenance needed, maintenance completed. Yes_____No_____
   g. If groundwater is present, flow rate of discharge: __________ GPM
4. Lab samples collected for monitoring. Yes_____No_____
   Types of analysis:______________________________________
   ____
   ____

Notes

2. ❑ Acceptable
   ❑ Unacceptable

3. ❑ Acceptable
   ❑ Unacceptable

Appendix C

Suggested Tools for Operation and Maintenance Service Visits

- **Permit/as-built plans/specs**
- **Clip board/O&M forms/pencil**
- **Calculator**
- **Binoculars for viewing remote components**
- **Hand mirror for viewing tank interiors**
- **Stethoscope for verifying mixing in enclosed tanks and for assessing pump bearing degradation**
- **Timing device (watch or stop watch)**
- **Radios/communication devices**
- **Flash light**
- **Global Positioning System (GPS)**
- **Key map**
- **Digital Camera**

- **Safety and personal protection**
  - Sunscreen/hat
  - Bug repellant
  - Drinking water
  - Rubber gloves
  - Leather gloves
  - Safety glasses, goggles, face shields
  - Bucket/chlorine
  - Wash water
  - Coveralls
  - Confined space equipment (for use by properly trained personnel)
  - Waterless hand cleaner
  - Disinfecting wipes
  - First-aid kit
  - Fire extingquisher

- **Measuring devices:**
  - Scum hook
  - Water column measuring device for measuring sludge depth, depth of clear zone, water clarity and biomass settleability
  - Standpipe with level indicator for measuring distal pressure
  - Measuring tape
  - Turbidity meter
  - Dissolved oxygen meter or test kit
  - pH meter or test kit
  - Thermometer
  - Pressure/vacuum gauge for air flow
  - Schrader valve
  - Chlorine test kit
  - Water meter

- **Hand tools**
  - Pipe wrenches
  - Wrenches
  - Pliers
  - Wire stripper
  - Screwdrivers
  - Hacksaw or cordless saw (for cutting large pipe)
  - PVC cutter (for cutting small pipe)
  - Valve keys
  - Cordless drill and bit set
  - Hammer
  - Shovel
  - Rake

- Auger
- Lid lifter or pry bar
- Probe with insulated handles
- Float switch lifter
- Specialized tools for safety screws
- Plumber's snake
- Bottle brush for flushing laterals
- Pressure washer for flushing laterals
- Electrician's snake

- **Electrical tools and supplies (Check local electrical code)**
  - Electrical tape
  - Spare fuses or breakers
  - Spare light bulbs
  - Watertight wire nuts
  - Nylon wire ties
  - Multi-meter
  - Wire soap for lubricating wire during replacement
  - Duct seal
  - Liquid tape for sealing connections
  - Anti-oxidizing compound for application to electrical connections
  - GFCI drop cord
  - Electrical wire

- **Miscellaneous**
  - PVC cleaner and glue
  - PVC adapters and common fittings
  - Petroleum jelly to lubricate O-rings and grommets
  - Liquid or powder tracing dye
  - Hose with backflow prevention device and nozzle
  - Hose reel
  - Hydraulic cement
  - Duct tape
  - Tarp for placing soil on, collecting debris
  - Plastic trash can for storing/collecting contaminated debris
  - Spare trash bags
  - Five-gallon bucket
  - Small utility sump pump

- **Appropriate replacement parts for specific technologies and proprietary devices that are regularly serviced**

Appendix D

Residential Evaluation Survey

Procedures for residential evaluation survey

The facility owner or user affects the performance of the onsite wastewater treatment system. Use of the Residential Evaluation Survey (Form D-1) is a way for the service provider to gain information on how the facility user is loading the onsite wastewater treatment system. This form is not required for baseline information; instead, it is used in troubleshooting. When a system is not performing as desired, a thorough evaluation of all components should be performed. The Residential Evaluation form facilitates documentation of considerable information about the user.

Detailed discussion points are provided to help you use the form more effectively. The items below match the numerical sequence on the form.

Home/residents (Q 1-8)

1. First time users of onsite wastewater treatment systems can make poor choices. Your understanding of the relative experience of the user will help identify system problems.

2. A number of educational materials are available for the owner to help him or her understand his or her responsibility towards the system. The lack of using this material is another source of potential mistakes.

3. The as-built drawings provide a record of how the system was installed and should assist in locating the components.

4. The amount of time spent at the facility will affect how the system operates. The longer the system is in use the shorter the resting period that is available.

   The number and ages of the people living in the home will directly affect the water use. Typically teenagers use the most water. Knowing the size of the home and the number of bedrooms indicates typical water use amounts and patterns.

5. If the home is connected to central water, the service provider can gain access to the records. In some areas, this information can no longer be released to third party individuals. The service provider may have to request that the homeowner request that information. Other water sources may affect water quality and quantity going into the system.

6. In-home businesses can directly affect the system. Use for daycare increases the overall flow and can increase the use of antibacterial soaps. Other small businesses may indicate the use of chemicals that could directly impact the system. These include: antique refinishing, beauty shops, lawn care, photo

labs, dog grooming, and taxidermy shops. Barbershops and beauty shops typically discharge large amounts of hair.

7. Prescription antibiotics and drugs are a problem for systems. They are extremely hard on the biology of the system and when identified in the wastewater source, an increase in maintenance is recommended.

8. Heavy use of bath and body oils can raise the FOG values that are in the system. Removal or reduction of these can increase the performance of the system.

9. Use of septic tank additives has not been proven to be beneficial to system performance and is not recommended.

Appliances and cleaning products (Q 10-24)

10. Water-saving devices reduce the wastewater flow but also increase the strength of the wastewater. For some systems this can affect the performance, and required effluent limits may not be achieved.

11. A garbage disposal adds to the overall loading of the system. This addition is in four distinct ways:
    - More loading due to use.
    - 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 that will take longer to settle.

12. The use of the dishwasher in a typical home is not a real concern. If the homeowner adds commercial appliances, their use can have some impact.

13. The laundry is an important part of the source in terms of water use. Powdered detergent can plug cast iron piping, and some soap contains forms of bentonite as filler. Keeping these out 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 will help the system perform at its best.

14. Whirlpool or jacuzzi tubs (inside) typically use large volumes of water. Information on how much water these devices use and the pattern of their use will help the service provider assess the impact on the system.

15. The use of toxic drain cleaners can affect the ability of the system to properly treat wastewater. These chemicals will directly affect the activity of the bacteria resulting in a dead tank with poor separating characteristics.

16. Antibacterial soap will also affect the biology of the tank. Liquid soap tends to be easily overused and may create problems in the system.

17. Excessive amount of toilet paper going into the system results in faster sludge build-up. Treated toilet paper, such as those containing lotion, can prevent toilet paper from settling, and forms a thick layer of scum at the top of the tank. Additionally, disposing of other types of products, such as wet wipes, into the system can be a problem and should be discouraged.

18. Toilet and drain cleaning chemicals can also directly affect the system. Antibacterial products will cause problems for the biological components of the system if used to excess.

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.

No automatic cleaners should be used. The continual impact of these chemicals on the system can cause long-term problems.

19. Listing the cleaning products used in the residence will raise owner awareness concerning the types of products used.

20. Listing of antibacterial products used in the residence is helpful. These products can have a cumulative effect on the treatment system.

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

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

23. Use of commercial ice machines can add large amounts of clean water. Condensate discharge is not sewage and should not go through the system.

24. Footing drains and sump pumps collect clean water from below the foundation in an effort to lower the surrounding water table. These clean water sources can overload the system and cause a hydraulic failure.

Treatment System (Q 25-41)

25. The relative ability of owners to identify system components indicates their level of awareness

26. The maintenance or lack of maintenance is important for the long-term use and life cycle of the system.

27. The fact that a system has backed up indicates possible hydraulic problems.

28. Plugging of the baffles indicates use issues or construction problems.

29. Presence of an effluent screen indicates a newer system or recent maintenance. It is also a key maintenance point.

30. The effluent screen requires periodic cleaning. The need for frequent cleaning may indicate a lack of settling occurring in the septic tank.

31. The need for repairs indicates past problems and potential construction or design concerns.

32. Surfacing effluent is a failure condition, and the cause(s) should be identified.

33. The alarm is a warning device. Activation of the alarm is the first indication of problems. Remote sensing of the system should also be identified if available.

34. The soil in which the 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 will provide valuable information for the long term care of the system.

35. The type of treatment, distribution, and dispersal component dictates certain maintenance activities.

36. The presence of a control on the pump helps assure performance and adds direction to the maintenance requirement

37. Knowledge of the system's design flow allows for evaluation of the hydraulic loading of the system.

38. Knowledge of tank capacities is essential to the operation process. This information should be on the permit

39. Sludge levels in the tanks can provide an indication of the amount of settling in the tank and where settling is occurring. Scum should 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.

40. Sludge accumulation in the pump 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 needed for settling.

41. The pump is needed to convey effluent out of the pump tank. This pump must be able to be turned on and off through the use of the proper controls.

42. 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 cross-sectional 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 discharge rate.

Water use

Monitoring of the flow is key to problem identification and allows for proactive versus reactive behavior.

Sampling

If sampling is required, the location and timing of the sample should be noted. When an effluent sample is collected, a proper chain of custody should be observed to document the proper handling of the sample.

Site sketch

Your site sketch should include as much detail as you can provide, including obvious critical elements (adjacent property wells). When available, attach an as-built plan or record of construction.

Form D-1. Residential evaluation survey (RES).

Name: ______________________ Date: __________ Time: __________

Address: ______________________ Phone: ______________________

Parcel #: ______________________ PM phone: ______________________

Designer: ______________________ Installer: ______________________

Home/Residents

1. Is this your first home with an on-site wastewater treatment system? YES / NO
2. Did you receive any septic system user information? YES / NO
3. Did you receive the as-built drawing for the system? YES / NO
4. Type of use: Permanent / Seasonal If seasonal, number of months used __________
   a. Number of people living in the home: Adults: ____ M ____ F
   b. Children: ____ M ____ F Teenagers: ____ M ____ F
   c. Number of bedrooms: __________ Number of bathrooms: __________
5. Water supply: Private well / Centralized system / Other supply
6. Do you have an in-home business? YES / NO
   If "yes," what type. ______________________
7 Is any resident using long term prescription drugs or antibiotics? YES / NO
   Type: ______________________

   ____
8. Do you use bath/skin oil/moisturizer? YES / NO
   Use: ______________________times/week.
9. Do you use septic system additives? YES / NO
   If "yes," what products. ______________________

Appliances and cleaning products

10. Home equipped with water conserving fixtures/appliances. YES / NO
11. Garbage disposal. YES / NO Use: ________ times/day ________ times/week
12. Dishwasher used. YES / NO Use: ________ times/day ________ times/week
13. Laundry: Maximum _____ loads per day consecutive loads: YES / NO
    Total _____ loads/week
    a. Brand of laundry detergents used. ______________________ powder / liquid
    b. Bleach used. YES / NO powder / liquid Use: ______ cups/load ______ loads/week
    c. Hot or cold water used. YES / NO
14. Whirlpool tub. YES / NO Use: ________ times/day ________ times/week
15. Is a drain cleaner used? YES / NO Type: ______________________
    Frequency of use: __________
16. Hand-washing soap brand. ______________________ Antibacterial. YES / NO
17. Number of rolls of toilet paper used per week. ______________
18. Toilet cleaning product brand. ______________________
    Cleanings/month ______________________
    Continuous cleaner used in toilet tank. YES / NO

Form D-1. (continued). **Residential evaluation survey (RES).**

19. Please list commonly used cleaning supplies:
    Shower ______________________ Kitchen ______________________
    Floors ______________________ Other: ______________________
20. Please list any antibacterial products:______________________
21. Water treatment device: YES / NO
    a. Is a water softener used? YES / NO Backflushes to: ______________________
    b. Reverse osmosis. YES / NO Discharges to: ______________________
    c. Other: ______________________
22. Air conditioner unit(s). YES / NO condensate drains to: ______________________
23. Commercial ice machine. YES / NO condensate drains to: ______________________
24. Footing drains or basement sump pumps connected into the system. YES / NO

Treatment System (completed by O&M service provider)

25. Type of pretreatment system: ☐ Septic tank ☐ ATU ☐ Media filter ☐ Constructed wetland
26. How old is the system? ________ years Date of last pump out: ______________________
27. Has the system ever backed up? YES / NO
28. Have the baffles ever been plugged? YES / NO
29. Effluent screen in septic tank outlet. YES / NO
30. Has effluent screen ever plugged? YES / NO Date(s): ______________________
31. Has the system ever been repaired? YES / NO
32. Has effluent ever surfaced? YES / NO
33. Has the alarm ever sounded? YES / NO
34. Soil type - at drainfield depth or lower: ______________________
35. Type of distribution/dispersal system: ☐ Gravity ☐ Trench ☐ Pressure dose ☐ Mound
    ☐Drip ☐Spray ☐Other: ______________________
36. Control system: Demand / Timed
37. Design rate for system: ________ GPD
38. Septic tank size: ____________ gal pump tank: ________ gal
39. Sludge levels in septic tank: 1st compartment accumulation ________ Floating materials ______
    2nd compartment accumulation ________ Floating materials ______
40. Sludge level in pump tank: Accumulated _______ Floating materials ________
41. Is the pump working? YES / NO
42. Duration of pump cycle: _________ minutes pump drawdown: ________

Water use

Actual water use (GPD): Average: ________ High: ________ Low: ________

Reading this date from: ________ cycle counter
________ hour meter on pump
________ water meter
________ other

Form D-1 (continued)**. Residential evaluation survey (RES).**

Effluent sample

Collected from: ______________________ Date: ____________ Time: __________

Chain of custody completed. YES / NO

Laboratory results

BOD_5 ______________________ mg/L   SS ______________________ mg/L

TSS ______________________ mg/L   FC ______________________ MPN/100 ml

O & G ______________________ mg/L   TKN ______________________ mg/L

pH ______________________ NH_4 ______________________ mg/L

Temp ______________________ °C 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:

Form D-1. Residential evaluation survey (RES).

Site Sketch (Sketch the system or attach record of construction (as-built)

Scale 1 in = ________ feet

Glossary

Acceptable is a condition in which a component is performing its intended purpose and is considered to be in an operable state.

Compensation is the action of being paid a fair price for a proper service.

Inspection is the process of identifying the current status of a system for reporting purposes.

Maintenance is the action of performing routine planned activities.

Malfunction is a condition in which a component of a system or an entire system is not performing its intended purpose.

Management is a term describing all the steps necessary to conduct operational services, including maintenance, monitoring, and compensation.

Mitigation is the act of fixing a system that is in failure. Fixing the system should be preceded by an evaluation of all the components (source, collection and storage, pretreatment, final treatment and dispersal) to determine the reason for the malfunction. Certain jurisdictions may require a permit before mitigation occurs.

Monitoring is the action of verifying performance requirements for a regulatory authority.

Operation is the action of assessing the functionality of each component of a system.

Performance Requirements are specific and measurable parameters that effluent must meet.

Repair is the action of fixing or replacing substandard or damaged components. Repairs may be required repairs, recommended repairs, or upgrades and may require a permit from the local regulatory authority.

Replacement is the process of exchanging a component with an equivalent component.

Reporting is the action of submitting a detailed report of operation and maintenance activities performed on a system.

Service is the action of performing activities such as, but not limited to, inspection, assessment, and maintenance of system components.

Troubleshooting is the act of identifying and correcting sources of system malfunction.

Unacceptable is a condition in which a component is not operable. This condition indicates the need for implementing maintenance, upgrades, repairs, or further investigation.

Upgrade is the action of creating a better system by adding or modifying a component to improve the level of treatment provided by a system or facilitate system management.

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