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Drip Dispersal Systems Technology Assessment and Design Guidance

Iowa Department of Natural Resources

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NOTICE

This document has been reviewed in accordance with the Iowa Department of Natural Resources policies and procedures and has been approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Application

Drip dispersal systems provide a method of discharging large volumes of partially treated wastewater to the soil environment where it receives final treatment by the natural soils prior to contact with the groundwater. When properly designed and positioned on suitable sites the drip dispersal network distributes the wastewater evenly over the soil infiltrative surface. Drip dispersal systems are suitable for use in domestic strength waste applications.

Performance

Drip dispersal systems are method of distributing the wastewater out over the soil infiltrative surface. Primary treatment components and, if used, secondary treatment components pretreat the effluent to reduce the wastewater strength to acceptable levels prior to the drip dispersal component. The natural soil environment is where the final polishing and treatment of the wastewater occurs. The following table shows the treatment performance expected from the natural soils below a drip dispersal network.

Constituent	Soil Water Quality At	
	24 inches	48 inches
5-day biological oxygen demand (BOD_5)	<1 mg/L	<1 mg/L
Total Kjeldahl Nitrogen (TKN)	0.77 mg/L	0.77 mg/L
Total Nitrogen (TN)	21 mg/L	
Nitrites & Nitrates (NO_3-N)	21.6 mg/L	13.0 mg/L
Total Phosphorus	.01 – 3.8 mg/L	.02 – 1.8 mg/L
Fecal Coliform	<1 MPN/100mL	<1 MPN/100mL

Recommended Design Parameters

Primary treatment required	Two compartment septic tanks required
Septic tanks size	2 X or 3X design flow depending on collection system
Design Flow (AWW)	100 gal/person/day
Wastewater Strength	Domestic
Applicable to	25,000 gpd or less
Hydraulic Loading Rate	Based on soils encountered
Drip Lateral Spacing	2 feet on center
Drip emitter spacing	2 feet on center
Dosing method	Timed dosing

Limiting Conditions

Normal tubing installation depth	8" to 12" increased freezing concerns
Suitable soil depth	24 inches below tubing installation depth to seasonal saturation or bedrock
Orientation of drip laterals	long and narrow placed along the contour,
Practical length of runs	150'+/-, adjustable based on input from manufacturer
Maximum slope	30%
Green space requirements	initial zone layout + zone replacement area + area downslope of zones for water to be assimilated back into the environment

Design Process

The general design procedure outlined in this manual follows these steps :

Step 1 - Determine design requirements

a. Characterize design flow rates
b. Characterize influent wastewater makeup
c. Characterize native soils textures, and loading rates

Step 2 - Size primary unit

a. Septic tank size, number and layout
b. Tank configuration
c. Effluent screens

Step 3 - Size Dosing Tank

a. Determine base volume
b. Select type of pumps to be used
c. Determine pump cover volume
d. Determine working volume
e. Determine reserve volume

Step 4 - Drip Zone Configuration

a. Select manufacturer of drip components
b. Select type of emitter to be used
c. Determine individual zone area required
d. Determine total zone area required
e. Determine optimal zone layout
    i. Length
    ii. Width
    iii. Lateral and emitter spacing
    iv. Determine number of zones

Step 5 - Size dosing pumps and controls

a. Select the type of remote zone valve
b. Determine dosing rate based on the number of emitters per zone
c. Determine dual zone dosing and field flushing rate
d. Select pump cycle times, dose volumes and frequency based on flow and drip zone configuration

Step 6 - Determine hydraulic profile and set elevations

I. INTRODUCTION

A. Scope

The Iowa Department of Natural Resources (DNR) has commissioned this manual in order to broaden the number of treatment options considered for managing wastewater within Iowa's small rural communities. Current rules and regulations do not recognize drip dispersal systems as a viable wastewater treatment and disposal systems. This manual is intended to expedite the design and review process for these technologies by:

- Summarizing existing research and performance data;
- Acting as a guide to determining the applicability of drip dispersal systems;
- Advising the designer as to the selection and sensitivity of design parameters;
- Providing an overview of the design process; and
- Providing three example designs for populations of 25, 100, and 250 people.

The manual has application for:

- Treatment of Domestic Waste Only; and
- Population Equivalents from 25-250 people.

The following assumptions on waste quantity and strength have been used throughout the manual:

- Design influent BOD of 250 mg/l or less;
- Design influent TSS of 250 mg/l or less;
- Design influent TKN of 40 mg/l or less; and
- Design Hydraulic Loadings of 100 gpcpd

This manual is intended for use by Owners, Consulting Engineers, DNR review engineers and associated DNR personnel, as well as funding source personnel to provide guidance to the successful design for the use of drip dispersal systems within Iowa. The design approach contained within this manual should be construed as a minimum basis of design. Nothing within this manual should be construed or viewed as eliminating additional alternative treatment systems, or alternative design approaches with respect to drip dispersal systems, provided that adequate justification and data from actual installations is submitted.

B. Terminology

Definitions of some terms used in this evaluation report are as follows:

ADW	Average Dry Weather Flow Rate. ADW is average daily flow when groundwater is at or near normal and a runoff condition is not occurring. The period of measurement for this flow should extend for as long as favorable conditions exist up to 30 days, if possible
AWW	Average Wet Weather Flow Rate. AWW is the daily average flow for the wettest consecutive 30 days for mechanical plants, or for the wettest 180 consecutive days for controlled discharge lagoons
Biochemical Oxygen Demand, five day (BOD)	A measure of the amount of oxygen required by bacteria while stabilizing, digesting or treating biodegradable organic matter under aerobic conditions over a five-day incubation period; commonly expressed in milligrams per liter (mg/L).
Bedrock	General term for the solid rock that underlies the soil and other unconsolidated material or any solid rock that is exposed at the surface
Component	A subsection of a treatment train or system.
Device	A subunit of a component.
Part	A subunit of a device.
Dispersal	Spreading the effluent over and into the final receiving environment.
Drip Dispersal System	A pre-engineered wastewater treatment and dispersal system that incorporates a high pressure, low flow disposal mechanisms in a manner that does not create saturated flow conditions with associated treatment units, tanks, filters, pumps, control panels, piping and all other equipment that is designed, installed, operated and maintained in accordance with this document by a drip dispersal system owner.
Drip Lateral	Length of drip line extending from the supply manifold to the return manifold.
Drip Line	Polyethylene tubing with drip emitters uniformly spaced along its length.

Drip Zone	1) A group of drip laterals that are managed as a single unit. 2) Part of a Drip Dispersal component where effluent is spread out and into the final receiving environment.
Denitrification	The process of biologically converting nitrate/nitrite (NO_3^-/NO_2^-) to nitrogen gas.
Design Flow	Equals the AWW (average wet weather flow rate). Estimated volume of wastewater for any 24-hour period, used for the design basis for all treatment components.
Emitter, Drip	Drip distribution device that dispenses effluent to the soil at a predictable rate.
Emitter, pressure compensating	A drip emitter that discharges water out an orifice of the drip tubing at a constant rate over a range of operating pressures.
Emitter, turbulent flow	A non-pressure compensating (non-PC) emitter that discharges water out an orifice of the drip tubing at a rate that varies directly with the operating pressure.
Excessive Infiltration/Inflow	The quantity of infiltration/inflow which can be economically eliminated from a sewer system by rehabilitation as determined by a cost-effective analysis that compares the costs for correcting the infiltration/inflow conditions with the total costs for transportation and treatment of the infiltration/inflow.
Flow, pressurizing	The portion of a dosing event during which the dispersal system is being filled to its operating pressure.
Flow equalization	The process of reducing the variability of the influent flow to a system component by storing peak flows and metering their release at a predetermined rate close to the average daily flow.
Flushing	The process by which drip tubing is hydraulically cleansed to prevent emitter clogging by increasing the velocity of water flow through the tubing to scour and transport solid materials that may have accumulated in or on the interior surfaces of the tubing. The minimum flow rate required for tube flushing is 2ft/sec.
Infiltration	The water entering a sewer system (including service connections) from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls. Infiltration does not

	include, and is distinguished from, inflow.
Infiltration/Inflow	The total quantity of water from both infiltration and inflow without distinguishing the source.
Inflow	The water discharged into a sewer system (including service connections) from such sources as, but not limited to, roof drains, cellar, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catch basins, storm water, surface runoff, street wash waters, or drainage. It does not include, and is distinguished from, infiltration.
Landscape Linear Loading Rate	The quantity of effluent applied along the length of a drip zone, expressed as gallons per day per linear foot (gal/day/ln.ft.).
Limiting Factor	Refers to a soil layer or horizon, which inhibits the natural flow of water such as bedrock, slowly permeable soils, compact dense till, or the fringe zone of the groundwater.
Linear Loading Rate	The quantity of effluent applied along the length of a single drip line, expressed as gallons per day per linear foot of drip line (gal/day/ln.ft.).
Loading Rate, Area	Quantity of effluent applied to the footprint of the soil treatment area expressed as gallons per day per square foot (gal/day/sq.ft.).
Nitrification	The process of biologically oxidizing ammonia (NH_4^+/NH_3) to nitrate/nitrite (NO_3^-/NO_2^-).
Present Worth	The total present worth method of evaluating sewage treatment systems involves bringing all costs of buildings, operating and maintaining the sewage treatment systems over a 20-year period to a total present worth.
Primary Treatment	Level of treatment involving removal of particles, typically by settling and flotation with or without the use of coagulants; some solids are anaerobically broken down but dissolved contaminants are not significantly removed in this treatment step (e.g. a septic tank provides primary treatment).
Sanitary Sewer	A sewer intended to carry only sanitary wastewater, from residences.

Secondary Treatment	Any component or combination of components that provides treatment of wastewater to secondary treatment standards (≤ 30 mg/L BOD_5 & TSS) prior to conveyance to a final treatment and dispersal component.
Storm Sewer	A sewer intended to carry only storm waters, surface run-off, street wash waters, and drainage.
Suspended Solids	Those solids that either float to the surface of, or are suspended in water, sewage, or industrial waste, which are removable by a laboratory filtration device.

Also see United States Environmental Protection Agency, 2002. Onsite Wastewater Treatment Systems Manual: EPA 625-R-00-008; Glossary

Abbreviations of some terms used in this report are as follows:

ATU	aerobic treatment unit
BOD_5	five-day biochemical oxygen demand
$CBOD_5$	carbonaceous five-day biochemical oxygen demand
cfs	cubic feet per second
DNR	Department of Natural Resources (State of Iowa)
EPA	Environmental Protection Agency (Federal)
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
HRT	hydraulic retention time
I/I	infiltration/inflow
IAC	Iowa Administrative Code
lb/day	pounds per day
lb/cap/d	pounds per capita per day
MGD	million gallons per day
mg/l	milligrams per liter
msl	mean sea level
NH_4-N	ammonia nitrogen
NO_3-N	nitrate nitrogen
scfm	standard cubic feet per minute
SRT	solids retention time or sludge age
TKN	total Kjeldahl nitrogen
TP	total phosphorus
TSS	total suspended solids
WWTF	Wastewater Treatment Facility

II. PROCESS DESCRIPTION

A. System Description

1. General

A drip dispersal system is the final dispersal component of a complete wastewater treatment system. The major component of a drip dispersal system discussed in this manual are the pressure dosing and drip dispersal components. For detailed information and sizing criteria of the primary and secondary treatment components the reader is referred to the Appendix entitled "Primary and Secondary Treatment Units". A complete wastewater treatment system consisting in part of a drip dispersal component requires some treatment processes upstream of the component, which at a minimum removes solids and provides required levels of additional treatment prior to discharge to the drip dispersal component.

Drip dispersal is a shallow slow rate pressure-dosed system used for land application of wastewater. This type of system uses small diameter piping with drip emitters, and must be preceded by filtering mechanisms, which conforms to the manufacturer's specifications for the particular emitter used. Effluent must be adequately filtered before distribution through the drip tubing and emitter system.

Subsurface drip dispersal networks have the capability of equally distributing effluent at relatively low application rates over the entire absorption area with the goal of preventing saturation of the soil. Wastewater is applied at a controlled rate in the plant root zone. Shallow placement of the drip emitter lines is intended to allow for enhanced evapotranspiration and plant uptake of effluent as compared with conventional subsurface dispersal systems.

The unique feature of drip dispersal networks is the use of uniformly spaced drip emitters that are inserted within flexible tubing to control the rate of wastewater discharges out of the tubing through small orifices. This method of application of the wastewater to the native soils maintains an unsaturated flow condition and enhances the retention time in the soil for optimal treatment. Drip line is installed directly into the soil without aggregate or other media. When used as a method of delivering treated wastewater to the final treatment medium it is referred to as drip dispersal rather than drip irrigation. Drip dispersal is seldom designed to meet the watering requirements of the covering vegetation but instead its primary focus is to maximize infiltration of water into the soil.

2. History

Drip irrigation technology was originally developed for agriculture as a technique to improve the efficiency of water delivered to plants, especially in environments where water supplies are limited. It is used extensively in commercial and residential application for landscape irrigation. It has been used in the U.S. for dispersal of wastewater onto soil infiltrative surfaces since the 1980's. The advent of reliable filtration and dosing control mechanisms has made drip dispersal a viable alternative for subsurface dispersal of wastewater effluent.

3. Treatment Process

The treatment process begins at the wastewater source. A discussion of the strength of typical residential wastewater at different points in the treatment process is found in the performance section of this manual and in Appendix A. The design guidance presented in this manual is limited to systems capable of treating domestic strength wastewater. Wastewater is transported to the treatment site by a variety of methods via a collection system designed specifically for the purpose. The collection system may discharge directly to a common septic tank via a standard gravity sewer main or by use of individual tanks located at each residence then through small diameter gravity or low-pressure sewer mains to the treatment site. Additional information regarding the design and selection of various alternative collection systems can be found in the IDNR Alternative Collection Systems Manual.

Once the wastewater is transported to the treatment site the major components found in the drip dispersal treatment process are:

- Primary Treatment - septic tank(s), if not located at the residence
- Secondary Treatment Unit – optional
- Pressure Dosing Component
- Drip Dispersal Component
- Native Soil

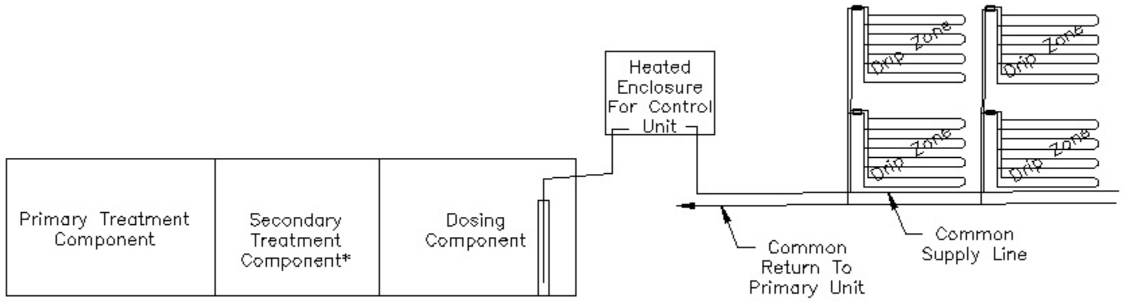

Figure 2-1
Drip Dispersal System Components
*secondary treatment component is optional based on manufacturer's concurrence & recommendations

B. Primary Treatment Component

The function of a septic tank is to remove solids and TSS from the wastewater stream by settling and floatation. To a lesser degree, reducing influent BOD is needed prior to discharge to a treatment/dispersal component. For clusters of homes and small communities, either individual septic tanks on each lot or large multi-compartment tanks are options available for primary treatment of the wastewater.

Requirements for sizing and lay out of septic tanks are discussed in Appendix A of this manual. The system designer should review Appendix A for expected performance levels, design criteria and sizing of septic tank installations for population equivalents of 25, 100 and 250 people.

C. Secondary Treatment Component

Use of a secondary treatment unit (in addition to the septic tank) may be an option for consideration during the design of a small community wastewater drip dispersal system. The goal of using a secondary treatment component is to reduce the strength of the wastewater as necessary to achieve discharge compliance equal to or less than 30 mg/L BOD_5 & TSS. Treatment of effluent to secondary standards enhances the performance of the mechanical filtration process.

1. <u>Types of Units</u>

Secondary treatment systems can be divided into two types of units; suspended growth and fixed film processes. Commonly used secondary treatment units are aerobic units (ATUs), and media filters including sand, peat and textile filters. Units must provide documented effluent performance limits of less than 30 mg/L BOD_5

and TSS or have a proven technology with an established record of producing similar results.

Many of the commercially available secondary treatment units were originally developed and designed for single-family applications but most suppliers of these types of treatment units have adaptable the technology for use in larger flow applications such as small community systems. Besides treatment performance goals this component should be evaluated for cost effectiveness, maintenance and monitoring requirements.

It is highly recommended that the designer select a treatment unit or process with well-documented performance standards and to insure that the units are adequately sized based on factors such as the design flow and the anticipated biological loading the unit will receive. Some secondary treatment components utilize septic tanks as the containment vessels for their technology while others are provided in their own container or vessel and are delivered to the construction site and simply placed in an excavation provided by the contractor. All units require some additional plumbing and electrical connections on site to complete the installation. Sand filters utilizing either single pass or recirculating technology may also be utilized as secondary treatment components. They are available from equipment suppliers in kit form and manufacturers will generally assist with the design process for the device. See the IDNR Recirculating Sand Filter Design Manual for design guidance on sand filters.

The system designer should select the best unit or component available for the particular project.

D. Pressure Dosing Component

The pressure-dosing component of a drip dispersal system includes the dose chamber, pumps, control switches, filters and electrical panels. The function of the dosing component is to serve as a storage system to hold the effluent until it's dosed into the drip fields or zones. This component provides flow equalization, a method of delivering the wastewater to the final dispersal component and emergency storage during periods of pump failure or electrical outage.

While no specific treatment process is associated with this device, it plays an important role by providing storage and a means of discharging effluent in uniform doses over the 24-hour design period. Small, evenly spaced doses throughout the day, contribute to enhanced performance and longevity in the final treatment and dispersal component by providing regular resting cycles between doses. Flow equalization is one of the main goals of the design and operation of a drip dispersal system.

Specifics regarding dose chamber volumes will be discussed in more detail in the design guidance section of this manual.

E. Drip Dispersal Component

The drip dispersal component consists of parts and devices such as zone control valves, common supply and return lines, drip tubing, drip emitters, supply and return manifolds, check valves, and air release valves/vacuum breakers. System configuration is dependent on site and soil characteristics. Alternative layouts such as looped systems, zone loading with equal and unequal configurations, split zones, and zones with sub headers on steeper slopes are readily adaptable to most sites. Consult with the manufacturer to assess what if any variations on the basic zone layout may be appropriate for your site.

1. Drip Tubing & Zones

The drip tubing is normally a ½-inch diameter flexible polyethylene tube with emitters attached to the inside wall of the tubing. Emitters are typically evenly spaced at 2 feet on center but can be ordered with alternate spacing intervals. Drip tubing commonly comes in 500 and 1,000 foot rolls. Normal installation depth for drip tubing is 8” to 12” but may be installed deeper if necessary for frost protection and if adequate suitable soils are available. Shallow installation is one of the advantages of drip tubing technology. Tubing installed in the active root zone provides water reuse for plant watering needs and during the warm season, takes advantage of evapotransporation opportunities. The tubing is typically installed at 2 feet on center throughout the drip zone but may be placed 1 to 3 feet apart horizontally depending on soil texture and site conditions. A 3 feet spacing is sometimes recommended on very steep (25% to 30%) slopes to allow adequate distance between tubing runs for the water to infiltrate before impacting the next downslope drip tube. Consultation with the manufacturer is recommended to determine the most desirable spacing of the tubing based on soil texture, slope and soil conditions at a particular site.

Design Note: Spacing of emitters closer together should not change the footprint of the area required based on soil loading rates established by the soil evaluation.

The tubing is installed along the contour with each run laid as level as possible. A run is defined as a single length of drip line installed along the contour. A lateral is defined as a run or series of runs extending from the supply manifold to the return manifold in a single dispersal zone. Typical installation of the tubing is with a vibratory plow or trencher, which creates very little disturbance to the surface area.

Drip zones are a group or set of laterals, which operate independently of the other zones in the component. The number of drip zones required is dependent on the site and soil conditions encountered. Zones may be equal or unequal. Equal zones will have the same number of emitters and therefore the same dosing rate to each zone while unequal zones will have varying numbers of emitters and have different dose rates for each zone. Unequal zones are used to "fit" a zone to the available space. Because each zone is completely independent of all the other zones they do not need to have the same number of emitters or length of tubing. The amount of wastewater applied per emitter will be the same no matter what size the zone is.

The drip dispersal component is divided into enough zones to make the use of smaller horsepower pumps practical and economical. Multiple zones also adds some flexibility for operation of the system by providing the opportunity for complete resting of a zone if the soil becomes saturated or a malfunction occurs that requires some time to repair. The dose controller automatically alternates zone doses. Zones may be dosed individually or dual zone dosing can be employed.

No treatment of the wastewater can be attributed to the drip tubing; effluent quality requirements must be addressed prior to final dispersal or in the soil after dispersal. Drip tubing's function is to distribute the effluent as evenly as possible over the suitable soil area.

2. Emitters

Drip emitters are designed to create a high head loss between the in-line pressure of the drip line and the outlet orifice in the drip tubing wall. The pressure loss created, controls the pressure at the emitter so that the discharge is maintained within a desired range. Each emitter acts as a point discharge, which releases water at a rate nearly equal to the discharge rate from other emitters in the same drip line. Drip tubing is available with two types emitters:

- Pressure compensating, and
- Turbulent flow non-pressure compensating

a) Pressure Compensating Emitters

This emitter style is designed to maintain a constant discharge rate over a range of pressures from 5 to 70 psi. Pressure compensating emitters are available for nominal flow rates ranging from 0.4 to 1.0 gallons per hour depending on the manufacturer.

A common discharge rate for pressure compensating emitters is 0.61 gallons per hour. A pressure compensating emitter designed for use with wastewater uses an elastomeric diaphragm or disk placed over a turbulent-flow labyrinth to reduce variable inlet pressures to a constant outlet pressure resulting in uniform flow rates on both sloping and level sites. The advantage of using drip tubing with pressure compensating emitters is that the laterals can be run longer distances (up to 300') and are more adaptable for installation sloping sites than tubing with non-pressure compensating emitters. The disadvantage is the tubing is more expensive than non-pressure compensating emitter tubing.

b) *Turbulent Flow, Non-Pressure Compensating Emitters*

With non-pressure compensating emitters the discharge rate will vary with the in line pressure. Angles in the emitter flow path are designed to cause turbulence in order to equalize flow between emitters and keep the emitters clean. The recommended operating pressure for this emitter is 10 to 45 psi. Emitters installed at different elevations will have variable discharge rates; lower emitters will have a higher discharge rate than emitters located at higher elevations. A typical flow rate in tubing with turbulent flow emitters is 1.30 gallons per hour at 20 psi. Because of the variable flow rates at different pressure the use of a pressure-regulating valve is recommended when there is a difference in elevation of 6 feet or more between the highest and lowest lateral in a zone. The maximum flow variation between any two emitters in a single zone should not exceed 10 percent. When determining flow variation consideration should be given to the effect of "drain down", an effect which occurs in the field laterals after the pump shuts off that results in unequal distribution and excess flows in the runs of pipe placed at the lowest elevation. Lateral lengths should also be kept under 200' to maintain the pressure differential across the drip lateral within a tolerable range. Non-pressure compensation emitters are generally less expensive than pressure compensating emitters.

3. Zone and Air Release Valves

a) *Zone Valves*

Zone valves recommended for use in small community flow applications are electrically actuated valves. The zone valve is used to control the flow to each zone. Solenoid zone valves are typically in a closed position until the dose controller activates the valve during a routine dosing event. When the controller starts a dose cycle the pump is activated and one or two zone valves are simultaneously opened to discharge the dose to the designated zones.

The zone valve requires a structure for access and maintenance purposes. The structure is typically buried and insulated to provide frost protection, removable lids at the surface are provided for access for maintenance purposes. Typically the zone valve is positioned higher than the highest lateral in a zone and equipped with an air release valve to allow for the drainage of water away from the valve after each dose.

b) *Air Release/Vacuum Breaker Valves*

The air release/vacuum breaker valve is one of the most crucial parts of the drip dispersal component. Air/vacuum breakers are installed at high points in the zone to aid in pressurization of the zone and at pump shut off to keep soil from being sucked into the emitters due to back siphoning or back pressure and to allow the water to readily drain out of the supply and return manifolds and into the drip laterals after each dose. Each zone requires two air/vacuum valves, one on the supply side and one on the return side. The air release/vacuum breaker valve is located in a small meter box or manufacturer supplied housing structure with sufficient space to provide airflow around the valve and an access point for periodic maintenance.

4. Drainage During Depressurized Flow

When the pump shuts off, the remaining effluent in the drip lateral and manifolds will drain out through the emitters. On sloping sites and to some extent on level sites, it will flow via the tube and manifolds to the lowest point where it will flow out the emitters. This may cause severe overloading and breakout on the ground surface especially in larger systems and on slowly permeable soils. Things that can be done to minimize this from happening are:

- Keep each zone as small as is reasonable.

- Use a small compressed horizontal manifold with small diameter pipes extending to the drip laterals. This compressed manifold isolates drip laterals from one another as it is normally placed on the up slope side of the zone. The isolated lines supplying effluent from the manifold to the drip laterals prevents drainage of the manifold to the lower drip laterals.

- Isolate each lateral by having the PVC feeder tubing for each lateral pass over an elevated berm between the manifold and beginning of the tubing to reduce gravity flow out of the lateral. In looped systems, elevating the loop will keep the effluent in its respective run.

• Use a sufficient dose volume so that the percentage of effluent which drains by gravity is small compared to the amount delivered while the laterals are fully pressurized.

• Use a bottom-loading supply manifold with check valves installed before each lateral to prevent residual water from flowing down the slope. The return manifold should also have check valves to prevent water flowing down the slope during drainage.

• The supply and return manifolds can also be drained from the bottom of the field back to the pump tank. This prevents effluent from draining into the drip laterals and returns it back to the tank to be dosed again during the next event.

F. Soil Component

The soil is the ultimate receiver of the wastewater and the most important part of the drip dispersal component. It is also the most variable and must be carefully evaluated. The discharged wastewater moves through the soil vertically and/or horizontally. The area footprint of each drip dispersal field depends upon the horizontal and vertical acceptance rate of the soil (Converse and Tyler, 1986). As with all soil based treatment systems the drip dispersal component benefits by the use of a long and narrow configuration to promote water dispersion away from the system, for gas diffusion beneath the system (Tyler et al., 1986) and dispersion into the groundwater.

Because drip tubing is installed directly into the soil without any use of aggregate to help spread out the wastewater flow, the wetting pattern observed with drip tubing is different than in other soil absorption systems. In most soil types there will be a small zone of saturation immediately around each emitter. The wetted volume from one emitter should approach the boundary of the wetted volume from adjacent emitters in the same drip line and to the emitter in adjacent drip lines. The wetted volume in clayey soils depends mainly on capillary forces while gravitational forces have a greater effect in sand soils. A larger lateral spread of the wetting front typically occurs with increasing fines and or higher drip rates, (Report #1007406, EPRI & TVA, 2004).

After discharge from the drip tubing wastewater must flow through an unsaturated zone for final treatment prior to discharge to the groundwater. In a properly functioning system all wastewater applied over the footprint of the dispersal component must leave the system, therefore the flow rate of the applied wastewater must be equal to or less than the flow rate in the unsaturated zone. Water in the underlying saturated zone also must continue to move away from the system until it is dispersed into the environment or the soil will become saturated back to the point of application and ultimately result in system failure.

At some point away from the system all the wastewater is assimilated into the environment such that it is not detectable or will not influence the system operation. This is called the system boundary. System boundaries are located both horizontally and vertically away from the drip dispersal zones. The boundary could be, but is not limited to, restrictive soil layers, a surface water discharge point, change in slope, area of convergent flow in the landscape or the groundwater surface. The system boundary for each system is determined during the detailed site evaluation as described later in this manual.

III. Performance

The factors that determine good performance from a drip dispersal system include:

1) A knowledgeable evaluation & characterization of the flow data and wastewater strength
2) A thorough and competent investigation of the site and soil conditions
3) A design based on conservative linear and area loading rates carefully matched to the soil and site conditions
4) Use of a site specific engineered design
5) Competent construction practices
6) Adequate operation and maintenance procedures

Wastewater samples and laboratory analysis data are used to evaluate the performance of the primary and secondary treatment components. For the drip dispersal component there is no qualitative data that can be used to determine if a drip system is functioning as designed other than physical observations of the ground surface around and near the drip zones. Groundwater sampling, via monitoring wells can confirm the treatment capabilities of the native soil but does not confirm nor dispute the effectiveness of the dispersal method.

Another method of determining if the drip dispersal zones are performing as expected is to install soil moisture sensors. Soil moisture sensors placed in the drip zones can provide a signal to the operator when and if saturated soil conditions are present due to the application of greater flows than the soil is capable of transmitting away from the zone. This device provides a warning of soil wetness and allows the operator to remove a zone from the dosing rotation for a short period of time or reduce the volume per dose to that zone to a rate more compatible with soil acceptance rate.

Other than moisture sensors the performance of the drip dispersal component can be determined by visual observation of the ground surface. The surface over the drip laterals should be dry and no surfacing of the effluent should be visible if the application rates are matched correctly to the soil conditions at the site.

Performance data is presented in the following section and in Appendix A shows the expected effluent quality at various points in the treatment process. Effluent volumes discharged to the drip dispersal component must not exceed the ability of the natural soils to transmit and move the volume of water away from the point of discharge. The following data is compiled from various studies done to measure the performance of the major components that will be used in a drip dispersal system.

A. Performance Data

1. Wastewater Flows

Wastewater flows from residential sources have been established in publications such as the USEPA *Onsite Wastewater Treatment Systems Manual*, Chapter 3, 2002 and *Small and Decentralized Wastewater Management Systems*, Crites and Tchobanoglous, 1998. A typical range of flows reported is 50 to 70 gallons/capita/day. The design flow rate used in this manual is referred to as the average wet weather flow rate (AWW) and shall be 100 gal/person/day. This flow rate allows for a safety factor in the design to account for variables such as fluctuating flows and non-uniform soil conditions. The designer may want to adjust the design population based on additional allowances for infiltration and inflow depending on the type and age of the collection system. Anticipated future growth in the community over the design life of the system should also be considered when determining the design population total.

2. Wastewater Source

This manual is intended to provide design guidance for the treatment of wastewater from residential sources. The qualitative characteristics of wastewater generated by residential sources can be distinguished by their physical, chemical, and biological composition. Wastewater flow and the type of waste generated affect wastewater quality. The concentrations of typical pollutants in raw residential wastewaters are shown in Appendix A.

3. Primary Treatment – Septic Tank Effluent (STE)

Septic tanks are the most commonly used method of providing primary treatment in drip dispersal systems. Septic tanks provide treatment by removal of solids from the wastewater stream and reduce levels of TSS to help prevent fouling of the final dispersal component. Some initial BOD reduction has been documented as well, although experience shows this can vary significantly from system to system. The performance expectation for a primary treatment unit is shown in Appendix A.

4. Secondary Treatment Components

Secondary treatment components are generally installed directly downstream of the septic tank and are intended to provide additional treatment prior to discharge of the effluent to the final dispersal component. Examples of secondary treatment units are packed –bed filters such as sand filters, peat and textile filters and aerobic units. The performance goal of secondary treatment units is to consistently produce an effluent quality with concentrations of $\leq$ 30 mg/L BOD_5 and TSS and Fecal Coliforms of <10,000 col/100mL.

5. Natural Soils Treatment Performance

The effectiveness of the soil to provide final treatment of the effluent after it drips from the tubing depends on the residence time in the soil and maintaining predominately aerobic (unsaturated flow) conditions (Report #1007406, EPRI & TVA, 2004 & USEPA Onsite Wastewater Treatment Systems Manual, 2002).

Table 3-1 shows typical concentrations of wastewater constituents found in soil 24 inches and 48 inches below a conventional leach field. The performance of the soil in the treatment of wastewater from a drip dispersal field are expected to be the same. The concentrations shown in this table are based on discharge of septic tank effluent to a typical in-ground leach field or dispersal cell.

Table 3-1 Treatment Performance of Soil

From: Various Sources*

Constituent	Soil Water Quality At	
	24 inches	48 inches
5-day biological oxygen demand (BOD_5)	<1 mg/L	<1 mg/L
Total Kjeldahl Nitrogen (TKN)	0.77 mg/L	0.77 mg/L
Total Nitrogen (TN)	21 mg/L	
Nitrites & Nitrates (NO_3-N)	21.6 mg/L	13.0 mg/L
Total Phosphorus	.01 – 3.8 mg/L	.02 – 1.8 mg/L
Fecal Coliform	<1 MPN/100mL	<1 MPN/100mL

*USEPA Onsite Wastewater Treatment Systems Manual, Chapter 3, 2002 adapted from Anderson et al., 1994

Bacterial and Nutrient Removal in Wisconsin At-grade On-site Systems, Converse, J.C., Kean ME, Tyler EJ, and Peterson JO. 1991

Onsite Sewage System History and Current Practices, Burks B., Minnis M., and Langstroth R., 1998

B. Existing Small Community Drip Dispersal Systems

The following tables identify known drip dispersal systems located in Iowa and some of the surrounding states where the technology has been adopted for use.

Iowa						
Site Name	Location	Daily Design Flow (gpd)	STE Or Secondary Treatment (type)	Final Treatment & Dispersal	Installed	Comments
None Found						

Illinois						
Site Name	Location	Daily Design Flow (gpd)	STE Or Secondary Treatment (type)	Final Treatment & Dispersal	Installed	Comment
Newport Cove Subdivision	Lake Co	160,000	Aerobic	Drip	2006	

Minnesota						
Site Name	Location	Daily Design Flow (gpd)	STE Or Secondary Treatment (type)	Final Treatment & Dispersal	Installed	Comment
Audubon Subdivision	Still Water		Aerobic	Drip	2006	
Discovery Crossing Subdivision	Washington Co.	9,000	Aerobic	Drip	2006	
Lutsen Mountain	Lutsen	14,000		Drip	1997	
Miller Farms Subdivision	Still Water	29,000	Aerobic	Drip	2006	
Prairie Hamlet		4000	Constructed Wetland	Drip		
Windsor Park Community	Sherburne Co.	39,600	Sand Filter	Drip	2003	

Wisconsin						
Site Name	Location	Daily Design Flow (gpd)	STE Or Secondary Treatment (type)	Final Treatment & Dispersal	Installed	Comment
Don's Mobile Manor	Dane Co.	25,000	Sand Filter	10 Drip Zones	2003	discharge permit renewable every 5 yrs., licensed operator, sampled & inspected weekly, remote operation & monitoring,
Selwood Farms	Columbia Co.	20,500	Sand Filter	6 drip zones	2001	discharge permit renewable every 5 yrs., licensed operator, inspected weekly, sampled monthly, remote operation & monitoring
Village of Yuba	Richland Co.	10,000	Sand Filter	4 drip zones	2002	Construction permit, licensed POWTS maintainer, inspected weekly, sampled quarterly

C. Conclusion

Drip dispersal systems have been used successfully for the dispersal of wastewater to the soil for many years. Drip dispersal systems have been designed and constructed nationwide for a wide variety of flows from single-family home systems to those capable of handling 100,000's of gallons per day. The technology has been accepted in many of the states surrounding Iowa including Illinois, Wisconsin and Minnesota.

Small community drip dispersal systems should incorporate the following strategies into the design to enhance consistent, long-term performance:

- A detailed site and soil evaluation performed by a competent qualified person, which establishes the soil loading rates and boundaries for the system;
- A design that includes consultation with and concurrence by the drip equipment manufacturer selected;
- Drip laterals laid out parallel to the contour;
- Zones located in appropriate landscape positions;
- Timed dosing providing dosing & resting cycles for each zone;
- Automatic dosing, back flushing of filters and zone flushing;
- Duplex dosing pumps;
- A flow meter to keep track of the actual gallons of wastewater discharged to the drip zones;
- A design that includes adequate access points to the primary and secondary treatment units for ease of operation, monitoring and maintenance;
- An operation and monitoring plan that clearly identifies sampling frequency, locations, record keeping and routine maintenance requirements;
- Remote operational control and monitoring of the drip component should be considered for increased response time due to equipment malfunction or failure.

IV. Design Guidance

A. Design Guidance Note

The design of a drip dispersal system is driven primarily by the soil characteristics and site conditions. A thorough evaluation of the soil and site is the first step in the design process. The design guidance section of this manual begins with a discussion of the soil and site evaluation but other issues will also have a great impact on the design of a drip dispersal system. The design and selection of the major parts and devices used in the dosing and drip dispersal components of the system depend largely upon which manufacturer is selected to provide the drip tubing and associated equipment. A designer using this manual is strongly urged to interview and select one of the major manufacturers and suppliers of drip equipment early on in the design process. The designer and manufacturer need to cooperatively work out a design, based on the site and soil conditions, which provides a reliable wastewater treatment system for the community.

The manufacturer/supplier of the drip equipment can provide detailed design guidance tailored to match the specific site and soil conditions. Rather than try to provide detailed design guidance that takes into account all of the variability of the equipment and design approaches used by the manufacturers of drip dispersal parts and devices, this guidance manual will provide general design requirements and examples of system details that can be incorporated into a specific design.

The reference section of this manual lists publications, which discuss theory, operation and function of drip technology. The reference section also lists the contact information of the major manufacturers/suppliers of drip dispersal equipment.

B. Site and Soil Evaluator Qualifications

The development of a design for a large community drip dispersal system begins with a site and soil evaluation performed by a qualified person. In addition to a thorough knowledge of soil science, the site evaluator should have a basic understanding of chemistry and water movement in the soil environment, as well as a basic knowledge of soil-based treatment system operation and construction. Either the soil and site evaluator or the system designer shall have sufficient skills in surveying to create site contour maps and site plans that include temporary benchmarks, horizontal and vertical locations of site features, and investigation, sample, or test pit locations. A general knowledge of hydrology and biology is helpful. Finally, good oral and written communication skills are necessary to convey site information to others who will make important decisions regarding the best use of the site.

The role of the site evaluator is to identify, interpret, and document site conditions for use in a soil-based wastewater treatment system selection, design, and installation. The information collected should be presented in a manner that is scientifically accurate and spatially correct. Documentation should use standardized nomenclature to provide geophysical information so that other site evaluators, designers, regulators, and contractors can use the information.

C. Site and Soil Evaluation

1. Preliminary Site Evaluation

Because land acquisition is normally a large part of the process when selecting a site for a community drip dispersal system, it is often necessary to conduct preliminary evaluations of multiple sites before an extensive evaluation is done on one or two selected sites. A preliminary evaluation can eliminate some obviously unsuitable sites from the selection process based on a site visit and/or review of available data such as property maps, USGS topographic maps, floodplain maps, wetland maps (if available), aerial photos and NRCS soil maps of the area in question. The first step in the preliminary review involves completing a general evaluation of the proposed site. The site or sites should be evaluated for conditions that might inhibit construction or proper operation of the drip dispersal component (see Preliminary Site Evaluation form on next page). From the onset it must be recognized that not all site locations will be suitable for a drip dispersal component.

If the site looks appropriate for a drip dispersal component, the general type and direction of groundwater flow should be determined. Groundwater flow direction can often be determined based on various topographical features such as slope and relationship to nearby surface waters. Reference documents such as the USGS Hydrologic Investigation Atlas for the area (if available) and well logs of nearby wells are also sometimes helpful in making initial evaluations of the subsurface environment. This information is helpful during the design process.

Community drip dispersal systems will require some owner-controlled space around the drip zone fields. Down gradient "green space" is required to fully treat and dilute the effluent. If soils are permeable and flow is vertical, the down slope buffer zone width is less critical. Additional space on up slope and side slope areas of the drip field should be included in the plan to protect the shallowly placed drip tubing from disturbance by human or animal activities. Restricting access to the site by fencing can reduce the excess area requirements.

Preliminary Site Evaluation

Name of Project: ____

Legal Description: ____

County: ________________________

Client Name, address, and phone: ________________________
____
____
____

General Description of the Project: ________________________________
____
____
____

Site Dimensions and Site Size: _________________ Approximate Acreage _______

A. Preliminary site evaluation of the proposed site should include the following information:

(1) Easements on the property within 50 feet of the proposed system;

Easements within 50'? _______Y _______N _____ easements drawn on map

(2) Floodplain designation and flood elevation from published data or data that is acceptable to and approved by the permitting authority, within 200 feet of the proposed system;

Floodplain within 200'? _______Y ________N _____ flood elev. drawn on map

(3) Wetland designations within 200 feet of the proposed system;

Wetland within 200'? _______Y ________N _____ wetland drawn on map

(4) Property lines of the proposed site;

Property lines shown on map? ________Y _______N

(5) Required setbacks from the system:

Habitable buildings within 1000'? _____Y ____N ____ building shown on map

Shallow public water supply wells within 1000'? _____Y _____N ____ public well shown on map

Deep public or private water supply wells within 400'? ______Y _____N ____ private well shown on map

Surface water within 400'? ______Y _____N ____ surface water drawn on map

(6) Current land use of the site and surrounding areas.

Current land use drawn on map? _______Y _______N

Soil survey map with site designated? ______Y _______N

Page 1

Preliminary Site Evaluation-cont.

B. Surface Information.

(1) General description of vegetation: ____

____

(2) USGS quadrangle map of site and surrounding area. ________Y _______N

Site boundaries, setbacks, easements identified, located, and marked. ________Y _______N

C. Surface evidence of disturbed or compacted soil.

(1) Surface evidence of disturbance or compaction? _______Y _______N

Description of surface evidence of compaction:

____

____

____

Surface evidence of disturbance mapped? . ________Y _______N

D. Flooding or overland flow potential from adjacent properties.

(1) Evidence of flooding or overland flow potential? _______Y ________N

Description of flooding or overland flow potential:

____

____

____

Flooding or overland flow potential mapped? . ________Y _______N

E. Landscape position, landform, micro-features, slope gradient and surface conditions:

Description of surface features:

____

____

____

____

F. Additional Comments:

____

____

____

____

____

____

Page 2

For guidance on land requirements, examples of drip dispersal field sizing at the basic population equivalents identified in this manual are presented later in this section.

2. Detailed Soil Evaluation

The objective of the detailed site evaluation is to evaluate and document site conditions and characteristics in sufficient detail to allow interpretation and use by others in designing, siting, installing, regulating and maintaining the system. Detailed site evaluations should attempt to identify critical site characteristics and design boundaries that affect site suitability and system design. At a minimum, the detailed investigation should include soil profile descriptions and topographic mapping. Several backhoe pits, deep soil borings, ground water characterizations, and pilot infiltration testing processes may be necessary for large community drip dispersal infiltration systems. This information should be presented with an accurate site plan.

The detailed evaluation should address surface features such as topography, drainage, vegetation, site improvements, property boundaries, and other significant features identified during the preliminary evaluation stage. Subsurface features to be noted include soil characteristics, depth to bedrock and ground water, subsurface drainage, presence of rock in the subsoil, and identification of hydraulic and treatment boundaries. Information must be conveyed using standardized nomenclature for soil descriptions and hydrological conditions. Evaluation procedures must follow accepted protocol and standards. The following pages contain a standard form to be used in the evaluation processes.

Wastewater application rates vary with soil type and site conditions. In sandy soils with greater water application rates or where wastewater dispersal / groundwater recharge is the main design criteria, vegetation may have to tolerate periods of excessive wetness. In clay soils with lower long-term acceptance rates, selection of drought tolerant plants will allow optimum utilization of the wastewater (Lesikar and Converse, 2005).

The vertical separation distance to both groundwater and restrictive horizons may be less for drip dispersal than for conventional gravity dispersal technologies. A suitable site must still have a minimum 24 inches of unsaturated soils below the drip dispersal laterals as determined by a soils and site evaluation conducted by a qualified person.

In areas with high groundwater, consideration must be given to how the water leaves the soil dispersal area. The presence of shallow groundwater below the drip zones reduces the ability of water to move out and away from the drip field. The wastewater moves into the soil and down into the groundwater and then must move laterally through the soil profile to exit the site. Shallow groundwater in the dispersal field area requires extensive evaluation of the site conditions to determine how the water will drain from the treatment area. (Lesikar and Converse, 2005).

Based on the proposed design flow, an area equal to 150% of the estimated required treatment area should be investigated. Investigation of additional area will allow some flexibility later in the design stage if preliminary design flow values change or the drip dispersal component needs to be shifted up or down slope or horizontally due to physical placement issues that cannot be for seen in the early stages of design.

Test pits should be spaced and distributed on the landscape in a manner that provides a reasonable degree of confidence that conditions are similar between pits. Attempt to place pits so they will not be under the future treatment area. For small community systems (2,500 gpd to 10,000 gpd), five to ten test pits should be sufficient on sites with uniform soil characteristics. They should be generally located around the periphery with one or two in the center of the proposed infiltration area to confirm soil conditions. Larger community projects (10,000 gpd to 25,000 gpd) may require more test pits. Test pit spacing can be adjusted based on landscape position, soil variability, and observed conditions. Hand auger borings or soil probes may be used to confirm conditions between or at peripheral test pit locations. The actual number of test pits will depend on the variability of the soils at the site. Enough pits should be constructed so that the range of characteristics of the next pit that might be dug can reasonably be predicted. Confirmation of an adequate site takes fewer test pits when uniform soils are encountered than when highly variable soil is found on the site.

Soil Boring Log

Page____ of______

Property Owner:	Property Location: ¼ ¼, Sec. T R			
Mailing Address:	Lot No.		Parcel I.D.	Subd. Name or CSM#
City	State	Zip Code	Phone	☐ City ☐ Village ☐ Town

Construction: ☐ New ☐ Replacement	Use: ☐ Residential ☐ Public/Commercial	Flow ______ Ave.______ Peak
Population ______	Bedrooms ______	Describe public/commercial use:
Parent Material:	Flood Plain Elev.:	
Comments:		

Boring #	☐ Pit ☐ Hand Boring		Ground Elev. ______ Feet		Depth to Limiting Factor: ______ Inches				Soil Loading Rate*	
Horizon	Depth In.	Dominant Color Munsell	Redox Description Qu., Sz., Prominence, Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	Roots	Eff#1 GPD/ft^2	Eff#2 Gal/ft/day

Boring #	☐ Pit ☐ Hand Boring		Ground Elev. ______ Feet		Depth to Limiting Factor ______ Inches				Soil Loading Rate	
Horizon	Depth In.	Dominant Color Munsell	Redox Description Qu., Sz., Prominence, Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	Roots	Eff#1 GPD/ft^2	Eff#2 Gal/ft/day

* From Table 4-6 Effluent #1 = Septic Tank Effluent Treatment Level Effluent #2 = Secondary Treatment Level

Project Name: ______________________ Page ___ of ___

Boring #	☐ Pit ☐ Hand Boring	Ground Elev. ________Feet		Depth to Limiting Factor ________ Inches					Soil Loading Rate	
Horizon	Depth In.	Dominant Color Munsell	Redox Description Qu., Sz., Prominence, Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	Roots	Eff#1 GPD/ft^2	Eff#2 Gal/ft/day

Boring #	☐ Pit ☐ Hand Boring	Ground Elev. ________Feet		Depth to Limiting Factor ________ Inches					Soil Loading Rate	
Horizon	Depth In.	Dominant Color Munsell	Redox Description Qu., Sz., Prominence, Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	Roots	Eff#1 GPD/ft^2	Eff#2 Gal/ft/day

Boring #	☐ Pit ☐ Hand Boring	Ground Elev. ________ Feet		Depth to Limiting Factor ________ Inches					Soil Loading Rate	
Horizon	Depth In.	Dominant Color Munsell	Redox Description Qu., Sz., Prominence, Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	Roots	Eff#1 GPD/ft^2	Eff#2 Gal/ft/day

* From Table 4-6 Effluent #1 = Septic Tank Effluent Treatment Level Effluent #2 = Secondary Treatment Level

Soils Evaluator:	Address:	Telephone:
Signature:		Date of Evaluation:

For community drip dispersal systems, a detailed soils evaluation of the proposed area is the basis for design selection and to establish loading rates and configuration of the dispersal unit. The purpose of the detailed soils evaluation is to determine if the soils are capable of accepting and treating the design flow and if the minimum requirement for the presence of the unsaturated soil in the area selected for the dispersal zones can be met following the full use of the system based on the specified daily flow rate.

See the references section in this manual for resources in performing detailed site & soil evaluations.

a) <u>*Topography*</u>

Topography and landscape features are somewhat less of an issue for drip installations than for other types of soil based wastewater dispersal methods. Layout and installation of drip dispersal laterals is easier to do on sites with long, continuously even contours they also can be placed on convex landscape positions such as the nose of a hill or on variable sloping sites. Drip laterals are installed with the long axis parallel with the contours. Drip zones should not be installed in areas with a concave contour presentation to prevent a situation of converging flows concentrating large amounts of water into one small area. Surface drainage features should be closely evaluated, with drip zones being placed on the topography such that swales and natural drainage ways are avoided and left undisturbed to continue transporting surface water away from the site and the drip fields.

b) <u>*Vegetation*</u>

Heavily wooded sites offer advantages and disadvantages to drip installation. In heavily wooded areas where forest debris is left in place and snow accumulates, experience has shown that drip components function very well during the cold season (Bohrer and Converse). Conversely a site with a short cover crop of vegetation is not a good choice for drip tubing installation in cold climates because of frost protection issues. The disadvantage of installation in a heavily wooded area is the increased amount of handwork needed to install the tubing around tree trunks and through dense root zones. Systems designed for populations of 25 to 250 people will require 5,000 to 50,000 feet of drip tubing or more. Installation by hand digging of more than a few hundred feet of tubing would drastically increase the cost of the system because of the increased labor costs. The tubing can be installed on open sites much more economically and rapidly than in wooded sites.

D. Design Criteria

This manual provides general design guidance for a complete drip dispersal system including all of the components that may be used in complete treatment system. The design guidance is summarized in the following discussions, figures and tables. A design report and detailed plans must be submitted for review and approved by IDNR prior to construction.

Table 4-1 Wastewater Flows and Soil Loading	
Population Design Flow (AWW)	25 to 250 persons 100 gal/person/day
Influent Wastewater Strength Average value of Fats, Oil and Grease (FOG) Average value of BOD_5 Average value of Total Suspended Solids (TSS)	 ≤ 30 mg/L ≤ 250 mg/L ≤ 250 mg/L
Effluent Wastewater Strength Discharged to the Drip Dispersal Component	BOD_5 ≤ 220 mg/L & TSS ≤ 150 mg/L
Soil loading rate	Equal to the most restrictive soil horizon within 24" of the infiltrative surface in Table 4–6
Linear loading rate	12 gal/l.f.
Max. volume discharged to a single drip dispersal zone in 24 hours.	AWW ÷ No. of Zones
Max. particle size released from primary treatment	≤ 1/8 inch
Max. particle size discharged to the drip laterals	≤ 100 microns

Table 4-2 Drip Dispersal Zone Requirements	
Dispersal zone width	As per manufacturer's recommendations and conformance with linear loading rate
Minimum dispersal area required	≥ Design flow ÷ loading rate in Table 4-6 for the most restrictive soil horizon within 24” of the infiltrative surface
Orientation	Longest dimension parallel with surface grade contours
Drip Lateral Depth	Shall be 24” above the limiting factor. 8” to 12” (Typ.)
Drip Emitter Spacing	≤ 2 ft, modified as recommended by the manufacturer based on the soils evaluation
Drip Lateral Spacing	2 ft typical but can vary from.1 ft. to 3 ft. on center, consult manufacturer for specific site recommendations
Slope of original grade	≤ 30%
Vertical separation between dispersal zone infiltrative surface and limiting factor.	≥ 24 inches + drip tubing installation depth
Horizontal separation between dispersal zones	≥ 10 ft. or as per manufacturer’s recommendations

Table 4-3 Drip Dispersal Dosing Details	
Effluent application	Timed Pressure Dosing
Pressure Piping Material	Pressure Rated Pipe
Dosing Chamber Volume	Equal to AWW (minimum)
Dosing Control	Automatic timed dosing, filter washing and field flushing
Flow Monitoring Requirements	Flow meter
Frost Protection	As per manufacturers recommendations

Table 4-4 Miscellaneous Drip Dispersal Specifications	
Grading of surrounding area	Naturally occurring waterways and drainage patterns shall not be disturbed
Limited activities	Walking trails, vehicular traffic, excavation, and soil compaction are prohibited in the drip zone field area
Installation inspection	Designer to confirm compliance with approved plan
Operation & Management	In accordance with this manual and manufacturers recommendations

E. Design Flow

For a system designed under these guidelines the design flow is described as the average wet weather flow (AWW) and shall be 100 gal/person/day.

AWW = no. of people x 100 gal/person/day

Table 4-5 AWW for Various Populations		
Population	Flow/Person	Design Flow
25	100	2,500
100	100	10,000
250	100	25,000

As with any system a careful evaluation of the wastewater source is necessary. The designer should try to determine if there are any sources of unusual flow that may have a significant effect on the anticipated design daily flow. Some items that the designer and the owner/community should be aware of and watchful for are:

- Sump pumps that may add substantial wet weather flows;
- Poor landscaping around access points to the collection system, which may add surface water to the system;
- Leaky plumbing fixtures;
- Condensate drains from furnaces;
- Water softener discharge;

If any of these items will pose a significant increase in expected flow rates, adjust the design daily flow accordingly.

F. Wastewater Source & Strength

Drip Dispersal systems designed under this guidance manual should be capable of accepting and processing hydraulic flows from residential sources while providing the necessary pollutant removal efficiency to achieve performance goals. The concentrations of typical pollutants in raw residential wastewaters and average daily mass loadings are summarized in Table 3-1. Typical concentrations of pollutants found in septic tank effluent are shown in Table 3-2.

G. Primary Treatment Component – Septic Tanks

See Appendix A for design criteria.

H. Dosing Component

1. Dose Chamber

The pressure-dosing component is a watertight vessel, which stores the effluent, pumps and float switches. The dose pumps discharge small doses of effluent throughout the 24-hour design period to the distribution network. All of these parts, functioning as a complete system, will provide a uniform application of effluent to the drip tubing at programmed dose volumes and times to be determined during the system design.

a) Volume

A generally accepted method of sizing this device is to start with a volume equal to the design flow then make adjustments based on consideration of the following items.

(1) Pump Submergence

The pump submergence water volume is the volume needed to maintain pump submergence and prevent the pump from sucking air and causing cavitation. To provide this, the water level must remain at least two (2) inches above the pump. The water level in the pump chamber should be sufficient to keep the pump motor submerged and cool during operation. For systems using turbine pumps, the required pump cover volume will be greater due to the height of the intake and motor. Suction pumps located outside the pump chamber do not require as much volume but the inlet piping should be held off the bottom to minimize any uptake of solids that may accumulate in the bottom of the chamber. Additionally, four to six inches of effluent above the inlet of the intake pipe must be maintained at all times to prevent losing the pump prime.

(2) Dose Volume

To maintain uniform distribution, the minimum dose volume in a drip dispersal network is determined by 80% of the dose being dispersed during times of equal distribution, accounting for pressurization time and redistribution at pump shut off but no less than three times the volume of the pipe (plus the volume of supply /return lines and field manifolds where applicable). The dose volume stores the water to be dosed into the drip fields or zones. Systems designed for flow equalization over a daily or longer period require a greater storage capacity. The dose volume includes the space between the pump timer enable float and the high water alarm float. Timed dosing will require space for normally timed out doses plus a storage volume for surge flows. If the timing program includes an automatic advancement of the dosing frequency based on a peak float activation then the volume can be reduced. Consult the manufacturer for specifics on the volume required based on the type of pumps selected and the dosing program used.

(3) Reserve Volume

The emergency storage or reserve volume stores additional effluent generated after the alarm float is activated. The alarm may be activated due to a pump malfunction or because the timing selected has not kept up to the incoming flows. The storage volume allows the facility to operate until the pump is repaired or timing adjustments can be made.

Measures such as duplex pumping equipment used in conjunction with override controls can reduce the emergency storage volume required. The provision for this volume should be based on the designer's experience with timed dosing programs and a judgment of the operator's ability to react to alarms in a timely manner. The minimum volume considered should equal 30% of the design flow.

If the design calls for use of a precast or manufactured tank for this device, the manufacturer should supply data such as the liquid depth of the tank, the inside dimensions and the volume per inch or foot so that calculations can be made to verify that the adequate volume is being provided. For site constructed tanks the designer will need to adjust the length, width and height of the tank until adequate volumes is provided.

Example of calculating dose tank volume requirements.

_______	inches = pump cover = _________ gal. (tank bottom to height of pump or low water switch)
+ _______	inches = switch separation = ________gal. (low water switch to enable timer switch – 4” minimum)
+ _______	inches = dosing volume = ________gal. (enable timer to alarm sensor)
+ _______	inches = reserve volume = ________gal. (minimum 30% of the design flow)
= _______	total inches = total dose tank volume ________gal.

Select a tank that will provide a minimum total depth and volume, which will accomplish the tasks listed above. Over sizing this device will provide more temporary storage in the event a malfunctions occurs.

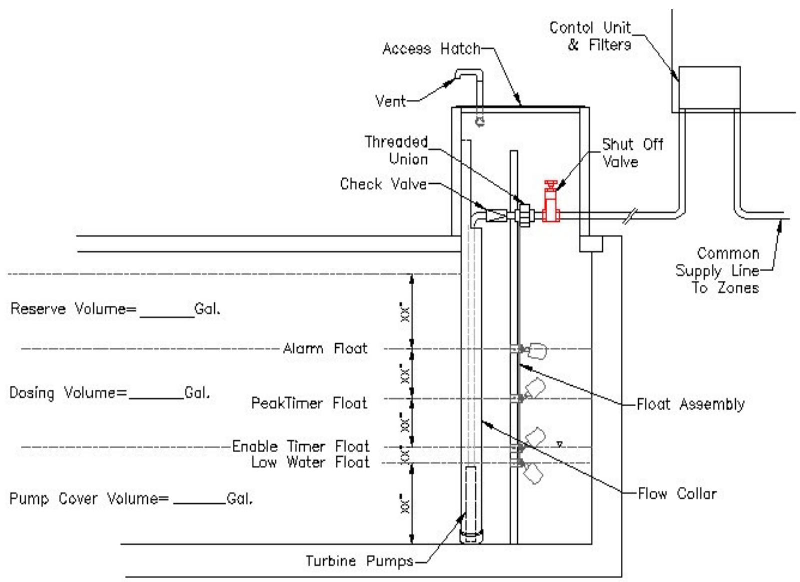

Figure 4-1 Dose Tank Cross Section

Courtesy of: American Manufacturing Company, Patent # 6,261,452,B1

b) *Pumps*

Pump selection is dependent on the overall system design, the requirements for proper filter operation, pressure required to dose the drip zones, field flushing flows and total dynamic head conditions. Consult the drip dispersal equipment manufacturer for assistance in the pump selection process.

Pumps are used to fill and pressurize the drip line sufficiently to achieve uniform distribution. Typical pressures in the dispersal lines range from 15 to 60 psi during a normal dosing event while filter flush pressures may range from 15 up to 150 psi. The pump must also be sized to provide adequate flow volume and pressure for zone dosing and field flushing and washing the filters. The pump must be capable of providing a minimum of 2.0 fps of velocity in the drip tubing during regular flushing cycles of the laterals to minimize build-up of bacterial growth on the tube lining.

Two types of pumps commonly used in a drip dispersal system are centrifugal pumps (both surface mounted and submerged) and turbine pumps. Surface mounted centrifugal pumps are generally mounted to the frame of the hydraulic control unit and will require a heated enclosure to protect them during cold weather periods. Submerged centrifugal and turbine pumps are located in the dose chamber and do not require a weatherproof structure for protection. In large flow drip systems a heated structure is commonly required to provide shelter for control panels, hydraulic control units and remote operation equipment so the use of frame mounted centrifugal pumps in these systems should not add to the cost of the system.

Pump selection needs to match the maximum flow rate needed to pressurize the drip zones and the total dynamic head (TDH) created in the system during field flushing cycle requirements. Pumping requirements will vary for every project but common issues to all drip dispersal systems are:

- Equipment Accessibility-risers required over submerged pumps, level control switches, valves, etc.;
- Pumps need to be removable without entering the tank;
- Frame mounted centrifugal pumps need to be placed in a protective, heated enclosure;
- Duplex pumps are required with alternating capabilities;
- Timed dosing required;
- Flow meter required

c) <u>Controls</u>

Controls include the water level switches and the control panel. Water level switches should be installed in the dose chamber in a manner, which allows removal of the float assembly for periodic adjustment of the floats to match actual conditions. Commonly used mercury float switches work very well in this application but other methods of water level monitoring such as pressure transducers are acceptable. A redundant low water cut off switch or float must be included to prevent the pumps from running dry and to insure that the water level does not drop below the inlet pipe of a frame mounted centrifugal pump.

Design Note: The use of the term "floats" in this discussion does not preclude the use of other types of signaling devices to activate the pump controls and perform the alarm functions required.

Outside mounted control panels shall be weather proof, rain tight, NEMA 4X enclosures, equipped with all necessary mechanisms for duplex timed pump operations, run time meters and event counters must be capable of all required alarm functions. Electrical surge protection and lightening arrestors should also be incorporated into the panel. Systems providing remote control operation and function will require a heated enclosure.

The drip component controller activates the dose pump and the entire supply line is charged. Simultaneously one zone valve is opened, the zone is dosed with a preset volume of wastewater and the valve closes. The zone then enters the resting cycle until all of the other zones are dosed. In this manner all of the zones are alternately rested and dosed throughout the 24-hour time period. During the automatic zone or field flushing operation the controller opens a master flush valve at scheduled intervals (usually two times per month but may be more frequent if septic tank effluent quality wastewater is being discharged) and scours the drip line at a minimum velocity of 2ft/sec. Periodic field flushing prevents a buildup of biological material within the drip tubing. The material is flushed out of the drip tubing, through the return line and discharges to the primary treatment component.

The controller operates master flow valves, zone valves and field flush valves as required to maintain flow through the system, flush the drip line and backwash filters automatically. This device can also be connected to a monitoring computer, which stores operating data documenting wastewater flows, zone flush events, system performance and is useful in diagnosing system malfunctions. Monitoring system function and performance is essential to proper operation.

d) *On Demand Dosing*

On demand dosing is not allowed in drip dispersal system designed under the guidelines of this manual.

e) *Timed Dosing*

Each drip dispersal field or zone shall be time-dosed at regular intervals, throughout the day, based on the average design flow. Drip dispersal pump operations shall be regulated by a timer mechanism, which is activated by the control switches used in the dose chamber. When the timer is activated small doses of wastewater are pumped to the dispersal field at periodic intervals throughout the day. Control switches can also be used to activate peak timing incorporated into the dosing program to automatically compensate for surge flows in the system.

Intermittent dosing provides several significant benefits. It allows time for the soil at the infiltrative surface to reaerate so the soil can maintain an aerobic environment for biochemical treatment of the wastewater to occur. It makes better use of the hydraulic capacity of the soil to accept the wastewater by avoiding few, large doses. Timed dosing protects the infiltration system from receiving wastewater in excess of the design flow storing the excessive flows in the dose chamber for later discharge.

The drip equipment manufacturer should be consulted and provide the designer with detailed information regarding this item. Options available for "timed" dosing include:

1) A simple adjustable 24 hour timer which operates the pump at set intervals,

Or

2) A programmable timer (PLC) that can be set and adjusted on site or remotely to discharge average flows and then automatically increases dose frequency when a peak float is activated.

The first option may only be appropriate for small flow systems. Systems designed for larger flows will require all of the flexibility derived from a programmable timer.

f) *Filters*

The pressure-dosing component of a drip dispersal system also includes a hydraulic control unit, which contains the filters, pressure gauges and flow meter. The pump delivers effluent to the filters during a normal dosing cycle. The type of filter used is dependent on which manufacturer supplies the drip dispersal equipment and the strength of the wastewater discharged. The filters are essential to a properly functioning drip system. They protect the emitters in the drip tubing by removing any remaining particles in the effluent that might contribute to clogging the emitters. Each manufacturer and supplier of drip dispersal components has a certain type of filter that they use. The designer's selection of manufacturer / supplier will determine the type of filters used.

Commonly used filters are disk filters and spin or screen filters. Both types of filters are capable of trapping and removing particles >100 to 150 microns in size. Typically the filters are self-cleaning by means of automatic back flushing cycles built into the dosing program. Accumulated solids are flushed out of the filters via a washing cycle and returned to the primary treatment unit. Discharge of septic tank effluent with TSS at ≤ 250 mg/L as compared to wastewater treated to secondary levels and TSS at ≤ 30 mg/L will play a major role in determining the frequency of filter washing episodes.

g) *Alarms*

Because these types of systems are located in relatively remote areas, where visual and audible alarms can go unnoticed for extended periods of time, a dedicated phone line and an automatic alarm dialer for notification of alarm conditions is required. The methods available for alarm notification and monitoring of the drip dispersal system range from standard automatic alarm dialers to computerized systems that allow remote monitoring and manipulation of system operation and also performs all of the standard alarm functions. In either case a dedicated phone line is required.

I. Drip Dispersal Component

1. Loading Rates

System design should not be based solely on soil loading rates established by soil textural classes and structure. Soil loading rate estimates are an indicator of the general status of the soils capability to transmit wastewater over the long term. Soil loading rates are the first parameter reviewed in the design process to establish the required area necessary. Application of wastewater treated to secondary standards assumes that a greater volume of water can be moved through the soil profile and this is reflected in the loading rates shown in Table 4-6 but consideration should also be given to landscape linear loading rates especially if a design requires multiple zones located directly up and down slope from one another. The landscape linear loading rate is the volume of effluent (gallons) applied per day per lineal foot of drip field or zone along the natural contour (gpd/ft).

Much of the infiltrating wastewater will flow downward from the drip zones as shown in Fig. 4-2. If the flow rate or hydraulic conductivity unsaturated, K_1, through the upper horizon is greater than the saturated conductivity, K_2, of the slowly permeable horizon then water will perch above the lower horizon and saturate the lower portion of the upper horizon.

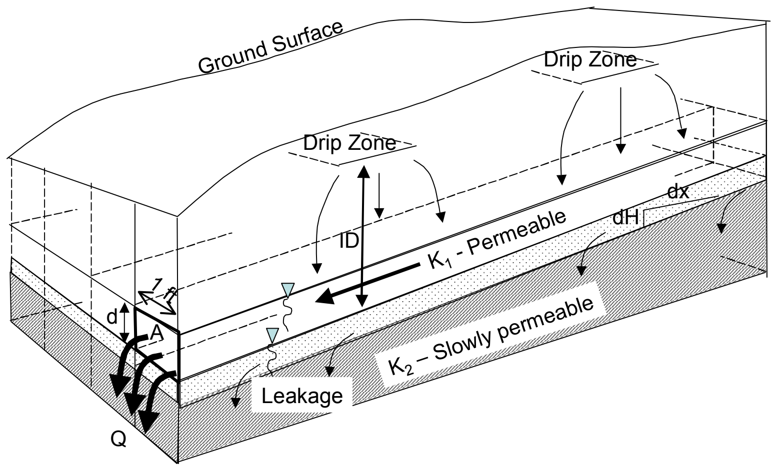

Figure 4-2 Landscape Linear Loading
Courtesy of: American Manufacturing Company, Inc, Patent #5,984,574B

Although water will continue to "leak" into the lower horizon on sloping land much will move down slope. Using Darcey's law for saturated flow the amount of water flowing, Q, through a cross section of area, A, is:

$$Q = K_1 A \frac{dH}{dX}$$

The saturated hydraulic conductivity, K_1, is estimated from the soil morphological information including soil texture, structure and consistence. For design, the maximum allowable depth, d, is assumed based on the proposed location of the drip zones and the needed separation distance. Also, assuming that the drip zones are much longer than the width then the end effects are minimal and can be ignored. Therefore, the design can be based on the unit zone length. Using English measurement units each segment of the zone is assumed to be 1 ft long. The height and width of the cross sectional area for flow is the area, A, where the depth, d, is incorporated into the value for the infiltration distance, ID, and the width is 1 ft making the A the ID. Infiltration distance is the distance from the drip tubing to the limiting factor or natural seasonal soil saturation. The slope of the slowly permeable horizon is defined by dH/dX.

All values are estimated from soil and site data. For soil conditions where K_2 approaches K_1 perching of water will not occur and this approach to landscape linear loading rate should not be applied.

As an example if the soil loading rate is 0.2 gal/sf/day and the design of the zone includes 12 runs of drip tubing spaced 2.0' on center then the landscape linear loading rate for that zone will be 0.2 gal/sf/day x (12 x 2) = 4.8 gal/lf/day.

The recommended Landscape Linear Loading Rate (LLLR) for any one zone or group of zones located on the same slope is 12 gal/lf/day.

High landscape linear loading rates can be avoided and minimized by installing laterals as long as possible along the contour and limiting stacking (placement of zones directly up and down slope from one another) of zones. Zones or groups of zones should be placed in differing landforms or landscape positions to enhance the hydraulic dispersal of the effluent into the environment. Increasing the number of zones reduces the linear loading rate to any one particular zone.

Table 4−6 Maximum Soil Loading Rates Based Upon a Detailed Soil Evaluation For Native Soils Below The Drip Dispersal Component *				
Soil Characteristics			Loading Rate ($gal/ft^2/day$)	
Texture	Structure(a) Shape	Structure(a) Grade	Secondary Treatment Levels BOD_5 & TSS ≤ 30 mg/L	Primary Treatment Levels BOD_5 > 30 mg/L ≤ 220 mg/L TSS > 30 mg/L ≤150 mg/L
Coarse Sand, Sand	sg	0	1.20	0.40
Loamy Sand, Fine Sand	−−−	0, M	0.50	0.20
	PR, BK, GR	1, 2, 3	0.70	0.35
Sandy Loam	−−−	0, M	0.30	0.20
	PR, BK, GR	1	0.25	0.10
		2, 3	0.40	0.20
Loam Silt Loam	−−−	M	0.15	0.05
	PL	1	0.15	0.05
		2, 3	0.10	0.025
	PR, BK, GR	1	0.25	0.10
		2, 3	0.35	0.20
Sandy Clay Loam, Clay Loam Silty Clay Loam	−−−	M	0.025	0.00
	PL	1,2,3	0.10	0.05
	PR, BK, GR	1	0.15	0.05
		2, 3	0.25	0.10
Silty Clay Sandy Clay Clay	−−−	M	0.00	0.00
	PL	1,2,3	0.025	0.00
	PR, BK, GR	1	0.025	0.00
		2, 3	0.10	0.075

Note a: PL − Platy GR − Granular
PR − Prismatic M − Massive 1 − Weak
BK − Blocky sg – Single Grain 2 − Moderate
0 − Structureless 3 − Strong

*adapted from:
Wis. DCOMM, Drip Dispersal Component Manual
Geoflow Design Manual
American Manufacturing, Inc Design Manual

a) *Soil Loading Rate Example*

To illustrate the application of the loading rates a typical soil found in central Iowa was selected. Data from the USDA NRCS Soil Survey (http://websoilsurvey.nrcs.usda.gov/app) was reviewed and the following is an example of the information available and the loading rates that would apply.

Clarion loam, 2 to 5 percent slopes

Setting
Landscape: Till plains
Elevation: 950 to 1500 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 165 days

Description of Clarion
Landform: Ground moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy supraglacial till
Slope: 2 to 5 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high or high (0.57 to 1.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate maximum: 30 percent
Gypsum maximum: 0 percent
Available water capacity: High (about 11.3 inches)

Table 4-7 Loading Rate Example

Typical Clarion Profile			**Soil Loading Rate**	
Depth (in.)	Soil Texture	Structure*	BOD_5 & TSS ≤ 30 mg/L	BOD_5 & TSS > 30 mg/L
0 to 7	loam	weak, blocky	0.25	0.10
7 to 18	loam	Moderate, blocky	0.35	0.20
18 to 36	clay loam	Moderate, blocky	0.25	0.10
36 to 60	loam	Weak, blocky	0.25	0.10

*soil structure data assumed

This example assumes a drip tubing installation depth of 8" to 12" and seasonal saturation > 36". The most restrictive soil horizon found within 24" of the drip tubing is the 18" to 36" horizon with a clay loam texture and moderate blocky (2) structure. The loading rate selected for the design, based on this example, would be

0.25 gal/ft^2/day with effluent treated to a secondary level and 0.10 gal/ft^2/day when septic tank effluent is the treatment level selected.

2. Groundwater Mounding Considerations

Maintaining the required vertical separation distance from the drip laterals to the limiting factor (seasonally saturated and/or impermeable soil layer or bedrock) is required for optimum hydraulic and treatment performance. Depending upon the site/soil conditions and the system design, groundwater mounding may occur.

There are two major situations to estimate increased groundwater mounds. The first assumes a mound is formed in a horizon of hydraulic conductivity, K_1, over a horizon of much lower conductivity, K_2. There is no perched natural water table over the lower conductivity horizon. Wastewater added at a rate greater than the rate of acceptance of the lower horizon will perch water in the shape of a mound. The situation is shown in Figure 4-3 and has been defined (Khan 1976) and used for defining mounding under large onsite wastewater infiltration systems (Poeter, McCray et al. 2005).

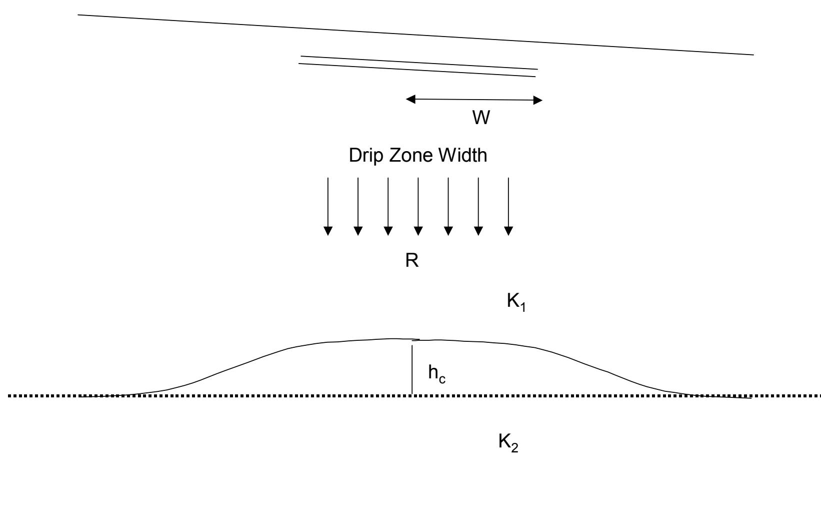

Figure 4-3. Groundwater Mound Over a Slowly Permeable Horizon Without Natural Perched Water Beneath the Dispersal Zone

Courtesy of: American Manufacturing Company, Inc, Patent #5,984,574B

The equation is:

$$\frac{h_c}{w} = \left[\frac{K_2}{K_1} \left(\frac{R}{K_2} - 1 \right) \left(\frac{R}{K_2} \right) \right]^{1/2}$$

Where h_c is the mounding height at the center of the mound, w is half the drip zone width, K_1 is the hydraulic conductivity in cm da^{-1} of the upper more permeable horizon, K_2 is the hydraulic conductivity in cm da^{-1} of the slowly permeable subsurface horizon and R is the recharge or loading rate in cm da^{-1} of the wastewater. If the K_2 were greater than R there would not be a mound.

The second situation is a more permeable horizon over a less permeable horizon but natural water perches in the upper horizon over the lower (Figure 4-4). In this situation the addition of wastewater raises the elevation of the existing groundwater beneath the dispersal zone. A discussion of one method using a solution by Hantush (1967) along with a calculator for Microsoft Excel® has been created (Poeter, McCray et al. 2005). A method based on Dupuit-Forchheimer assumptions can be used for estimating dispersal cell widths.

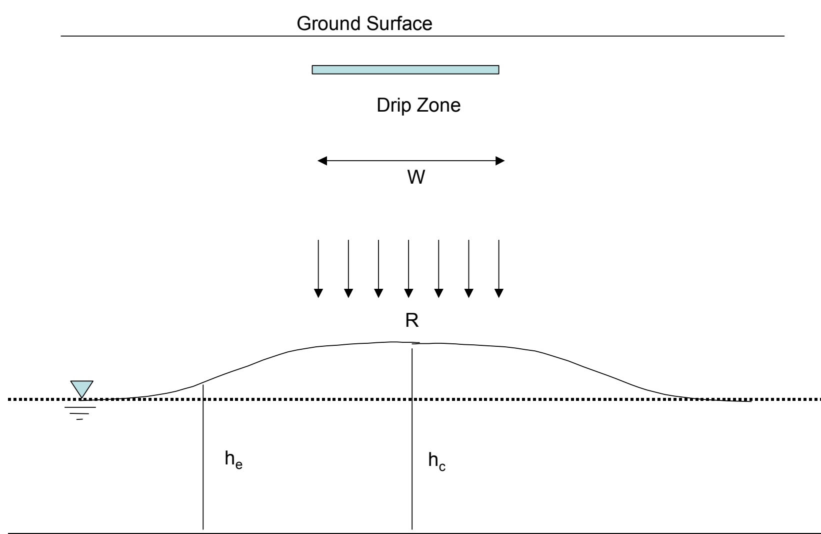

Figure 4-4. Groundwater Mound Over a Seasonal Soil Saturation Beneath a Drip Dispersal Zone.

Courtesy of: American Manufacturing Company, Inc, Patent #5,984,574B

The equation (Bouma, Converse et al. 1975) is similar in format to many others and is:

$$h_c^2 - h_e^2 = \frac{RW^2}{2K}$$

The symbols have been changed from those in the literature to be consistent with the previous figure and equation. Note that W is the total zone width not the w for the half width as in the previous equation. The soil conductivity, K, is measured in cm da^{-1}, the soil loading rate or recharge rate, R, is measured in cm da^{-1}, h_c is measured in cm and h_e, the height of the natural perched groundwater above the less permeable or impermeable horizon is also measured in cm. From site evaluation it is necessary to determine the depth and nature of the less permeable or impermeable horizon even if it is below the elevation of the estimated season saturation or limiting factor. Hydraulic conductivity may be estimated from soil morphology or from measurements.

Similar procedures could be used to design for a loading rate, R, as the variable to be changed. Also, it might be useful to determine the value of the product of R and 2w to use for varying the loading rate and dispersal zone width simultaneously. This sets all the values determined by site evaluation and design separation distance on the right side of the equation and the design variables of loading rate and zone width on the left.

$$RW^2 = 2K\left(h_c^2 - h_e^2\right)$$

The previous examples were for a dispersal zone of one unit. In situations where multiple zones stacked up and downslope from each other is necessary. A calculation similar to those already shown could be used except that R is the average loading rate across the entire width of the zones.

Spacing between dispersal zones may be great enough that the average loading rate, R, is low but the loading rate beneath each zone could be higher. It is important to confirm that the ground water mound beneath individual zones of a multi-zone system be within design limits by calculating the ground water mounding under each zone individually as in earlier examples.

Regardless of the estimating procedures, the site evaluation must provide a basis for determining saturated hydraulic conductivity and the depth to the slowly permeable horizon even if it is below the limiting layer of seasonal soil saturation.

A basic limitation in all of the formulas used to calculate an increase in groundwater mounding heights is the accuracy of the values used for saturated hydraulic conductivity. System designers aware of the potential problems caused by groundwater mounding will incorporate design practices that will either eliminate or greatly reduce the potential effects. These practices include use of the loading rates established in Table 4-6, dividing the total dispersal area required into separate subareas or zones and elongating the drip zones along the surface contours as much as possible.

3. Configuration and Layout

The drip dispersal configuration is based on the provision for low landscape linear loading rates. To provide LLLR a drip dispersal field must be constructed in a long and narrow configuration. The more restrictive the soil profile, as characterized by impermeable subsurface horizons or restrictive layers, the narrower and longer the drip dispersal component will be.

Special siting and construction considerations for large drip dispersal systems are:

- Zones should be laid out with as long a lateral as possible dependent on topography, soil characteristics, dosing scheme and manufacturers recommendation;
- Drip dispersal laterals to be installed parallel with the site contours;
- The required area for the drip dispersal field shall be evenly divided into a minimum of 4 zones for the lowest flows identified in this manual and as many zones as required based on the manufacturers recommendation
- Allow adequate horizontal distance between the zones for placement of the supply and return piping, this also adds assurance that they will not interfere with one another hydraulically.

Site slopes are generally not a limitation for locating the drip dispersal component. An upper limit of 30% is recommended based on construction safety concerns. Drip dispersal components on steep slopes with slowly permeable soils should be long and narrow to reduce the possibility of toe leakage. Consideration should be given to extending the separation between runs of tubing from the normal 2 feet on center to 3 feet on center to minimize the impact of upper tubing on those placed at lower elevations. Drainage of surface water around the drip dispersal component should be evaluated. One of the main advantages to drip dispersal technology is the ease of installation and minor disturbances to the ground surface. To maintain this advantage placement of zones should be carefully planned to avoid costly grading to prevent drainage water impacts on the system. Steeply sloped sites have the potential to create erosion problems.

The drip tubing is configured into zones with the number of zones dependent on the design flow and the landscape positions available at the site. Zones can be configured in several ways with the supply manifold and return manifold on opposite ends of the zone or on the same end. Figure 4-5 illustrates one manufacturers method of zone configuration. Other manufacturers and suppliers of drip dispersal equipment have other methods of configuring zones and locating the supply and return piping.

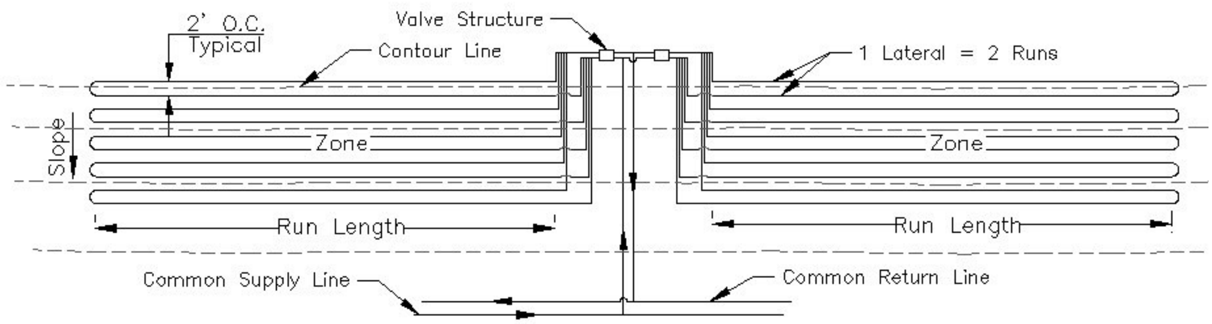

Figure 4-5 Supply & Return Lines on the Same End

As the diagrams indicate the common supply and return lines are connected to each zone in the drip fields. The function of the common return line is to transport the material flushed from the inside of the drip tubing back to the primary treatment unit. Figure 4-5 shows a configuration where the supply and return lines are on the same end of the zone. In this configuration if the run length is 150 feet, the lateral length is 300 feet.

Figure 4-6 shows a supply line on one side of the zone and the return line on the other. In this configuration when the run length is 100 feet, the lateral length is 300 feet.

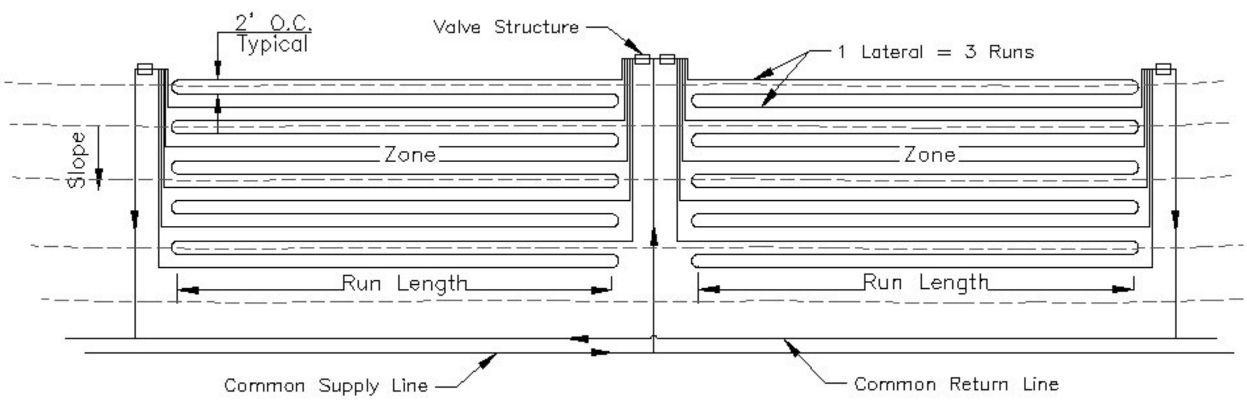

Figure 4-6 Supply & Return Lines on Opposite Ends

The top feed manifold shown in Figure 4-7 is one manufacturer's method of eliminating overloading of the lowest laterals in the system through redistribution as the dose cycle ends. The top feed manifold is located at the high side of the zone. The manifold invert must be placed at a higher elevation than the highest lateral to allow for drainage from the manifold into the lateral at the end of a dose.

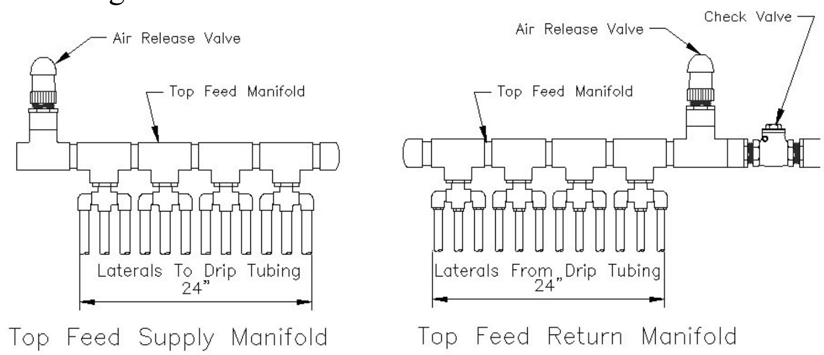

Figure 4-7 Supply & Return Top Feed Manifolds

A small diameter (1/2" to 3/4") PVC pressure class pipe connects the manifold to each lateral in the drip zone hydraulically isolating that lateral from all the others. The advantage of the short manifold is that it eliminates flow from one drip lateral to a lower lateral thereby reducing overloading of the laterals in the lower portion of the zone. Another benefit of this arrangement is frost protection. Water will drain out of the header and the drip tubing because of the air release valve. Other manufacturers have different piping and connection arrangements to help prevent the overloading of the lower laterals in the zone as shown in the following figures.

Figure 4-8 shows two methods of installing a continuous supply and return manifold along the ends of the drip zone. Supply and return lines can be laid on the either side of the drip zone. Both the supply and return manifolds should be buried below the frost line or be laid such that both pipes drain after every dose or field flush event, for frost protection. Consult the manufacturer for information on how to design and install this type of supply and return manifold.

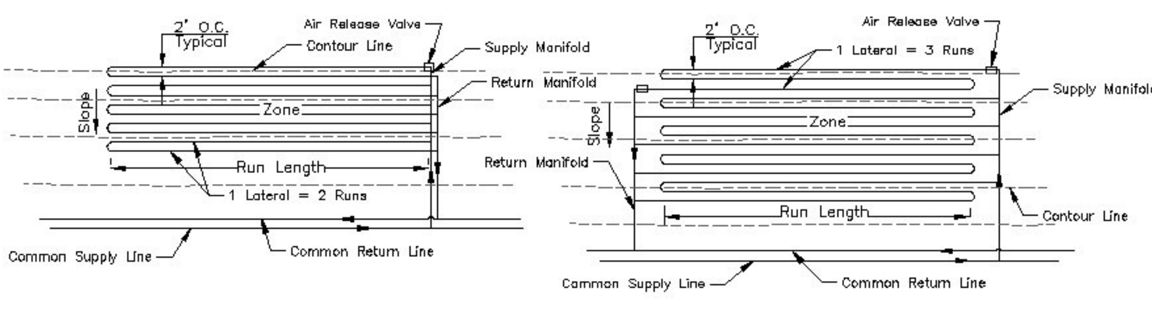

Figure 4-8 Common Supply & Return Manifolds

When a common manifold is run along the end of the drip zone an isolation check valve (Fig. 4-9) should be installed on the drip lateral to prevent the overloading of the lower drip laterals after depressurization of the drip zone.

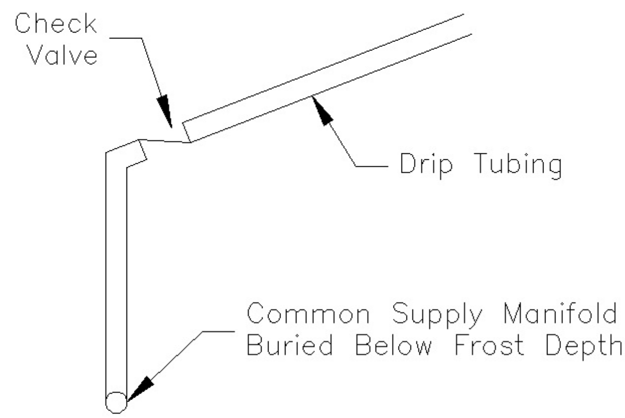

Figure 4-9 Isolation Check Valve On Drip Lateral

The zone valve structure is the most vulnerable point in the system and needs special attention for frost protection. Figure 4-10 shows one method of providing frost protection by use of heat tapes and insulation. There are other methods available for frost protection, each manufacturer has developed methods that may be more appropriate for their particular equipment, the manufacturer should be consulted for the most acceptable alternative for frost protection of all vulnerable points within the system early in the design process.

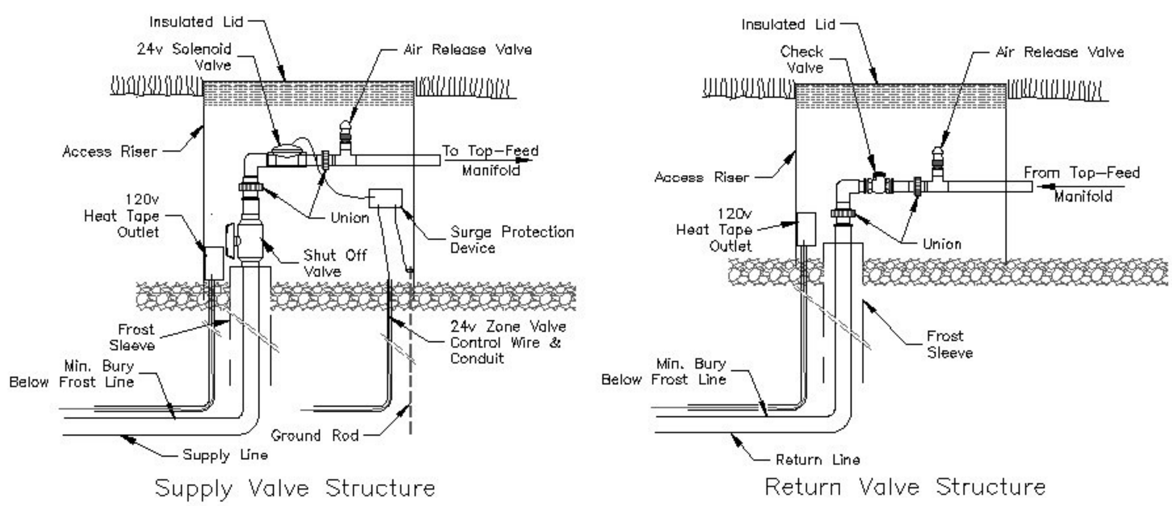

Figure 4-10 Supply & Return Valve Structures

4. Drip Dispersal Design Calculations

The initial design steps for determining area requirements begin with a calculation based on the soil-loading rate found in Table 4-6. Adjustment of the area requirements may be necessary to account for linear loading and contour loading within each zone. Once the base area requirement is established the designer will chose the appropriate number of zones for the project, this may require multiple attempts and variations of the design before a satisfactory balance between AWW, site and soil constraints, total daily pump run time and the dosing program is achieved. Consult the manufacturer for detailed instructions on layout of the zones for your particular site. The following calculations can be used to find the initial area requirements:

a) Size the Drip Dispersal Area

The area requirements are based on the site/soil conditions and loading rates established for the site. The basic calculation for area required in drip dispersal component is:

Design Flow Rate =100 gallons/person/day x population served
Soil loading rate - gal/ft^2/day from Table 4-6

Find:
Area = _______ gal/day ÷ _______gal/ft$_2$/day = _______ft^2

Find:
Tubing Length = Area ÷ 2 ft. tubing spacing
Tubing Length = _________ ft^2 ÷ 2 = ___________ Lineal Feet

Find:
No. of Emitters = Lineal Feet of Tubing ÷ 2 feet Spacing
No. of Emitters = _________ l.f. ÷ 2 = ___________ Emitters

The required lineal feet of tubing will be divided into as many zones as necessary based on the selected manufacturers dosing scheme, total daily pump run time and to match site & soil conditions.

5. Land Area Requirements

Adequate area for a community drip dispersal system includes providing space for the dispersal zones, treatment tanks, yard piping, site grading and separation distance for setbacks to property lines, drainage ways, cut banks, etc. The following calculations are made using the basic design flows identified in this manual for systems serving 25, 100 and 250 people. The following examples are presented to give the designer or owner an idea of what the approximate gross area required for this type of treatment system.

For this example a silty clay loam soil with weak, blocky structure and an area loading rate of 0.15 gal/ft^2/day is selected from the secondary treatment level column of Table 4-6 to illustrate system requirements on sites with moderately permeable soils. Actual land area required will depend on the landscape positions available for placing the zones. Sites where zones can be laid out along long continuous contours will require less overall total land area for the drip zones than sites with broken slope areas and many short contour sections available. When planning and designing a drip dispersal system a gross area of 4 times the zone area requirements should be evaluated to allow for as much flexibility in the layout of the drip zones as possible. Once the design has been finalized and drip zones are positioned on the most desirable locations, the minimum area remaining under the system owner's control could be reduced to 2 times the total area required for the initial drip zone installation. This will provide sufficient area in which to spread out the initial drip zones, locate other treatment components and provide area for replacement or additional drip zones if needed.

a) *25 People*

The design daily flow is 100 gal/day x 25 = 2,500 gal/day.

Assuming:
soil loading rate of 0.2 gal/ft^2/day
lateral spacing of 2.0 feet
emitter spacing of 2.0 feet

Initial Area Calculation:
2500 gal/day ÷ 0.15 gal/ft^2/day ≈ 16,667 ft^2 of area required

Selected number of zones = 6
(so dual zone dosing can be utilized and to keep pump flow rates at a reasonable level).

Therefore:
16,667 ft^2 ÷ 6 = 2,778 ft^2 / Zone

Length of Drip Tubing/zone:
2,778 ft^2 ÷ 2 = 1389 l.f. of tubing

Tubing runs of 140 l.f. are selected.

Therefore:
1389 l.f./zone ÷ 140 ft. = 9.92 runs
(The number of runs must be equal to provide 1 lateral for every 2 runs if the supply & return manifold are located on the same side of the zone so:

10 runs equals 5 laterals - 280 ft. long)
5 x 280 = 1400 lf of tubing/zone
1400 lf ÷ 2' = 700 emitters/zone

Zone Dimensions
Zone dimensions = 10 runs x 2.0' spacing x 140'
20 ft. x 140 ft. = 2800 ft^2

Total area of zones = 2800 ft^2 x 6 zones = 16,800 ft^2

Total area for system = 4 x zone area = 4 x 16,800 = 67,200 ft^2

Total acreage required for preliminary design purposes
= 67,200 ft^2 ÷ 43,560 = 1.5 Acre+/-

Pressure Compensating Emitter Flow Rates:
No. of emitters = 1400lf ÷2 = 700/zone, 4200/system
Flow rate/emitter = .6 gph (will vary slightly by manufacturer)
Dose rate/zone = (700 emitters x .6gph) ÷ 60 min/hr. = 7.0 gpm
Dual zone dose rate = 7.0 gpm x 2 = 14.0 gpm

Check Pump Run time:
2,500 gpd / 14 gpm dual zone dose = 178 minutes / 1440 = 12% pump run time

b) *100 People*

The design daily flow is 100 gal/day x 100 = 10,000 gal/day.

Assuming:
soil loading rate of 0.15 gal/ft^2/day
lateral spacing of 2.0'
emitter spacing of 2.0'

Initial Area Calculation:
10,000 gal/day ÷ 0.15 gal/ft^2/day ≈ 66,667 ft^2 of area required

Selected number of zones = 12 is selected for this example
(use an even number of zones to allow for dual zone dosing).

Therefore:
66,667 ft^2 ÷ 12 = 5,556 ft^2 /Zone

Length of Drip Tubing/zone:
5556 ft^2 ÷ 2 = 2778 l.f. of tubing

Tubing runs of 140 l.f. are selected.

Therefore:
2778 l.f./zone ÷ 140 ft. = 19.8 runs
(the number of runs must be equal to provide 1 lateral for every 2 runs if the supply and return manifold are located on the same side of the zone so:

20 runs equals 10 laterals - 280 ft. long
10 x 280 = 2800 lf of tubing/zone
2800 lf ÷2' = 1400 emitters/zone

Zone Dimensions
Zone dimensions = (20 runs) x 2.0' spacing x 140'
40 ft. x 140 ft. = 5,600 ft^2

Total area of zones = 5,600 ft^2 x 12 zones = 67,200 ft^2

Total area for system = 4 x zone area = 4 x 67,200 = 268,800 ft^2

Total acreage required for preliminary design purposes
= 268,800 ft^2 ÷ 43,560 = 6 Ac.+/-

Pressure Compensating Emitter Flow Rates
No. of Emitters = 1400/zone, 16,800/system
Flow Rate/emitter = .6 gph (will vary slightly by manufacturer)
Dose Rate/Zone = (1400 emitters x .6 gph) ÷ 60 min/hr. = 14 gpm
Dual Zone Dose Rate = 14 gpm x 2 = 28 gpm

Check Pump Run time:
10,000 gpd / 28 gpm dual zone dose = 357 minutes / 1440 = 25% pump run time

c) *250 People*

The design daily flow is 100 gal/day x 250 = 25,000 gal/day.

Assuming:
soil loading rate of 0.15 gal/ft^2/day
lateral spacing of 2.0'
emitter spacing of 2.0'

Initial Area Calculation:
25,000 gal/day ÷ 0.15 gal/ ft^2/day ≈ 166,667 ft^2 of area required

Selected number of zones = 24
(So dual zone dosing can be employed. 24 zones are selected for this example to keep zone flow rates at a manageable level).

Therefore:
166,667 ft^2 ÷ 24 = 6944 ft^2 /Zone

Length of Drip Tubing/zone:
6944 ft^2 ÷ 2 = 3472 l.f. of tubing

Tubing runs of 150 l.f. are selected.

Therefore:
3477 l.f./zone ÷ 150 ft. = 23.1 runs
The number of runs must be equal to provide 1 lateral for every 2 runs if the supply and return manifold are located on the same side of the zone so:

24 runs equal 12 laterals - 300 ft. long/zone
12 x 300 = 3600 lf of tubing/zone
3600 lf ÷2' = 1800 emitters/zone

Zone Dimensions
Zone dimensions = 24 runs x 2.0' spacing x 150'
48 ft. x 150 ft. = 7200 ft^2

Total area of zones = 7200 ft^2 x 24 zones = 172,800 ft^2

Total area for system = 4 x zone area = 4 x 172,800 = 691,200 ft^2

Total acreage required for preliminary design purposes
= 691,200 ft^2 ÷ 43,560 = 16 Ac.+/-

Pressure Compensating Emitter Flowrates
No. of Emitters = 1800/zone, 43,200/system
Flow Rate/emitter = .6 gph (will vary slightly by manufacturer)
Dose Rate/Zone = (1800 emitters x .6 gph) ÷ 60 min/hr. = 18 gpm
Dual Zone Dosing Flow Rate = 18 gpm x 2 = 36 gpm

Check Pump Run time:
25,000 gpd / 36 gpm dual zone dose = 694 minutes / 1440 = 48% pump run time

V. Operation Monitoring and Maintenance Issues

In cluster wastewater systems, there is more focus on flexible operation and a greater need to monitor how well a system is doing. Monitoring adds an additional burden, to the owner-operator as well as the regulatory agency, because of the need to track, evaluate and change (or add to) a system based on its operating record.

A. Operational Concerns

1. Primary Component

a) Sludge Management

Periodic measurements of the combined sludge and scum depth are required. When the depth of these two items reaches 1/3 of the liquid depth of the tank, the tank should be pumped. For individual tanks in STEG and STEP collection systems where the tank is owned and maintained by the community, a standard procedure is to pump out 1/3 of the tanks in the system every year to provide a three (3) year pump out rotation. A suggested frequency of monitoring this component is shown in Table 5-1. Other treatment tanks in the system such as aerobic unit tanks or dosing tanks should be monitored as necessary to prevent solids build up from interfering with the treatment process or pumping mechanisms.

b) Odors

Odors associated with the system generally are centered around the septic tanks, the anoxic environment in the septic tanks can create strong odors, which most people find objectionable. In most cases, if the lids are kept in place properly, the strongest odors will occur when the solids are pumped out of the tank. If strong odors are continually present remedies such as charcoal filters and raising vent pipes higher into the air have been successful in alleviating some of the problem. A community septic tank located as specified by the setback requirements in state code for treatment system components of 1,000 feet from a habitable residence will make odor issues more manageable.

Table 5-1 Operation & Monitoring Schedule

System Component	Frequency W	M	Q	S	A	2YR	3YR	OTHER	Comment
Primary Component									
1st Tank									
Sludge Depth					X				
Pump Contents								As needed	
2nd Tank									
Sludge Depth					X				
Pump Contents								As needed	
3rd Tank									
Sludge Depth					X				
Pump Contents								As needed	
Baffles (all tanks)					X				
Outlet Screen(s)		X							Clean as needed to maintain flow through the system.
Wastewater Sampling			X						
Secondary Treatment Component									
Process Operation									As per manufacturer's recommendation
Dosing Component									
Pump Operation	X								
Alarms & Meters	X								
Sludge Depth						X			
Wastewater Sampling			X						
Pump Contents								As Needed	
Drip Dispersal Component									
Ground Surface			X						
Valve Structures (Zone & Air Release Valves)			X						

W - Weekly, M - Monthly, Q - Quarterly, S - Semi-Annually, A - Annually

For those facilities with a design population of 25 or 100 people, the following monitoring requirements are recommended.

Table 5-2 Monitoring Requirements for Drip Dispersal Systems Sized for 25 or 100 people			
Parameter	**Sample Location**	**Sample Type**	**Frequency**
Flow	Raw or Final	Average Daily	Weekly
BOD_5	Raw	Grab	Quarterly
	Final	Grab	Quarterly
Suspended Solids	Raw	Grab	Quarterly
	Final	Grab	Quarterly
PH*	Raw	---	NONE
	Final	Field Measurement	Quarterly
Sludge Depth	Raw	Field Measurement	Annually
	Final	Field Measurement	Bi-annually

Raw = outlet of last septic tank or chamber; Final = dose tank to final component

For those facilities with a design population over 100 and up to250 people, the following monitoring requirements are recommended.

Table 5-3 Monitoring requirements for Drip Dispersal Systems sized for 100 to 250 people			
Parameter	**Sample Location**	**Sample Type**	**Frequency**
Flow	Raw or Final	24-hr. Total	Daily
BOD_5	Raw	Grab	Monthly
	Final	Grab	Monthly
Suspended Solids	Raw	Grab	Monthly
	Final	Grab	Monthly
PH	Raw	Field Measurement	NONE
	Final	Field Measurement	Monthly
D.O.*	Final	Field Measurement	Monthly
Temperature*	Raw	--	NONE
	Final	Field Measurement	Monthly
Sludge Depth	Raw	Field Measurement	Annually
	Final	Field Measurement	Bi-Annually

* at dose chamber if secondary treatment provided

c) *Structural*

This device should be checked routinely for structural abnormalities such as defective lids and leaking, cracked or broken or joints at pipe entry and exit points, as well as riser sections. Baffles should be checked periodically to insure that they are in place and not clogged with debris.

d) *Effluent Screen*

Effluent screens should be checked on a routine basis as suggested in Table 5-1. The interval for cleaning this device should be adjusted based on the wastewater strength and characteristics of the particular system.

2. Secondary Treatment Component

As per manufacturer's recommendation

3. Dosing Component

a) *Sludge Management*

Periodic measurements of the sludge depth are required. When the sludge depth reaches a level that interferes with the pumping equipment or controls, the sludge needs to be removed.

b) *Structural*

The dose chamber should be checked routinely for structural abnormalities such as defective lids and leaking, cracked or broken joints at pipe entry and exit points and riser sections. Surface water runoff should never be allowed to sit around risers or enter the tank through leaking riser sections, pipe connections or broken lids.

c) *Pumps, Controls & Electrical*

Monitoring of this component includes periodic recording of the run time meters and / or event counters. A record of operating hours or pumping events can be used to determine the actual amount of wastewater discharged to the dispersal component. This information will be a great asset for any trouble shooting needed on the system or in discussions about future expansion of the system. Alarms need to be checked routinely to make sure they function as designed. A suggested frequency of monitoring this device is included in Table 5-1.

4. Drip Dispersal Component

a) Hydraulic Overloading –Drip Dispersal Zones

Hydraulic overloading of the dispersal zones is monitored by visual observation of the ground surface or by soil moisture sensors located in the wetted zone near the drip emitters. Systems using moisture sensors can be programmed to remove zones from service automatically if the soil moisture level reaches a predetermined thresh hold. Keeping a record of any effluent ponding or surfacing will aid in trouble shooting problems early and may help in avoiding costly repairs. Ponding of effluent on the ground surface indicates hydraulic overloading of this part of the component. Adjustments such as turning off an overloaded zone until it dries out or reducing the dose volume to that zone temporarily may remedy the situation. This item should be checked more frequently if ponding is observed in any of the zones.

5. Freezing

Freezing of a drip dispersal system is a greater concern than for most soil based treatment systems because the piping and tubing is installed close to the ground surface. The main concern is with the piping leading up to and away from the control devices in the drip field. Supply and return lines should be installed below the frost line or provide for drainback after each dose. Insulating and heat taping valve structures are standard methods of providing frost protection for these devices.

On the drip dispersal zones it is advisable to allow the vegetative cover to go unmowed after late summer. A thick mat of vegetation will provide an excellent insulation blanket for the drip dispersal tubing. Frequent small doses of effluent also contribute to keeping the drip tubing frost free. Consult with the drip tubing manufacturer for the latest techniques that have been developed to eliminate or reduce problems associated with freezing in the drip tubing and associated devices. If a drip field is installed late in the season and vegetation has not had time to grow and provide the insulating blanket, then the owner should consider an application of marsh hay or other similar material to the drip field surface for frost protection.

6. Site Maintenance

a) Mowing

Mowing the drip dispersal field is not necessary except that shorter vegetation is helpful when trying to locate valve access structures that are constructed flush with the ground surface. Annual mowing to keep noxious weeds and thistles trimmed back is all that should be required. Mowing should be done with great care especially on sites with slopes over 10% so that ruts that can lead to erosion problems and exposure of drip tubing does not become a problem. On sites over 10%, a mowing pattern, which is generally parallel with the contours, should be employed rather than a pattern perpendicular to the contours. This pattern will provide fewer opportunities for rutting the ground surface and exposure of the drip tubing. Mowing frequency can be as little as once per year depending on the availability of equipment to mow through a thick deep stand of vegetation. If only smaller residential type equipment is available then more frequent mowing will be necessary. In no case should the drip field be mowed later than mid to late August in order to allow a good stand of vegetation to grow to sufficient height to provide an insulating blanket for the winter.

7. Record Keeping

The maintenance record keeping system for a drip dispersal system treatment facility can be effective while being kept fairly simple, due to the facility's size. The operation, monitoring and maintenance record keeping system should include the following features:

- Equipment Maintenance Records;
- Calendar Schedule of Maintenance;
- Dose Pump Counter Events and Run Time Meter Readings;
- Secondary Treatment Component Monitoring;
- Septic Tank Pump Outs including volumes and dates;
- Sludge Depth Measurements;
- Effluent Screen Cleaning Frequency;
- Dispersal Zone Flow Monitoring Results;
- Wastewater Sampling Results

The maintenance record keeping system may be modified to best suit the needs of the facility. It is very important that the system operator keeps the record system up-to-date by recording and filing in an orderly manner any information pertaining to the operation and maintenance of the facility.

Equipment maintenance records assure that information on operation and maintenance of facility equipment will be available should there be absences or changes in operations personnel. The operator should make sure that any information obtained on the equipment (either through operation, maintenance, or correspondence with equipment representatives) is recorded on equipment maintenance record cards or filed in an orderly manner. Regular review of the equipment maintenance files can alert the operator to problems, which might be developing at the facility, so that they can be corrected before costly emergency repairs are needed.

VI. Cost Estimates

Due to the extreme variably of local markets for labor and materials, it is not possible to estimate universally the cost of construction and operation of drip dispersal systems. Cost differentials are significant across local geographies and economies. Therefore the reader of this manual is advised to consult local markets for specific data.

A. Capital Costs

A major determinant in the overall cost of a project is its size. The larger the project, the greater the benefit from economies of scale. Therefore the reader of this manual is advised to consult with knowledgeable individuals for specifics relating to costs of construction for a particular project.

1. Capital Cost Estimating Spreadsheet

The next page details a typical cost estimating spreadsheet for estimating overall capital costs for a drip dispersal system. The spreadsheet identifies major components of the proposed construction and allocates units for each component. Upon completion of a standard design, actual units of installation may be inputted into the spreadsheet. Costs per unit must be obtained from local sources due to the aforementioned extreme variability in local markets.

Table 6-1 Drip Dispersal System Capital Cost Estimating Sheet
Drip Dispersal System

Capital Costs

Item	Quantity	Units	Unit Cost	Total Cost
Land		Ac.		
Site Work (Treatment Tank Area)		L.S.		
Primary TreatmentComponent				
Septic Tanks, Complet w/Bypass Valves		Ea.		
Effluent Filter(s)		Ea.		
Secondary Treatment Component		Ea.		
Treatment Unit, Complete w/Controls		Ea.		
Treatment Tanks		Ea.		
Site Electrical (3 Phase)		L.S.		
Dosing Component				
Dose Tank		Ea.		
Dose Pumps, Complete w/Control Panel		Ea.		
Distribution Valve & Vault		Ea.		
Hydraulic Control Unit		Ea.		
Flow Meter		Ea.		
Remote Monitoring System		L.S.		
Drip Dispersal Component				
Site Preparation		L.S.		
Supply & Return Pressure Pipe		L.F.		
Drip Tubing		L.F.		
Control Building (incl. Elec and HVAC)		L.S.		
Fencing		L.F.		
Yard Piping		L.S.		
Electrical (10%)		L.S.		
Mob./Demob., Bonding/Ins. (7%)		L.S.		
Subtotal				
Capital Contingencies (25%)				
Subtotal				
Engineering (20%)				
Legal and Administative (5%)				

Total Estimated Capital Cost

Table 6-2 Drip Dispersal System O&M Costs

Operation and Maintenance Costs	Quantity	Units	Unit Cost	Annual Cost
Labor		hours/yr		
Electric Power		kWh		
Supplies		L.S.		
Maintenance and Repair		L.S.		
Laboratory Testing		L.S.		
Sludge Disposal		Gal.		
Annual O & M Cost				

B. Annualized Costs

1. Operations and Maintenance Cost Estimating Spreadsheet

A spreadsheet showing the major operations and maintenance cost line items that could be anticipated is shown in Table 6-2.

2. Significant Assumptions

a) Sludge Removal

Bi-annual sludge removal from the first septic tank and a three year period between sludge removal operations for the remaining treatment tanks should be assumed for estimating purposes, with an annual amount built into the budget. Accumulation of sludge will vary from project to project and from one tank to another, the actual number of sludge removal events will be based on routine measurements of the sludge depth.

b) Power

Power costs will vary across the state, but a rate of \$0.10 per kWh should be used to estimate annual power costs for the dosing pumps. Power cost for the dosing pumps can be done by multiplying the total number of pumps times the average running time, and converting horsepower into kilowatts as per the following formula:

$$\text{Annual Power Cost} = (N_p)(T_{\%})(24\ \text{hours})(HP)(0.75)(\$0.10)(365)$$

Where:
- Np = Number of pumps
- T% = Percent daily run time
- HP = Horsepower of each pump

c) Maintenance

An annual set-aside for equipment replacement should be built into the budget. The amount set aside should be based on the original cost of the equipment, and prorated out over the expected design life of the equipment.

The annual cost should account for site maintenance such as grass mowing and snow removal.

d) Labor

The estimated cost for labor should be based on the total compensation for the operating staff, including any benefits, plus any administrative salaries for meetings, billing, etc. The estimated hours needed should consider the monitoring and sampling requirements of the particular facility, and include provision for periodic maintenance such as vegetation removal, flushing of laterals and regular pump maintenance.

e) Sampling and Analysis

The cost for a facility's sampling and analysis program will vary from one facility to another based on the permit. The cost should be based on the total number of samples expected in a year, and include the cost of analysis by a certified laboratory, plus the costs of sample delivery.

VII. References

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VIII. Suggested Reading

A. Site & Soil Evaluations

EPA Onsite Wastewater Treatment Manual, chapter 5

University Curriculum Development for Decentralized Wastewater Management, Site Evaluation Module

Wisconsin Department of Commerce Code Comm 85 Soil and Site Evaluations

NRCS Soil Survey Manual for Iowa Counties

B. Drip Dispersal Component Design

American "Perc-Rite" Drip Dispersal Systems Engineering Design Guidelines for Community and Commercial Dispersal Systems

Drip-Line Effluent Dispersal Component Manual, State of Wisconsin, Department of Commerce, ***www.commerce.state.wi.us/SB/SB-DivPublications.html#Component***

Design and Installation Manual, Geoflow, Inc.

Recommended Guidance for Design of Wastewater Drip Dispersal Systems National Onsite Wastewater Recycling Association

Subsurface Drip Dispersal Module Text, Lesikar, B.J. and J.C. Converse, University Curriculum Development for Decentralized Wastewater Management. University of Arkansas

Wastewater Subsurface Drip Distribution, Peer Reviewed Guidelines for Design, Operation, and Maintenance. Report #1007406. Revised Report, September 2004, Electric Power Research Institute and Tennessee Valley Authority,

Appendix A
Primary & Secondary Treatment Units