SEWERAGE SYSTEM
STANDARD PRACTICE MANUAL

VERSION 3

SEPTEMBER 2014

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

BRITISH
COLUMBIA

ASTTBC
TECHNOLOGY
PROFESSIONALS
QUALIFIED. REGISTERED. ACCOUNTABLE.

Developed in collaboration with the Applied Science Technologists and Technicians of British Columbia

Primary Authors

Ian Ralston, B.Sc., Pg.Dip.Ag.Eng., ROWP, Eng.L

Michael Payne, M.Eng., P.Eng., P.Geo.

SPM Sunset Clause

Sections 8(3) and 9(2) of the Sewerage System Regulation (SSR) outline that the Standard Practice Manual (SPM) can be amended from time to time.

This new, September 2014, SPM Version 3 brings into effect new amendments. This affects all versions previously issued by the BC Ministry of Health.

To allow industry a transition period from the old manual to the new, the previous September 2007 version will not formally sunset until midnight December 31, 2015. Immediate use of the new version is highly recommended, but during this transition period both versions are in effect and it is understood the Authorized Person can use either version. On January 1, 2016, only the SPM Version 3 will be in effect.

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SEWERAGE SYSTEM
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Volume I Table of Contents

VOLUME I INTRODUCTION

Volume I Introduction

I- 1 DEFINITIONS

These definitions are specific to this Manual.

I- 1.1 Glossary

A

Absorption: The process by which one substance is taken into and included within another substance, such as the absorption of water by soil or nutrients by plants.
Adsorption: The increased concentration of molecules or ions at a surface, including exchangeable cations and anions on soil particles. The adherence of a dissolved solid to the surface of a solid.
Alarm reserve: The holding volume of a pump or dosing tank, or connected tanks, that is above the high level alarm and below the point at which backup to the building sewer, or overflow occurs
Aerobic: Having molecular oxygen as a part of the environment, or growing or occurring only in the presence of molecular oxygen, as in "aerobic organisms."
Anaerobic: Characterized by the absence of molecular oxygen, or growing in the absence of molecular oxygen (as in "anaerobic bacteria").
Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
Area of Infiltrative Surface (AIS): Infiltrative surface area receiving effluent from the distribution system.
Areal loading rate: Quantity of effluent applied to the footprint of the soil treatment area (or the absorption area of an above-grade system) expressed as volume per area per unit time, for example, litres per day per square metre (L/day/m^2).
ASTM: American Society for Testing Materials

B

Basal Area: For sand mounds, sand-lined trenches, bottomless sand filters, Alberta At Grade systems and CTDS this is the native soil AIS, the effective surface area available or required to transmit the treated effluent into the original receiving soils.
Biochemical oxygen demand (BOD): A commonly used gross measurement of the concentration of biodegradable organic impurities in wastewater. The amount of oxygen, expressed in milligrams per liter (mg/L), used by bacteria while stabilizing, digesting, or treating organic matter under aerobic conditions is determined by the availability of material in the wastewater to be used as biological food and the amount of oxygen used by the microorganisms during oxidation. Most laboratories test for BOD_5. This is the BOD measured over a 5 day period.
Biomat: Soil clogging layer at and below the infiltrative surface to soil or to sand or other media. The layer of biological growth, organic compounds (including polysaccharides and polyuronides produced by bacteria in the mat) and inorganic residue that develops at the wastewater soil interface and extends up to about 25mm into the soil matrix. The term is used loosely to include all soil "clogging" affects, including pore size reduction, alteration of soil structure and gas production by the micro-organisms. Also referred to as *Biocrust*, *Clogging Mat*, and *Clogging Zone*.
Blackwater: Liquid and solid human body waste and the carriage waters generated through toilet usage.

Blinding layer: A layer of *Clean Coarse Sand* or Mound Sand that is installed between the infiltration surface (bottom of aggregate, base of chamber etc.) and the native soil, and which is up to 10 cm thick.

Breakout or effluent breakout: (Also used to refer to a place where there is a potential for breakout.) Visible movement of effluent to the surface of the ground.

C

Cemented (soil): Having a hard, brittle consistence because the particles are held together by cementing substances such as humus, calcium carbonate, or the oxides of silicon, iron, and aluminum. The hardness and brittleness persist even when the soil is wet.

Chlorine residual: The total amount of chlorine (combined and free available chlorine) remaining in water, sewage, or industrial wastes at the end of a specified contact period following disinfection.

Chroma: relative purity, strength, or saturation of a colour; directly related to the dominance of the determining wavelength of the light and inversely related to grayness; one of the three variables of colour; see also Munsell Colour System, hue, and value.

Clay: A textural class of soils consisting of particles less than 0.002 millimetres in diameter.

Coarse fragments: (in soil) rock fragments larger than 2 mm in diameter.

Coefficient of uniformity (soil or sand): This ratio is a numeric representation of how a soil or sand is graded, calculated as Cu = D60/D10.

Coliform bacteria: A group of bacteria predominantly inhabiting the intestines of humans or other warm-blooded animals, but also occasionally found elsewhere. Used as an indicator of human fecal contamination. Fecal coliforms are often used as a key indicator of fecal contamination in water, see Fecal Coliforms. Usually measured as number of colonies/100 mL or most probable number (MPN)

Colony-forming unit (CFU): The estimated number of live non-photosynthetic bacteria in a water sample, based on laboratory examination.

Combined Treatment and Dispersal System (CTDS): A sewerage system that provides treatment to a Type 2 or 3 standard using media or through other processes in the same cell or unit that disperses the effluent to the soil.

Confined Aquifer: An aquifer that is confined under a low-permeability geological layer, and in which ground water is confined under a pressure that is higher than the elevation of the top of the aquifer.

Consistence (soil): Attribute of soil expressed in degree of cohesion and adhesion, or in resistance to deformation or rupture. Consistence includes the resistance of soil material to rupture; resistance to penetration; and the manner in which the soil material behaves when subjected to compression. Refer to USDA manuals for tests and terms.

D

D10: In Sieve analysis of sand or soil. The size of the opening which will pass 10% (by dry weight) of a sample. Also known as effective diameter.

D60: In Sieve analysis of sand or soil. The size of the opening which will pass 60% (by dry weight) of a sample.

Daily Design Flow (DDF): The Daily Design Flow is the estimated peak daily flow to be discharged. For the purposes of the SPM this is considered to be synonymous with the SSR terms "estimated daily domestic sewage flow" and "daily design domestic sewage flow", and generally represents the maximum flow that the system will discharge.

Discharge Area (dispersal area): An area used to receive effluent discharged from a treatment method. The dispersal area is distinct from the "treatment method", and any additional treatment achieved by the dispersal area is not considered in the treatment method classification (Type 1, 2 or 3). See "dispersal system" and "treatment method".

Disinfection: The process of destroying pathogenic and other microorganisms in wastewater, typically through application of chlorine compounds, ultraviolet light, iodine, ozone, and the like.

Dispersal system: An underground system for discharging pretreated wastewater. The dispersal system includes the distribution piping, any sand or media installed around or below the distribution piping, the biomat at the wastewater-soil interface, and the unsaturated soil below. Also known as the "Subsurface Wastewater Infiltration System" (SWIS) and colloquially as a "septic field".

Distal: Furthest from a point of reference, example at the far end of a lateral. The opposite of distal is proximal.

Distribution system: A method and the components used to convey and distribute effluent to the infiltrative surface.

E

Effluent: Sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a septic tank, subsurface wastewater infiltration system, aerobic treatment unit, or other treatment system or system component.

Effective size: In a sieve analysis, the particle diameter of which 10 percent of the sample is finer by weight; also known as D10 or effective diameter.

Effluent filter (also called an effluent screen): A removable, cleanable device inserted into the outlet piping of the septic tank that is designed to trap excessive solids due to tank upsets that would otherwise be transported to the subsurface wastewater infiltration system or other downstream treatment components.

Effluent screen: See Effluent filter.

Ephemeral water body: A water body that flows or holds water only in direct response to precipitation and whose channel is at all times above the water table.

Evapotranspiration: The combined loss of water from a given area and during a specified period of time by evaporation from the soil or water surface and by transpiration from plants.

F

Fecal Coliforms: Fecal Coliform bacteria are members of the coliform group of bacteria. These bacteria are characterized by their ability to ferment lactose at 112.1°F (44.5°C) and are considered more specific indicators of fecal contamination than Coliforms which ferment lactose only at 95°F (35°C). Escherichia coli and some Klebsiella pneumoniae strains are the principal fecal coliforms

Field saturated hydraulic conductivity: See Hydraulic conductivity.

Floor area: See "living space".

Flow restrictive layer: See "Restrictive layer".

Fresh water, permanent: A fresh water body that holds water for periods more than 6 months in duration.

G

Gravel: rounded or subrounded rock fragment that is between 0.1 inch (2 millimetres) and three inches (76 millimetres) in diameter.

Graywater (greywater): Wastewater drained from sinks, tubs, showers, dishwashers, clothes washers, and other non-toilet sources.

Ground water: A subsurface water occupying the zone of saturated soil, permanently, seasonally, or as the result of the tides.

Groundwater mounding: localized increase in the elevation of a water table that builds up as a result of the downward percolation of liquid into groundwater.

H

Health hazard: As defined in the *Public Health Act*.

Health hazard: As defined in the *Public Health Act*.

High pumping rate community well: For the purpose of determining horizontal setbacks, this means a water supply well or well group that supplies potable to more than 500 persons. A water well may also be considered to be of a high pumping rate if it is pumped for more than three months at a rate of more than 190 L/min.

High water mark: The visible high water mark of a water body where the presence and action of the water are so common and usual, and so long continued in ordinary years, as to mark on the soil of the bed of the water body a character distinct from that of its banks, in vegetation as well as the nature of the soil itself, and includes the active floodplain.

Horizontal separation boundary: A point or location to which a separation distance for the dispersal area or tanks is defined by the standards

Hydraulic Application Rate (HAR): Depth of effluent applied to the infiltrative surface per dose (example mm), may also be expressed in terms of volume per area (example L/m^2) or in volume per orifice or emitter.

Hydraulic conductivity (soil): The ability of the soil to transmit water in liquid form through pores. This is termed "K" and is expressed in mm/day or other units of length/time. "Ksat" is the saturated hydraulic conductivity and is often the value intended when the term "hydraulic conductivity" is used loosely. "Kfs" is the field saturated hydraulic conductivity, as measured by the constant head borehole permeameter, and is approximately 0.5 Ksat. Hydraulic conductivity is often loosely referred to as "permeability".

I

Infiltrative Surface: In drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-Mound Sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.

Influent: Wastewater, partially or completely treated, or in its natural state (raw wastewater, sewage), flowing into a reservoir, tank, treatment unit, or disposal unit.

Instantaneous loading rate: Quantity of effluent discharged during a dosing event expressed as volume per unit time.

Intermittent fresh water body: For the purposes of this Manual, a fresh water body that flows or holds water during only part of the year and for a period less than six months in duration, other than an "ephemeral" water body.

Invert (pipe): Lowest point of the internal cross-section of a pipe or fitting.

L

Landscape position: specific geomorphic component of the landscape in which a site is located; two-dimensional landscape positions (hill slope profile positions) may be summit, shoulder, backslope, footslope, or toeslope; three dimensional views of geomorphic landscape position can be described as head slope, nose slope, side slope, base slope, etc.

Large flow system: a sewerage system with daily domestic sewage flow of over 9100 L/day.

Lateral: Perforated pipe or tubing used to carry and distribute effluent.
Latrine: See "Privy."
Limiting layer: The shallowest of a restrictive layer (see Restrictive Layer), water table, seasonal high water table or extremely permeable material (e.g. fractured rock, gravel). See Table II- 7 (page II-17) for specific soil conditions considered to be a limiting layer.
Living space: The total net floor area of a building less the floor area of a garage, breezeway, carport, crawl space or decks exterior to the building's foundation walls.
Loam: A specific class of soil texture that contains a balanced mixture of sand, silt and clay. Clay content is less than 27% by weight. Loams have enough sand to feel some grit and enough clay to give the soil some body, but the properties and behavior of the soil are dominated by neither sand nor clay.
Lysimeter: A device for collecting water from the pore spaces of soils and for determining the soluble (and in some cases, suspended) constituents removed in the pore water.

M

Macropore (soil): The term includes all pores that are (generally) drained at field capacity, commonly these pores are of 1mm or larger equivalent diameter. This includes root channels and soil macro structure. These pores are the main path for preferential (rapid saturated) flow in structured soils and fractured rock.
Manifold: A pipe used to distribute effluent to more than one lateral or dripline.
Mass loading: See "Organic loading rate". This may also refer to the mass loading to a sewage treatment system.
Matrix (soil): The portion of a given soil that has the dominant colour; also used to refer to the fine material (generally <2mm) forming a continuous phase and enclosing coarser material and/or pores—that is, soil peds or particles versus the voids between peds or in cracks.
Matrix flow: This is the relatively slow and even movement of solutes through the soil. The objective of careful effluent dosing and distribution is to encourage unsaturated matrix flow, improving soil based treatment. Also termed "uniform flow."
Media, distribution: Material used to provide void space (usually in a dispersal component) through which effluent flows and is stored prior to infiltration (for example, washed stone, aggregate, polystyrene blocks, chambers, etc.).
Media, treatment: Non-degradable material used for physical, chemical and/or biological treatment in a component of a wastewater system. Example sand in a sand mound.
Monitoring well: For the purpose of this Manual, a well that is dug or drilled to a depth that is lower than the expected seasonal high water table, with a well screen and a surface annular seal, which is used for measuring the depth of the water table and or collecting groundwater samples. In contrast, an "observation standpipe" does not have a surface annular seal, and is not intended for sampling of groundwater.
Mottling: Spots or blotches of different colours or shades of colour interspersed with the dominant soil colour caused in part by exposure to alternating unsaturated and saturated conditions. See "Redoximorphic."
Munsell Colour System: Colour designation system that specifies the relative degrees of the three variables of colour: hue, value, and chroma.

N

Nitrogen (N): Gaseous element (molecular formula N_2) that constitutes 78 percent of the atmosphere by volume and occurs as a constituent of all living tissues in combined form; nitrogen is present in wastewater, surface water and groundwater as ammonia (NH_3) or ammonium ion (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-) and organic nitrogen.

O

Observation Port: Larger diameter (over 3") pipe, open bottom or slotted, used to observe the infiltration surface or interior of a chamber.
Observation standpipe: See "Standpipe".
Oil and Grease (O&G): Fats, oils, waxes and other related constituents found in wastewater. Oil and Grease content is determined by extraction from the wastewater sample with trichlorofluoroethane, and is expressed in mg/L. Previously termed "Fat Oil and Grease" (FOG).
Organic loading rate (to infiltrative surface): The rate of application of soluble and particulate organic matter. It is typically expressed on an area basis as g/m^2 or pounds of BOD_5 per square foot per day ($lb./ft^2/day$).
Organic soil: A soil that contains a high percentage (more than 15 – 20%) of organic matter throughout the soil column.
Oxidation: Chemical reaction in which a loss of electrons results in an increase in oxidation number (valence) of an element; occurs concurrently with reduction of the associated reactant. Chemical or biological conversion of organic matter to simpler, stable forms with a concurrent release of energy.

P

Packaged treatment plant: Term commonly used to describe a pre-built aerobic treatment unit.
Particle size: The effective diameter of a particle, usually measured by sedimentation or sieving.
Particle-size distribution: The amounts of the various soil size fractions in a soil sample, usually expressed as weight percentage.
Pathogenic: Causing disease; commonly applied to microorganisms that cause infectious diseases.
Peat: Organic (fibric) soil material in which the original plant parts are recognizable.
Ped: (soils) a single unit of soil structure.
Performance boundaries: The point at which a wastewater treatment performance standard corresponding to the desired level of treatment at that point in the treatment sequence is applied. Performance boundaries can be designated at a point of the pre-treatment system (for example, septic tank, packaged treatment plant), at physical boundaries in the receiving environment (impermeable strata, ground water table, breakout), at a point of use (ground water well), or at a property boundary.
Performance objective: An objective established as part of the SPM or by a regulatory authority to ensure performance standards are met. Performance objectives are typically expressed as numeric limits (for example, pollutant concentrations, mass loads, wet weather flows, and structural strength) but may also be expressed as narrative descriptions of desired performance, such as no visible leaks or no odors.
Performance standard: A standard established as part of the SPM or by a regulatory authority, for example Type 2 treatment system performance standards established by the SSR.
Performance statement: A standard established as part of the SPM or by a regulatory authority to ensure future compliance with the public health and environmental goals. Performance standards are typically expressed as narrative statements such as "do not cause a health hazard".
Permanent Water Table: See "Water Table."
Permeability: The ability of a porous medium such as soil to transmit fluids or gases.
pH: A term used to indicate the acidity or alkalinity of the water. The logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per liter; provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral and greater than 7 is more alkaline and less than 7 is more acidic).

Phosphorus (P): Chemical element and essential nutrient for all life forms, occurring as orthophosphate, pyrophosphate, tripolyphospate and organic phosphate forms; each of these forms, as well as their sum (total phosphorus), is expressed in terms of milligrams per liter elemental phosphorus; occurs in natural waters and wastewater almost solely as phosphates. Total (TP) is the sum of all forms of phosphorus in effluent.

Plastic soil: A soil capable of being molded or deformed continuously and permanently by relatively moderate pressure.

Platy structure (soil): Laminated or flaky soil aggregate developed predominantly along the horizontal axes.

Point of Application (POA): The point within a sewerage system where the wastewater quality consistently meets the quality level for the treatment method selected (Type 1, 2 or 3), typically the infiltrative surface. For Combined Treatment and Dispersal systems (CTDS), the point at which a CTDS produces effluent at the defined quality level (Type 2 or 3).

Ponding: Accumulation of liquid on an infiltrative surface.

Preferential flow: Saturated flow in macropores or as finger or funnel flow in unstructured soils, it is the rapid and local transport of water and solutes in soils. For good soil base treatment this type of flow should be avoided. Also known as "bypass flow". See Matrix flow, macropore.

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 bio-degraded but dissolved contaminants are not significantly removed in this treatment step (for example a grease interceptor or a septic tank provides primary treatment). Type 1 effluent is produced by primary treatment.

Privy: A structure used for disposal of human waste without the aid of water; it consists of a shelter built above a pit or vault in the ground into which human waste falls. The vault may be impermeable (vault privy) or may include soil absorption (pit latrine or pit privy). Privies are not allowed under the Sewerage System Regulation.

Proximal: Nearest to a point of reference, example at the end of a lateral closest to the manifold. The opposite of proximal is distal.

R

Receiving area: the area 7.5m downslope from the system infiltrative surface, or on flat or low (≤ 2%) slope sites, the area 7.5m around the system infiltrative surface.

Redoximorphic features: or mottling is identified by the presence of oxidized and reduced states of iron or manganese in the same ped (single unit of soil structure). See "mottling."

Reduction (reducing): Addition of electrons to a chemical entity decreasing its valence or oxidation number; for example under anaerobic conditions (no dissolved oxygen present), sulfur compounds are reduced by bacteria to odor-producing hydrogen sulfide (H2S) and other compounds.

Restrictive Layer: A layer of soil or rock that impedes the vertical movement of water, air and the growth of plant roots. This may include hardpan, some compacted soils, bedrock, glacial till and unstructured clay soils. In this Manual, "restrictive layer" includes soils with a Kfs of less than 60 mm/day, if the soil underlies a soil layer of higher permeability. Also, for this Manual, "restrictive layer" includes soils with a consistency stronger than Firm (moist), or harder than Moderately Hard (dry).

Retention time: Time for which a liquid or sludge is retained in a process component (For example, in a lagoon). *See Detention Time.*

S

Seasonal High Water Table (SHWT): The SHWT is the upper limit of the soil water table which persists for more than 21 consecutive days or 30 total days, during a year which has normal precipitation. See Section III-3.3.2.2.(a).

Seasonal Low Water Table: See Water table.

Semi-prescriptive standards: Standards or specifications for planning, siting, and other procedures and practices for onsite system applications intended to, where applied, result in achievement of specified performance standards. Proposed deviations from the specified criteria, procedures, or practices do not require formal approval by a regulatory authority, but are made based upon achievement of equivalent performance by the system.

Septage: The liquid, solid, and semisolid material that results from wastewater pre-treatment in a septic tank.

Septic tank: A buried, preferably watertight tank that is designed and constructed to receive and partially treat raw wastewater. The tank separates and retains settleable and floatable solids suspended in the raw wastewater.

Settleable solids: Matter in wastewater that will not stay in suspension during a designated settling period.

Sewage: Any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of the SPM, "sewage" is generally synonymous with domestic wastewater or domestic sewage. Note that industrial wastewater falls outside the scope of the SPM.

Silt: A textural class of soils consisting of particles between 0.05 and 0.002 millimetres in diameter.

Slope Shape: Slope shape is described in two directions: 1) up and down slope (perpendicular (or normal) to the contour); and 2) across slope (along the horizontal contour). Concave: landscape form or feature that is curved like a segment of the interior of a hollow sphere. Convex: landscape form or feature that has a surface that is curved or rounded outward. This data element is split into two sequential parts (Slope Across and Slope Up & Down); for example, Linear, Convex.

Small flow system: a sewerage system with daily domestic sewage flow of 9100 L/day or less.

Soil horizon: A layer of soil or soil material approximately parallel to the land surface and different from adjacent layers in physical, chemical, and biological properties or characteristics such as colour, structure, texture, consistence, and pH.

Soil structure: The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterized and classified on the basis of size, shape, and degree of grade (distinctness).

Soil structure grade: Degree of distinctness (degree of aggregation), how well the structure is expressed in place. Refer to USDA or CANSIS manuals for terms.

Soil Ped: A single unit of soil structure. See "Ped."

Soil textural class: Percentage by weight of sand silt and clay such that each class possesses unique physical characteristics and management relative to the other textural class. The textural classes may be modified by the addition of suitable adjectives when rock fragments are present in substantial amounts; for example, "gravelly loam".

Soil texture: The relative proportions of the various soil separates (for example, silt, clay, sand) in a soil.

Soil water: A general term emphasizing the physical rather than the chemical properties and behavior of the soil solution.

Standpipe (observation standpipe): Pipe, slotted or open bottom, which is used to measure the depth of the water table. A standpipe is not sealed, and is slotted or perforated over most of its length. It could range in diameter from, typically, 25 to 150 mm diameter.

Structure (soil): See "soil structure".

Suspended solids (SS): The residue that is retained after filtering a sample of water or wastewater through a standard glass-fiber filter. The concentration of total suspended solids is the weight of the dried solids retained on the filter, divided by the volume of the sample from which the solids were collected. This is often expressed as mg/L.

Swale: Natural or constructed elongated depressional drainage feature used to divert run-on or runoff and direct the flow to an effective outlet.

T

Texture (soil): See "soil texture".

Toe Blanket: A blanket or mantle of sand or permeable soil that is placed at the toe of raised dispersal system or in the receiving area. The purpose is to aid seepage from the raised system into the native soil, or to provide additional depth for effluent to move away from the dispersal area and to provide a cover above soil that may be saturated.

Toe Drain: A subsurface drain installed near the toe of a sand mound or other raised dispersal system, or at the toe of a toe blanket. The purpose is the help drain the part of the dispersal system where water is most likely to accumulate. This is sometimes called a relief drain.

Transpiration: The process by which water absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, principally from the leaves.

Treatment method: The application of an appropriate onsite technology to achieve standards for Type 1, 2 or 3 treatment method as stipulated in the Sewerage System Regulation. The treatment method is a separate entity from the "discharge area", which may also treat effluent but has the primary function of effluent dispersal (see "discharge area").

U

Unconfined aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well. Also known as "water table aquifer".

Uniformity Coefficient (particle size distribution): See "coefficient of uniformity".

Unsaturated flow: Movement of water in a soil that is not filled to capacity with water.

Unsaturated soil: Soil in which the pore spaces contain water at less than atmospheric pressure, as well as air and other gases.

V

Vadose zone: Aerated region of soil located above the permanent water table, and hence unsaturated most of the time.

Vertical Separation (native soil): The depth of unsaturated, original, undisturbed permeable soil below the infiltrative surface and above any limiting layer.

Vertical Separation (as constructed): The depth of unsaturated, original, undisturbed permeable soil below the infiltrative surface and above any limiting layer PLUS the depth of sand media between the infiltrative surface and the native soil.

W

Water budget: In general use this is a hydrological formula used to determine water surpluses and deficits in a given area, providing a budget of the incoming and outgoing water from a region, including rainfall, evaporation, run-on, runoff, and seepage (absorption). For a dispersal system (Example an ETA bed or ET bed) this is used to provide a balance sheet for the inputs and outputs of water to the unit.

Water suction line: A pipe that delivers water to the suction or inlet side of a pump.

Water table: (Seasonal Low Water Table) (Permanent Water Table) The level in saturated soil at which the hydraulic pressure is zero (i.e., equal to atmospheric pressure). In terms of the Standard Practice Manual vertical separation standards the permanent water table refers to the lowest elevation of the water table during a year which has precipitation of at least 30% of average annual precipitation (to a maximum of 1 in 20 year return period precipitation).

Water well: As defined in the Ground Water Protection Regulation as a “water supply well”. Includes wells used to supply water for domestic purposes, for irrigation purposes, and open loop geothermal wells.

Wetland: Area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions; natural wetlands generally include swamps, marshes, bogs and similar areas, but not constructed wetlands used in wastewater treatment.

I- 1.2 Table of acronyms

ABBREVIATION	FULL TEXT
AIS	Area of Infiltrative Surface
AP	Authorized Person
APEGBC	Association of Professional Engineers and Geoscientists of BC
ASTTBC	Applied Science Technicians and Technologists of BC
BOD or BOD_5	Biochemical Oxygen Demand (5 day)
CFUs	Coliform Forming Units
CTDS	Combined Treatment and Dispersal System
D-box	Distribution box
DDF	Daily Design Flow
FOG	Fats, Oils, Grease (also known as O&G)
HAR	Hydraulic Application Rate
HLR	Hydraulic Loading Rate
HS	Horizontal separation
Kfs	Field Saturated Hydraulic Conductivity
LLR	Linear Loading Rate
Perc or Perc rate	Percolation rate
POA	Point of Application
ROWP	Registered Onsite Wastewater Practitioner
SDD	Subsurface Drip Dispersal
SHWT	Seasonal high water table
SPM	Sewerage System Standard Practice Manual
SSR	Sewerage System Regulation
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VS	Vertical Separation

I- 2 INTRODUCTION AND SCOPE OF THE MANUAL

The Sewerage System Standard Practice Manual (SPM) is a reference manual which provides standards and guidelines for site and soil evaluation, planning, installation and maintenance for sewerage systems under the Sewerage System Regulation (SSR) which identifies the SPM as a source of standard practice. The SPM is published by the Ministry of Health.

Holding tanks (including vault privies) are regulated by the SSR, but do not require planning or installation by an Authorized Person. For this reason holding tanks and vault privies are not covered by the SPM.

The SPM provides semi-prescriptive standards based on the achievement of performance criteria as supported by research. The result of using the standards and guidelines is that systems, when properly operated, will meet or exceed defined performance objectives.

I- 2.1 Purposes of the manual

The primary purpose of the SPM is to provide standard practices for the planning, installation, and maintenance of sewerage systems on single parcels of land such that the system will not create or contribute to a health hazard.

The SPM is not intended to address potential “cumulative impacts” of discharge from multiple systems within a given area (i.e. subdivisions). This aspect is addressed under the Subdivision Regulations, and applicable policies of the Ministry of Community, Sport and Cultural Development.

The SPM standards and guidelines are intended to support cost effective public health protection. The standards of this manual are presented as “minimum” standards only, not absolute standards. More stringent standards may need to be utilized for challenging systems or to address specific site conditions.

The SPM is not an Act or Regulation. No standards of the SPM are intended to conflict with any Act or Regulation (including the SSR and the Public Health Act). In all cases where a conflict arises, the Act or Regulation supersedes the SPM.

The SPM is not a design manual or an educational or training text.

I- 2.1.1 DEFINITION OF STANDARD PRACTICE

The Sewerage System Regulation (Part 1) defines standard practice:

> “standard practice means a method of constructing and maintaining a sewerage system that will ensure that the sewerage system does not cause, or contribute to, a health hazard.”

The SSR relies upon the Authorized Person (AP) to confirm that the sewerage system has been planned and constructed in accordance with standard practice.

I- 2.1.2 THE SPM AS A SOURCE OF STANDARD PRACTICE

The SSR identifies the SPM as a source of standard practice:

> In Section 8(3), “To determine whether the plans and specifications filed under subsection (2) (b) are consistent with standard practice, an authorized person may have regard to the Ministry of Health Services' publication "Sewerage System Standard Practice Manual", as amended from time to time.”
>
> And in Section 9(2), “To determine whether sewerage system construction and a maintenance plan in respect of the sewerage system are consistent with standard practice, an authorized person may have regard to the Ministry of Health Services' publication "Sewerage System Standard Practice Manual", as amended from time to time.”

These sections of the SSR confirm the SPM as guidance for meeting the standard practice requirement.

I- 3 ROLES AND RESPONSIBILITIES

I- 3.1 Stakeholders and Organizations

Key stakeholders and organizations relevant to the onsite system field of practice and their roles and responsibilities are summarized in Table I- 1 and Table I- 2.

Table I- 2 shows the relationship of stakeholders and organizations to the SSR and the SPM.

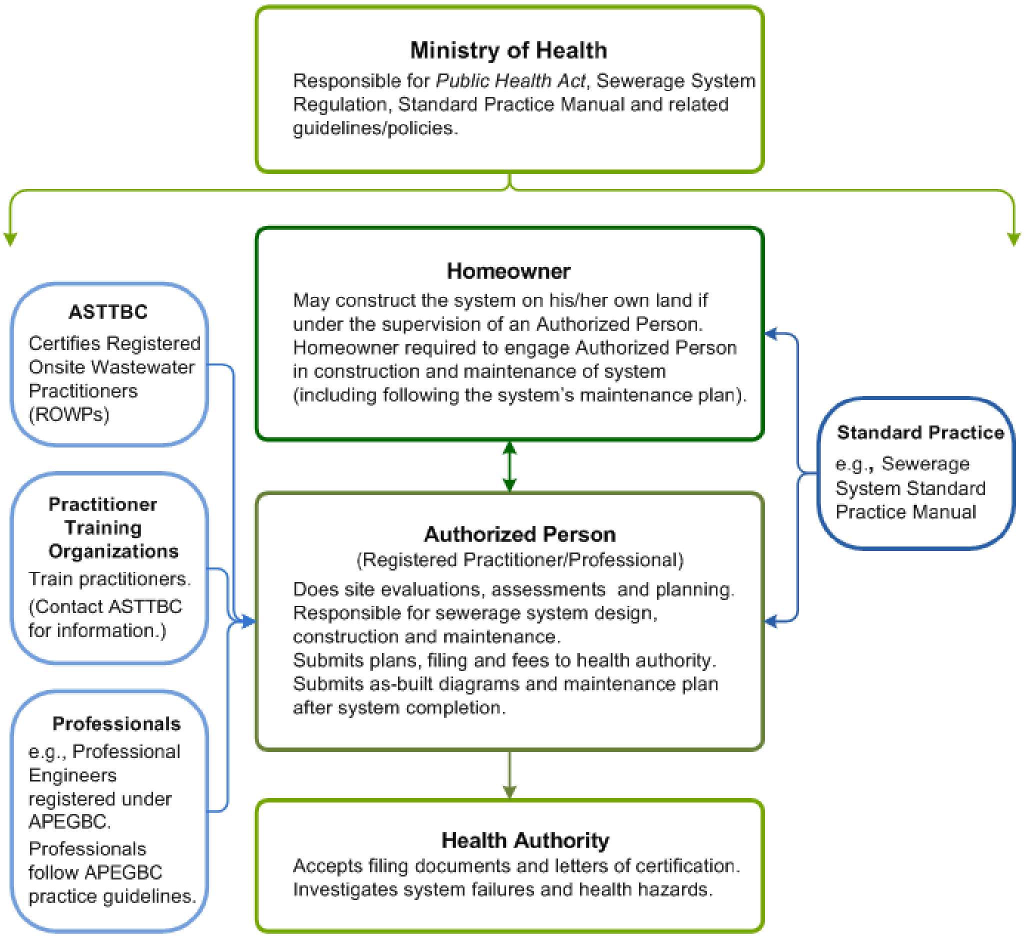
Table I- 1. SSR related roles and responsibilities

ORGANIZATION OR STAKEHOLDER	ROLE
Ministry of Health	Responsible for the SSR and maintenance of the BC SPM. Establishes policy for interpretation of the SSR and for Health Authorities.
Health Authorities and Environmental Health Officers (EHOs)	Administration of filings. Administration and enforcement of the SSR and the *Public Health Act*. Investigation and compliance action for the prevention or correction of health hazards caused by onsite systems. Receives and responds to complaints about health hazards.
Association of Professional Engineers and Geoscientists of BC (APEGBC)	APEGBC regulates the practice of its members and licensees, including those practicing in the area of onsite sewerage systems.
Applied Science Technologists and Technicians of British Columbia (ASTTBC)	Registers and regulates the practice of ROWPs
Authorized Persons (Professional or ROWP)	Responsible for the planning, installation and maintenance of a sewerage system in accordance with standard practice.
System Owner	Required by law to retain an AP (professional or ROWP) to plan, install and maintain the sewerage system (or supervise same), as outlined in the SSR. Responsible for operation and maintenance of the system, including retaining an AP to undertake maintenance of the system. The system owner may be involved with system installation and maintenance under AP supervision as per SSR section 6(1) (b) and 6(3).

Table I- 2. Non-SSR related roles and responsibilities

ORGANIZATION OR STAKEHOLDER	ROLE
Health Authorities and Environmental Health Officers (EHOs)	May respond to referrals for planned subdivisions in relation to sewerage systems.
Local Government	May enact bylaws further controlling siting of onsite systems. Have authority to mandate system maintenance, inspection and repair through local bylaws and enforcement activities. May integrate decentralized sewerage systems in their waste management planning.
Provincial Approving Officer (Ministry of Transportation and Infrastructure)	Subdivision approval in unincorporated areas, considering adequate provision for sewage management as a factor, under the *Local Services Act*
Federal Health, Aboriginal Affairs and Northern Development Canada (AANDC) and the First Nations Health Authority (FNHA)	Onsite systems on First Nations reserve lands are overseen by the First Nations Health Authority. ROWPs must follow the requirements of the Standard Practice Manual and file with the Environmental Health Officer at the local FNHA office.

Figure I- 1. Process and parties involved in sewerage systems under the SSR



Ministry of Health

Responsible for *Public Health Act*, Sewerage System Regulation, Standard Practice Manual and related guidelines/policies.

Homeowner

May construct the system on his/her own land if under the supervision of an Authorized Person. Homeowner required to engage Authorized Person in construction and maintenance of system (including following the system's maintenance plan).

ASTTBC

Certifies Registered Onsite Wastewater Practitioners (ROWPs)

Practitioner Training Organizations

Train practitioners.

(Contact ASTTBC for information.)

Professionals

e.g., Professional Engineers registered under APEGBC. Professionals follow APEGBC practice guidelines.

Standard Practice

e.g., Sewerage System Standard Practice Manual

Authorized Person

(Registered Practitioner/Professional)

Does site evaluations, assessments and planning. Responsible for sewerage system design, construction and maintenance.
Submits plans, filing and fees to health authority.
Submits as-built diagrams and maintenance plan after system completion.

Health Authority

Accepts filing documents and letters of certification. Investigates system failures and health hazards.

I- 3.2 Role of the Authorized Person

The SSR specifies that sewerage systems are to be constructed and maintained only by Authorized Persons (APs) or under their supervision. The SSR defines APs as Registered Onsite Wastewater Practitioners (ROWPs) or Professionals. The Authorized Person (AP) is responsible under the SSR for planning and installation of the system in accordance with standard practice, and is responsible for maintaining a system in accordance with standard practice.

I- 3.2.1 REGULATORY ASSOCIATIONS FOR AUTHORIZED PERSONS

I- 3.2.1.1 Registered Onsite Wastewater Practitioners (ROWPs)

The SSR in s7(1) and s7(2) outlines the qualifications for an ROWP and establishes Applied Science Technologists and Technicians of British Columbia (ASTTBC) as the registering body for Registered Onsite Wastewater Practitioners (ROWPs).

ASTTBC has established three categories of ROWP as Authorized Persons under the SSR:

- Planner, responsible for site and soil evaluation and planning of systems.
- Installer, responsible for installation of systems.
- Maintenance Provider, responsible for maintenance of systems.

Through its authority under the *ASTT Act*, the ASTTBC has implemented policies governing ROWPs.

See: http://owrp.asttbc.org/p/documents.php

ASTTBC maintains a web listing of those members with accreditation as ROWPS.

See: http://owrp.asttbc.org/c/finder.php

I- 3.2.1.2 Professionals

The SSR s7(3) outlines the qualifications for professionals. Members and licensees of the Association of Professional Engineers and Geoscientists of BC (APEGBC) are professionals under the SSR.

APEGBC maintains a web roster of those Professionals that have self-declared competence as professionals under the SSR.

See: http://www.apeg.bc.ca/members/sewerageprolist.html

APEGBC has published a guide entitled "Professional Practice Guidelines, Onsite Sewerage Systems" (APEGBC Professional Practice Guidelines - Onsite Sewerage Systems).

The APEGBC Professional Practice Guidelines - Onsite Sewerage Systems provides guidance on professional practice for Professional Engineers, Licensees and Professional Geoscientists who are members or licensees of APEGBC and design or advise on sewerage systems (onsite systems) under the *Sewerage System Regulation*. The publication guides professionals on site-specific and project-specific design of onsite systems.

See: https://www.apeg.bc.ca/APEGBC/media/APEGBC/Guidelines-Professional%20Practice/APEGBC-Guidelines-for-Onsite-Sewerage-Systems.pdf

I- 3.3 Roles of Health Officers or other Health Authority staff

Health Authorities and Health Officers have statutory authority under the *Public Health Act* and the *Health Authorities Act* to:

- Administer and enforce the Sewerage System Regulation.
- Issue permits for holding tank systems under the SSR.
- Carry out compliance and enforcement activities.
- As an administrative role, accept documents sewerage system filing documents and letters of certification documents for systems and confirm that these meet the documentation standards of the Sewerage System Regulation.
- Confirm that Authorized Persons plan (via filing), construct (via Letter of Certification) or maintain installed sewerage systems (or supervise these activities).
- Receive and respond to complaints about health hazards. Make a determination of health hazards related to an onsite sewerage system, and ensure corrective action is taken by responsible parties to alleviate health hazards.

Health Authorities can review filings at their discretion.

I- 3.4 Health Hazards

Refer to the Ministry of Health publication *Health Hazard Communication Guideline* for information on the roles of the Health Authorities, ASTTBC and APEGBC for the onsite industry.

http://www.health.gov.bc.ca/protect/pdf/health-hazard-communication-guideline.pdf

The *Public Health Act* and the SSR provides the authority for the Health Officer to intervene if a health hazard exists or is anticipated and holds the authority to take compliance and enforcement action. Actions that Health Officers may take include the following:

- Health Officers may issue Orders requiring compliance within specified time frames. An order can require documents or evidence or prescribe specific actions to avert a health hazard. Examples include repair or replacement of systems, connection to a public sewer, 'pump and haul' as an interim measure, discontinued use of a water source, and other remedial actions.
- Health Officers may defer acceptance of a Filing when information is missing or suspected to be false or misleading. A Filing may also be returned based on a failure to comply with standard practice, or if a Health Officer believes the system will cause a health hazard.
- Health Officers have discretionary authority to conduct on-site inspections and are responsible to investigate complaints regarding sewerage systems.

The roles, responsibilities, and communication protocols of Health Officers regarding Filings and sewerage systems can be found in the Health Hazard Communication Guideline.

I- 3.5 Owner responsibilities

The owner is responsible for ensuring that the sewerage system is used in the manner it was design for as stated in the filing and maintenance plan (example conforms to defined design flows). The SSR has specific requirements for owners, including the following:

- Do not cause or contribute to a Health Hazard.
- Ensure that sewage is discharged into a public sewer, or a permitted holding tank, or an onsite system that complies with all provisions of the SSR or as authorized by another enactment.

- Ensure the system is used and maintained according to the Maintenance Plan as filed with the Health Authority. Under s.10 of the SSR, homeowners must keep records of maintenance.
- Only construct or maintain a system on his/her own land if under the supervision of an Authorized Person.

I- 4 INTRODUCTION TO THE STANDARD PRACTICE MANUAL

I- 4.1 Organization of the SPM

The SPM is divided to four volumes:

Volume I: Introduction

- Glossary
- Purposes
- Instructions for use and application of the manual
- Administrative context
- Roles and responsibilities

Special terms used in this Manual are defined in the glossary.

Volume II: Standards

- Practice standards and checklists
- Site evaluation standards
- Tables and standards for system planning
- Specification and installation standards
- Maintenance and monitoring standards

This volume is for reference. It includes the key standards of the manual for site evaluation, planning, installation and maintenance. It does not include explanatory or educational material.

Volume III: Guidelines

- Explanation, guidance and examples for application of standards
- Guidance for system planning, installation and maintenance
- Description of system types
- Glossary
- Appendices

Volume III explains the standards in Volume II and provides guidelines on how to meet those standards. It is intended to be used alongside Volume II. It does not include standards.

The appendices include key standards tables converted to imperial units.

Volume IV: Rationale

- Performance statements
- Performance objectives
- Rationale for standards
- References

This volume explains the performance basis for the manual and provides rationale for the standards for planning systems in Volume II. It is intended for reference and for those looking for further reading. The text is technical in nature.

I- 4.2 Cross references and references in the SPM

Volume II (standards) and Volume III (guidelines) are arranged in the same order for easy cross-referencing. All standards in Volume II have corresponding sections in Volumes III.

Where references are cited, the full reference is in the bibliography at the end of Volume IV.

I- 4.3 Application of the SPM by Authorized Persons

All Authorized Persons must comply with the Sewerage System Regulation.

Where an AP has identified the SPM as his or her source of standard practice:

- The AP is to follow the standards in Volume II.
- Departures from the guidelines in Volume III are to be supported by written rationale.
- Volume IV performance statements and objectives are to be considered in any cases where the AP is departing from the guidelines of the manual.

I- 4.4 Using the Standard Practice Manual

I- 4.4.1 FOR A TYPICAL DESIGN AND INSTALLATION

The Authorized Person would use Volume II for:

- The checklists to ensure procedure standards are met.
- Standards to select a solution for the particular property and plan the system.
- Specification and installation standards.
- Maintenance standards to help develop the maintenance plan.

The Authorized Person would use Volume III, alongside Volume II:

- For an explanation of a standard or for examples.
- For guidance on selecting a suitable system for a site.
- For information on how to plan or install particular methods or equipment.
- Directions to supplemental information, such as design manuals.
- For guidance on maintenance for a specific system type for inclusion in the maintenance plan.

I- 4.4.2 DURING SYSTEM MAINTENANCE

The Authorized Person would use Volume II:

- For information relevant to updates to a maintenance plan.
- For minimum procedural standard checklists.

The Authorized Person would use Volume III:

- Where necessary, for description of a system type, how the system works and why it was specified
- For guidance on maintenance and monitoring for a specific system type.

I- 4.4.3 FOR HEALTH OFFICERS

A Health Officer may use the manual when reviewing a system filing or maintenance plan that refers to the SPM as the main source of standard practice.

The checklists of Volume II may be used to check on documents submitted with a filing or letter of certification.

Volume IV may be used to provide a background understanding of the performance objectives underlying the manual's standards.

I- 4.4.4 FOR OWNERS AND THE PUBLIC

The manual is intended for use by ROWPs and Professionals. However, an owner may find the manual useful in working with an AP to gain an understanding of his or her system and how best to operate the system.

SEWERAGE SYSTEM
STANDARD PRACTICE MANUAL

VOLUME II - STANDARDS

VERSION 3 SEPTEMBER 2014

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

BRITISH
COLUMBIA

ASTTBC
TECHNOLOGY
PROFESSIONALS
QUALIFIED. REGISTERED. ACCOUNTABLE.

Volume II Table of Contents

Volume II List of Tables

Volume II Standards

II- 1 INTRODUCTION

II- 1.1 How to use this Volume

Volume II contains this Manual's standards of practice for onsite sewerage systems in British Columbia. This volume is intended to be used for reference, refer to Volume III for explanations. The AP may wish to have a copy of this Volume readily available for easy reference.

The main sections in Volume II (e.g. II-2.1) have corresponding sections in Volume III (e.g. III-2.1).

Use Volume III alongside Volume II for explanatory information and examples. Cross references are not given to Volume III.

Volume I includes a glossary with definitions of special terms used in this Manual.

The appendix to Volume III includes key standards tables converted to imperial units.

II- 1.2 Principles behind the standards

The Sewerage System Regulation (SSR) defines a sewerage system as *"a system for treating domestic sewage that uses one or more treatment methods and a discharge area, but does not include a holding tank or a privy."* According to this definition, a sewerage system has two components (Figure II- 1):

- one or more treatment method(s); and
- a discharge area.

Both components of the sewerage system play a role in treating the sewage, but are addressed in different ways in the SSR and therefore, in this Manual.

II- 1.2.1 SEWERAGE SYSTEM PERFORMANCE

The purpose of a sewerage system is to treat the sewage to an acceptable level of quality by the time it reaches the limiting layer. For the purposes of this manual, this limiting layer is also known as the base of the specified vertical separation standard. The standards developed for this manual are based on the effluent being treated to, at minimum, recreational water quality objectives at the limiting layer (see Volume IV Section IV- 2.2 (Performance requirements and objectives)).

This level of effluent quality is to be achieved regardless of the treatment method (Type 1, 2, or 3 in the SSR) or dispersal method employed, and is universally applied to all sewerage systems that fall under the SSR. In other words, the standards for all sewerage systems are based on reaching the same water quality objectives at the limiting layer as illustrated inFigure II- 1 and Figure II- 2. Note that the objectives were used to develop the standards of this Manual only and are not a monitored requirement of the SSR.

Figure II- 1. Sewerage system key components and concepts: separated system

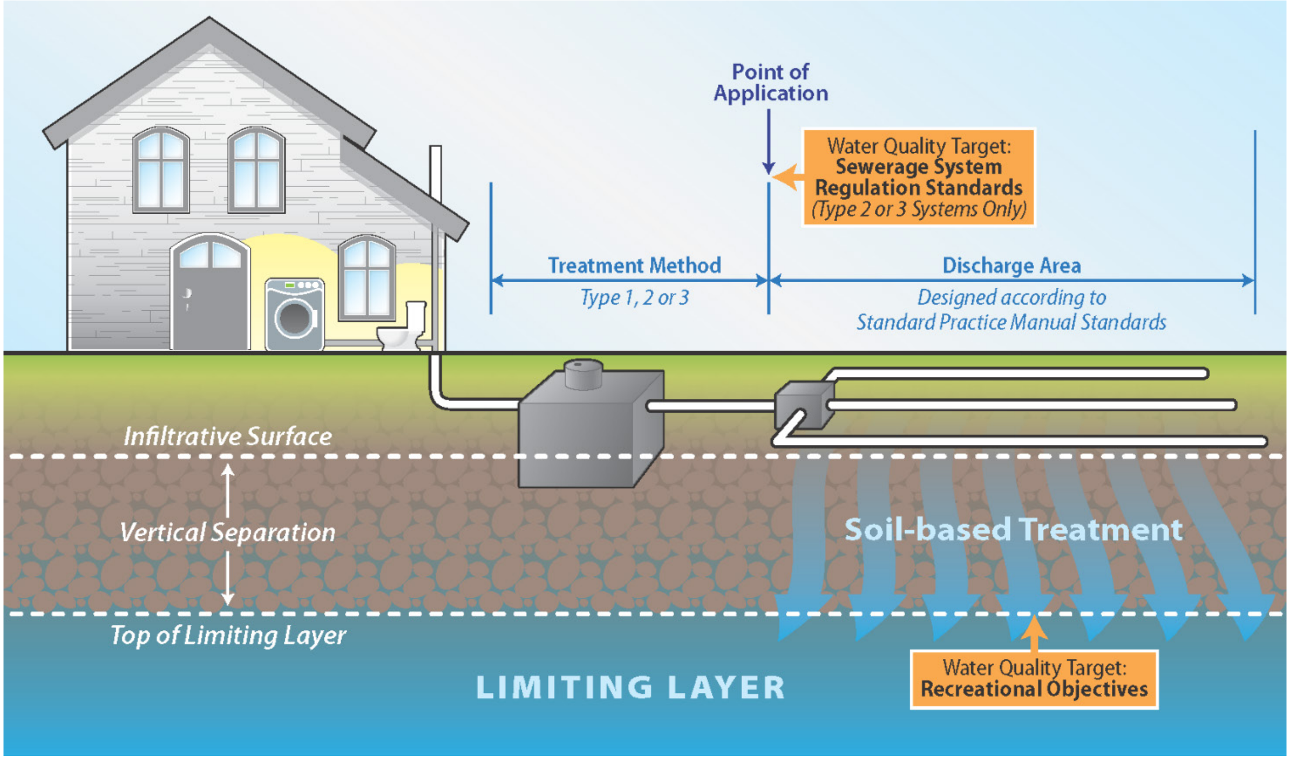
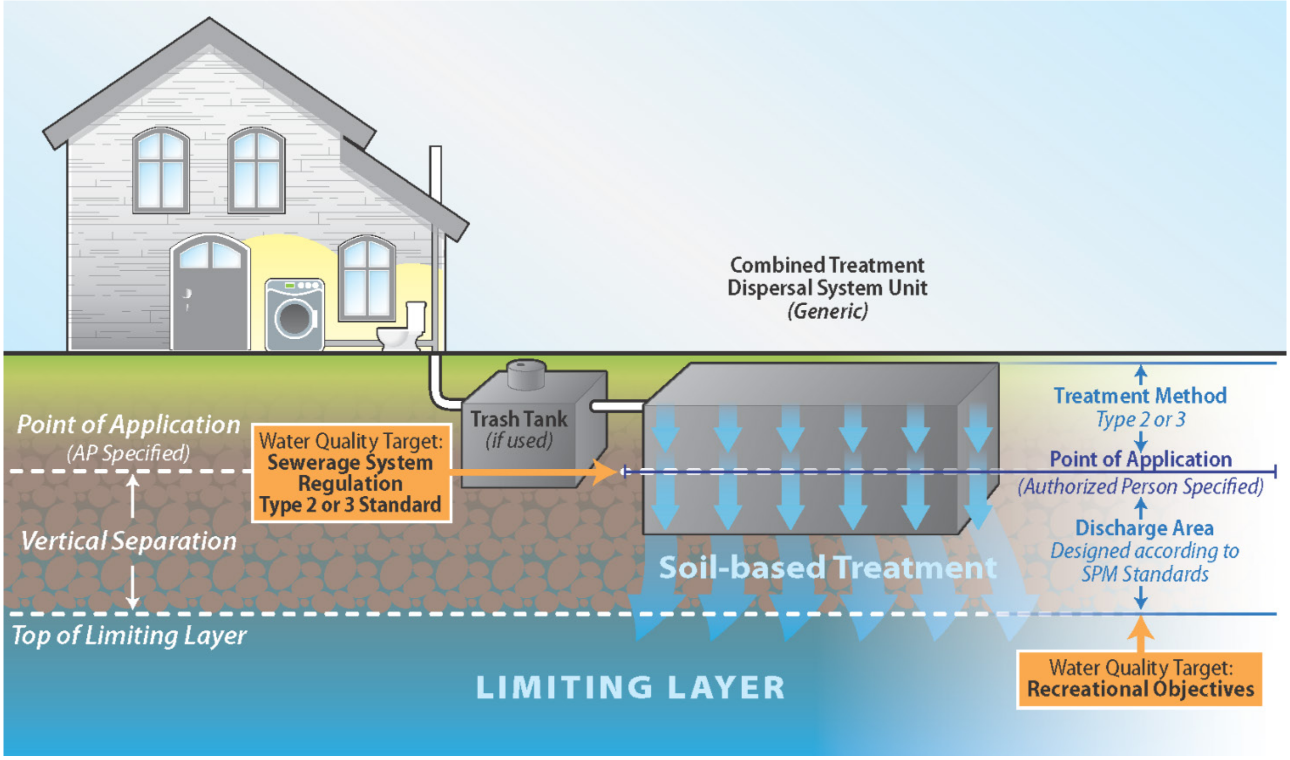


Figure II- 2. Sewerage system key components and concepts: combined system



II- 1.2.2 TREATMENT METHOD

The treatment method is the treatment system that precedes the dispersal area. Typically this consists of a septic tank (type 1) or a package treatment plant (type 2 or 3), and is defined in the SSR as:

> *"(a) Type 1 is treatment by septic tank only,*
>
> *(b) Type 2 is treatment that produces an effluent consistently containing less than 45 mg/L of total suspended solids and having a 5 day biochemical oxygen demand of less than 45 mg/L, and*
>
> *(c) Type 3 is treatment that produces an effluent consistently containing less than 10 mg/L of total suspended solids and having*
>
> *(i) a 5 day biochemical oxygen demand of less than 10 mg/L, and*
>
> *(ii) a median fecal coliform density of less than 400 Colony Forming Units per 100 mL."*

Package treatment plants come in a variety of configurations, and may also include Combined Treatment and Dispersal Systems, which combine both the treatment method and discharge area together (see Section II- 1.2.4). The point at the end of the treatment method and before the discharge area is referred to as, for the purposes of the SPM, the "point of application (POA)". It is at this point where the water quality must meet the treatment method water quality standards outlined in the SSR to the defined treatment method (for example, Type 2). It is up to the AP to decide the treatment method to be applied.

Treatment continues in the dispersal area as soil based treatment. The treatment method type (1, 2, or 3) selected influences which dispersal area standards will be used.

II- 1.2.3 DISPERSAL AREA

Dispersal areas are defined in the SSR as *"an area used to receive effluent discharged from a treatment method."*

In the past, the dispersal area was commonly considered as a means of getting the effluent into the ground ("disposal"). However, more importantly than disposal, the dispersal area is responsible for treatment for the wastewater as it travels through the soil column to the base of the vertical separation.

The standards of this Manual were developed in recognition of this soil based treatment and aim to achieve the recreational water quality objectives at the base of the vertical separation, while accounting for the long term acceptance rates of the soil. It is because of these factors this Manual provides differing dispersal area standards for different treatment methods, soil types, and dispersal methods. Simply disposing of effluent is not the intention of the standards for dispersal areas, nor are dispersal areas (including sand mounds) intended to meet specific treatment method (Type 1, 2, 3) SSR standards.

II- 1.2.4 COMBINED TREATMENT AND DISPERSAL SYSTEMS

A sewerage system consists of one or more treatment method(s) and dispersal area. These may be in the form of two discrete components (Figure II- 1), with a tank based treatment method and a soil based dispersal area.

Combined Treatment and Dispersal Systems (CTDS) typically marry the two discrete components into one unit. However, the expectations of a CTDS system (Table II- 1) are identical to those of a conventional sewerage system as illustrated in Figure II- 1. See Section II- 6.16 for more on CTDS.

Table II- 1. Comparison of separate and combined treatment and dispersal systems

PARAMETER	SEPARATE TREATMENT AND DISPERSAL SYSTEMS	COMBINED TREATMENT AND DISPERSAL SYSTEM
Treatment method	Septic tank or discrete treatment system (e.g. package treatment plant)	Package treatment and dispersal system
Point of application	Between outlet of treatment system and dispersal area, typically the infiltrative surface (with effluent quality monitoring at, for example, the pump chamber). Point where effluent quality meets Type 2 or 3 SSR standards (where applicable).	Point in package system where effluent quality meets Type 2 or 3 SSR standard and where that quality level is monitored
Dispersal area	Separate dispersal system, for example trenches, seepage bed or sand mound	Dispersal directly below and or around the treatment system.
Water quality objective at the base of the dispersal area vertical separation	Recreational water quality objectives established in Section IV- 2.2.	

As wastewater is treated through the CTDS, there is a point where the wastewater quality consistently meets the Type 2 or 3 standards of the SSR. This point is considered the point of application, just as it is for conventional treatment methods. CTDS systems are commonly third party certified based of testing of the complete CTDS system at a singular sampling point. The point of application should be identified by the AP based on testing information provided by the CTDS manufacturer.

The SPM design standards for dispersal systems apply at the point of application. As with all sewerage systems, the intention of the SPM standards as applied to CTDS systems is that, at the base of the vertical separation, the wastewater quality meets the recreational water quality objectives established in Volume IV Section IV- 2.2.

II- 2 GENERAL STANDARDS

II- 2.1 Existing systems and system repair

II- 2.1.1 EMERGENCY MEASURES

When a risk to health exists, notify the Health Authority immediately.

When a risk to health exists, under an emergency, an Authorized Person may carry out immediate repairs and remedies as well as source mitigation to eliminate the risk in cooperation with the owner. This may include temporary measures that fall short of strict adherence to SPM standards. These measures may be taken without first submitting Filing documents to the Health Authority.

Maintain the function of that system until permanent repairs or replacements can be carried out under a filing.

II- 2.1.2 REPAIR OF AN EXISTING SYSTEM

Refer to Table II- 2 for instruction on when to file documents with the Health Authority.

Table II- 2. Where a filing is necessary

NO FILING REQUIRED - Component Repair or Replacement includes the following:	FILING REQUIRED - System Repair or Replacement includes the following:
o Maintenance, including cleaning of components and cleaning or replacement of media in treatment units, flushing, vacuuming or jetting of dispersal laterals or other piping o Replacement of liquid level float switch or transducer o Replacement of a pump with one equivalent to the original o Replacement of D-box or other distribution device o Installation or replacement of tank inlet or outlet fittings or baffles o Installation or replacement of effluent filters o Installation or replacement of high level alarms o Replacement of short sections of pipe when the pipe is broken or damaged or not functioning as intended o Repair of a tank, including leak repairs, new lid and seal, new risers o Installation of new tank risers and lids.	o Construction of additional area of infiltrative surface such as new dispersal trenches or extensions to existing trenches/bed. o Removal of biomat or existing aggregate or soil or sand followed by replacement of aggregate or chambers. o Upgrading a gravity dispersal system from trickle gravity to pump to D-box configuration o Replacement of existing tank (including septic, pump chamber, treatment plant, flow equalization tank) o Addition of a secondary septic tank, flow equalization tank, grease interceptor or treatment plant/device o Retro-fitting treatment devices o Replacement of the treatment and or dispersal system.

See Section II- 2.1.2.2 for specific policy on horizontal separation to wells in repair situations.

In all cases ensure that the repair does not cause or contribute to a health hazard.

For all repairs:

- Assess and document all components of the sewerage system
- Confirm the Daily Design Flow.

II- 2.1.2.2 System repair and horizontal separation to drinking water well

The Ministry of Health *Sewerage System Policy for Setback from Wells Based on Repairs or Alterations* allows for repair or installation of replacement system components, for example tanks, where setbacks to the nearest well does not comply with the Sewerage System Regulation (SSR). This allowance is limited to systems where:

- Daily Design Flow is not changed (so no expansion of use), and
- The existing system was installed in accordance with legislation prior to June 25th 2010.

The policy exempts these systems from the requirements of section 3.1 of the SSR, including installing extra septic or treatment tanks.

http://www.health.gov.bc.ca/protect/pdf/sewerage-system-repair-policy.pdf

II- 2.1.3 UPGRADING OR REPLACEMENT OF AN EXISTING SYSTEM

When upgrading a system for a new use or for a higher Daily Design Flow or when replacing the system, plan the system to comply with the standards in this volume.

II- 2.1.4 NEW USE OF EXISTING SYSTEM

When assessing an existing sewerage system for a new use:

☐ Assess and document all components of the system.

☐ Measure or estimate the vertical separation in the dispersal area

☐ Estimate the Daily Design Flow for the new use

☐ Establish whether the existing system meets standards for the new use, and

☐ Document the upgrades needed to comply with standards.

II- 2.2 Special circumstances

See Volume III for guidance on the following special circumstances:

- Systems that will be used seasonally.
- Systems in isolated or restricted access areas.
- Off grid systems.
- Multiple homes on the same property.
- Use of adjacent property (off-site discharge).

II- 3 PROCEDURE STANDARDS

The following procedure standards indicate the **minimum** steps for site evaluation, planning, installation, and maintenance.

The checklists also show the minimum paperwork standards to document the system. **Retain these documents in the project files.** See Sections II- 3.5.1 (filing documents) & II- 3.7 (letter of certification) for documents to be submitted to the Health Authority.

II- 3.1 Sewage source characterization and site use

☐ Inform the owner of their responsibilities

☐ Gather information on the property and use (owner declaration)

☐ Select Daily Design Flow (DDF) and record how the flow was selected

☐ Evaluate the type of source of sewage

☐ Analyze the pattern of water use.

II- 3.2 Administration and Regulatory Requirements

☐ Check for other regulations that may apply for this system

☐ Check for any Health Orders for the property or sewerage system

☐ Identify any easements, covenants, or building schemes that may affect the system

☐ Check for development permits that affect the sewage system

☐ Check whether the SSR requires that a Professional design or review the sewage system

II- 3.3 Site and soil evaluation

II- 3.3.1 SITE EVALUATION

☐ Confirm the location of legal boundaries, covenants and easements.

☐ Identify relevant horizontal separation distances, including to drinking water sources, water courses and potential breakout

☐ Locate buried infrastructure (services)

II- 3.3.2 SOIL EVALUATION

For the potential dispersal and receiving area:

☐ Investigate and describe the soil profile in the proposed dispersal area

☐ When logging the soil profile in test pits:

  ☐ Describe the soil properties according to Table II- 3
  ☐ Identify any special soils that may constrain system selection (see Section II- 4.1.2.2)
  ☐ Excavate test pits deep enough to confirm the vertical separation for the proposed system

☐ Identify the planned location and depth of the infiltrative surface (e.g. trench base)

- Measure the soil permeability in a minimum of four locations or conduct a minimum of four percolation tests in the dispersal area at the planned depth of the infiltrative surface
    - If the soil, at the planned infiltration surface, has a moist consistence of Firm or stronger (or dry consistence of Moderately Hard or stronger, or is Very Weakly Cemented or stronger), then complete at least 6 permeability or percolation tests in that soil horizon.
    - If the soil, at the planned infiltration surface, has platy structure, complete at least 6 permeability or percolation tests.

Table II- 3. Minimum description of soil characteristics

SOIL CHARACTERISTIC	MINIMUM DESCRIPTION
Texture	o See Volume III, Table III- 1 (page III-12) for relevant soil texture categories. o See Table II- 4 (page II-13) for structure and consistence categories. o Report moist OR dry consistence OR cemented class.
Structure	
Consistence	
Coarse fragments	Percentage of soil particles larger than 2 mm for each soil layer
Rooting depth	Maximum observed depth of roots
Colour	Simplified soil colours, for each soil layer.
Mottling or gleying	Depth range of observed mottling or gleying
Restrictive layer	Depth to low permeability layer; description of that layer (texture, structure, consistence)
Water table or *Seasonal High Water Table*	Depth or *estimated depth*
Limiting layer	Depth or *estimated depth*
Moisture or seepage	Dry, moist or wet and depth to seepage, for each soil layer
Fill	Depth and description of each distinct layer of fill (texture, structure, consistence)
Soil profile	Depth from surface to top and bottom of each distinct layer (horizon)

II- 3.3.3 SITE AND SOIL EVALUATION REPORT

The site and soil evaluation report is to include, at a minimum:

- A site plan (to scale or showing all relevant dimensions from an identified point) showing all site information needed to plan the system, including:
    - Property lines, easements and covenants
    - The location of test pits and permeability tests
    - The location of all existing and proposed features relevant to dispersal area siting and horizontal separations (on the lot and on neighbouring properties)
    - Horizontal separation distances
    - Indication of slopes
- Text or tables, that include the following:
    - A description of the soil profile (test pit logs)
    - Results of soil permeability or percolation testing

- An estimation of the depth to water table on the date of the evaluation and the estimated Seasonal High Water Table (SHWT)
- Depth to an observed limiting layer in the soils
- Site vegetation
- Any special climate or soils factors
- A summary or list of easements, covenants, rights of way, relevant zoning or development permit(s) information, Riparian Area information, health orders etc. that may affect the system

II- 3.4 Selecting a suitable system based on site conditions

Match the selected system to the site conditions, and record the reasons for selecting the system. This includes the following steps:

- Assess the capability and constraints of the dispersal site
- Choose the depth or height of the infiltration surface that will meet the standard for vertical separation
- Select an appropriate soil type and permeability for use in system selection and sizing
- Select a type of system and layout that is suitable for that particular dispersal site, considering the constraints of that site.
- Calculate the area, length and width of the dispersal area to meet the standards (sizing and layout)
- Briefly record the reasons for the type of system and layout selected.

II- 3.5 Plans and specifications

Draw the plans and write the specification. Keep all calculations and supporting reports on file.

II- 3.5.1 FILING DOCUMENTS

Before construction (including repair) of a sewerage system, the AP must submit filing documents to the Health Authority with, at least the following:

- Health Authority filing form and fee (see s. 8(2) of the SSR)
- Site and soil evaluation report and attachments
- Record of design
- Drawings for construction
- Specifications
- Daily Design Flow and type and quality of influent
- Hydraulic loading rates
- Supporting hydrogeology report if reducing a horizontal separation to a drinking water well (see s. 3.1 of the SSR)
- Any other information specifically required by the Health Authority

II- 3.5.2 MINIMUM STANDARDS FOR CONSTRUCTION DRAWINGS

Show system features with a level of detail adequate to construct the system, including:

- A title, with identification of the property, reference to any specifications, date and revision number
- Plan drawing with all relevant features shown accurately with respect to the parcel boundaries. Draw to scale, with a scale bar and true north meridian, or if not to scale show all relevant dimensions.
- The location of all components, with horizontal separations shown on the drawing or as measurements
- One or more permanent “survey control points” (e.g. property pin)
- Detail drawings of the system that show the key features to the installer.
- A cross section showing the planned elevations of the trenches and the sand media depth, if any, and showing the vertical separation, restrictive layer, and water table.

For simple systems the construction drawing can be combined with the site evaluation drawing.

II- 3.6 Installation

- Install the system according to the drawings and specifications
    - Keep records of installation (photographs, notes)
- File amendments for any significant changes to the plans or specifications
- Commission the system and record system information for the maintenance plan
- Measure system component locations for the record drawing
- Where an AP other than the filing AP installs the system:
    - The owner retains the planner or designer to review the installation for conformance with the drawings and specifications. Keep records of this review.
    - The installer provides the filing AP with information on the installed system.

II- 3.7 Letter of Certification, record drawing and as installed specifications

Within 30 days of completing construction, submit the letter of certification, record drawing and maintenance plan to the Health Authority (see s.9 of the SSR).

Provide a copy of the record drawing, maintenance plan and letter of certification to the owner (see s. 9(1) (a) of the SSR).

II- 3.7.1 RECORD DRAWING

- Show the system on a record drawing that meets the general standards of the construction drawing, is understandable by the maintenance provider and is adequate to locate all system components.
- Attach any revised specifications if changes were made from the original drawings and specifications.

II- 3.7.2 MAINTENANCE PLAN

Write a maintenance plan, including:

- A statement of the allowable average flow for any 30 day period (the maximum allowable average flow is 50% of DDF where Table II- 8 or Table II- 9 DDF values (page II-20, II-21) are used).

- Operation manual for the system
- A schedule for maintenance and monitoring including prescribed maintenance tasks
- Contact information and emergency contact information for the AP who filed the system, the installer, a maintenance provider and the electrician
- Information and advice for the system owner.
- Sign off by owner that they have received and understood the requirements of the plan

II- 3.8 Maintenance and monitoring

When maintaining a system:

- Maintain the sewerage system according to the maintenance plan and the standards in this Manual.
- Confirm safe access for ongoing maintenance and monitoring
- Confirm the safety of the sewerage system including, but not limited to, physical, electrical and biological hazards.
- Confirm that the sewerage system is performing as intended.
- Write a brief report on each maintenance activity.
- Report all maintenance to the owner (with owner acknowledgement or “sign off”).
- Report all suspected health hazards to the Health Authority.

II- 4 STANDARDS FOR SELECTING A SYSTEM FOR A SITE

Sewerage systems consist of two components under the SSR: a treatment method and a discharge area (dispersal area). The dispersal system is used to distribute effluent from the treatment method into the discharge area. The dispersal area is distinct from the “treatment method”, and any additional treatment that is achieved by the dispersal area is not considered in the treatment method classification (Type 1, 2 or 3).

When planning a sewerage system, first consider the simplest design options (example, Type 1 treatment method with gravity seepage bed dispersal system), and increase design complexity only where site conditions necessitate it.

II- 4.1 Dispersal system selection

II- 4.1.1 CONCEPTUAL DESIGN

When selecting a dispersal system, document the selection of the system as follows:

☐ Determine the soil structure and consistence category using Table II- 4. Check soil and site conditions to Table II- 5, Table II- 6 and Table II- 7; and

☐ Check the required vertical separation (VS) and VS options, following Section II- 5.3; and

☐ Check Section II- 6 and Volume III Section III-6 for standards and guidelines for the types of sewerage system proposed.

II- 4.1.2 SITE CAPABILITY AND SYSTEM SELECTION

II- 4.1.2.1 Soil characteristics for the site capability tables:

- The site capability tables (starting on the following page) apply to the soil characteristics of the horizon in which the infiltration surface will be placed, as well as the characteristics of the underlying soil.
- When using the tables below, determine the soil horizon within 30cm below the infiltrative surface that will result in the most conservative system design. Use this soil type with the site capability tables.
- For soil types or conditions identified in the tables as restrictive or limiting layers, consider all soil horizons when establishing the restrictive or limiting layer.
- Establish the soil structure and consistence category for each soil horizon being considered, following Table II- 4.

Table II- 4. Soil structure and consistence categories

MOIST CONSISTENCE	LOOSE TO FRIABLE	FIRM	VERY FIRM OR STRONGER
OR CEMENTATION	NON CEMENTED EXTREMELY WEAKLY CEMENTED	VERY WEAKLY CEMENTED	WEAKLY CEMENTED OR STRONGER
OR DRY CONSISTENCE	LOOSE TO SLIGHTLY HARD	MODERATELY HARD	HARD OR STRONGER
STRUCTURE			
Single grain (structure-less) soils	F	P	NA
Strong or moderate grade: Granular, Blocky or Prismatic	F	P	NA
Weak grade: Granular, Blocky or Prismatic	P	VP	NA
Weak grade Platy structure (and Sandy Loam or Loam)	P	VP	NA
Weak grade Platy structure, all other soils	VP	VP	NA
Moderate or Strong grade Platy structure	NA	NA	NA
Massive (structure-less) soils	VP	VP	NA
F=Favorable, P=Poor, VP=Very Poor, NA=Not allowed.			

Notes:

- See Volume III for information on Single Grain versus Massive structure-less soils.
- If the category is "NA" then the soil horizon is a restrictive layer, and unsuitable for dispersal, regardless of texture and permeability. The soil horizon may be suitable for an ETA bed or BC zero discharge lagoon.
- Structure and consistence (rupture resistance) descriptions follow USDA methodology.

II- 4.1.2.2 Site capability tables

In the following tables, "NA" means not allowed under the standards of this Manual.

The site capability tables are intended to be used in sequence. Work down through the tables and record each constraint found.

Table II- 5. Situations where gravity distribution systems are allowed or not allowed

SOIL TYPE, SITE CONSTRAINT OR PLANNED TYPE OF SYSTEM	OTHER FACTORS	GRAVITY DISTRIBUTION?
Very or Extremely Gravelly Sand or Coarse Sand		Not Allowed
Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand	And where vertical separation (VS) is at least 150cm in native soil (can include blinding layer)	Allowed
Fine Sand, Loamy Fine Sand, Sandy loam, Loam	And Type 1 effluent HLR, where VS is at least 90cm in native soil (can include blinding layer)	Allowed
	And Type 2 effluent HLR, where VS is at least 120 cm in native soil (can include blinding layer)	Allowed
Silt Loam, Silt	And where VS is at least 120 cm in native soil (can include blinding layer)	Allowed
Clay loam;, sandy clay loam; silty clay loam; Sandy clay, silty clay or clay	And dispersal to an ET bed or ETA bed or to a lagoon	Allowed
	And dispersal to any other than an ET bed or ETA bed or to a lagoon	Not Allowed
○ Kfs > 17,000 mm/day ○ **Or** Perc rate faster than 0.5 min/inch		Not Allowed
○ Kfs > 1,500 ≤ 17,000 mm/day ○ **Or** Perc rate 0.5 min/inch to less than 5 min/inch	And where vertical separation (VS) is at least 150cm in native soil (can include blinding layer)	Allowed
○ Kfs ≤ 1,500 mm/day ○ **Or** Perc rate 5 min/inch or slower	And Type 1 effluent HLR, where VS is at least 90cm in native soil (can include blinding layer)	Allowed
	And Type 2 effluent HLR, where VS is at least 120 cm in native soil (can include blinding layer)	Allowed
○ Kfs < 150 mm/day ○ **Or** Perc rate slower than 60 min/inch	And dispersal to an ET bed or ETA bed or to a lagoon	Allowed
	And dispersal to any other than an ET bed or ETA bed or to a lagoon	Not Allowed

SOIL TYPE, SITE CONSTRAINT OR PLANNED TYPE OF SYSTEM	**OTHER FACTORS**	**GRAVITY DISTRIBUTION?**
The coarse fragment content of the soil is more than 60% (soil particles larger than 2 mm).		Not Allowed
The planned system has sand media below infiltrative surface or Point of Application (see Section II- 6.16.1)	Other than blinding layer	Not Allowed
The planned system is an above grade system		Not Allowed
The planned system uses a blinding layer*	See footnote	Allowed
The land slope is over 15% in the dispersal area	And trickling gravity	Not Allowed
	And dosed to D-box or splitter tee	Not Allowed
	And dosed to sequential trenches or using a pressure manifold	Allowed
The total planned infiltrative surface exceeds 100 m^2	And trickling gravity	Not Allowed
	And Dosed gravity	Allowed

Note: * A blinding layer is a layer of *Clean Coarse Sand* or Mound Sand that is installed between the infiltration surface (bottom of aggregate, base of chamber etc.) and the native soil, and which is up to 10 cm thick.

Table II- 6. Key constraints for systems

SYSTEM TYPE	THIS TYPE OF SYSTEM IS NOT ALLOWABLE IF:
Trench systems	○ The land slope in the dispersal area is more than 45% ○ **Or** more than 25% and the vertical separation is less than 90 cm
Raised systems, sand mounds & at-grade beds	The land slope in the dispersal area is more than 25%
Trickling gravity distribution	The land slope in the dispersal area is more than 15% (except ET beds or ETA beds with sequential distribution)
Dosed gravity, dose to D-Box or splitter tee	The land slope in the dispersal area is more than 15%
Alberta at Grade (AAG) systems	○ Treatment method is Type 1, ○ **Or** The land slope in the dispersal area is more than 15%, ○ **Or** The soil profile has less than 5 cm of undisturbed L-F-H horizon, or equivalent, ○ **Or** The site is not forested.
Type 1 below grade Seepage Beds, Type 1 sand lined beds and Type 1 bottomless sand filters.	○ The soil at the infiltrative surface is Loam, Silt Loam, Silt, Clay Loam, Sandy Clay Loam, Silty Clay Loam, Sandy Clay, Silty Clay or Clay, ○ **Or** the soil at the infiltrative surface is Loamy Sand, Fine Sand, Loamy Fine Sand, Sandy Loam, Fine Sandy Loam with a structure and consistence category of Poor or Very Poor, ○ **Or** The median Kfs is less than 250 mm/day, ○ **Or** The median Perc rate is slower than 40 min/inch
Seepage Beds, sand lined beds and bottomless sand filters	The land slope in the dispersal area is more than 15%
BC zero discharge lagoons	○ The median Kfs is greater than 150 mm/day, ○ **Or** The median perc rate is faster than 60min/inch
	The property is smaller than 1.6 Ha
	The land slope is more than 12%
	There is no annual net positive evaporation
	The VS is less than 90 cm to SHWT or to a soil type or layer with Perc or permeability unsuitable for a lagoon
ETA beds	○ The median Kfs is greater than 150 mm/day, ○ **Or** The median perc rate is faster than 60min/inch
	There is no annual net positive evapotranspiration
	The VS is less than 90 cm to SHWT or to a soil type or layer with Perc or permeability unsuitable for an ETA bed
ET beds	The annual net positive evapotranspiration is less than 600 mm

Table II- 7. Soil constraints summary

SOIL	STRUCTURE AND CONSISTENCE CATEGORY	CONSTRAINING FACTOR	REQUIREMENTS (IN ADDITION TO OTHER STANDARDS)
○ Very or Extremely Gravelly Sand or Coarse Sand ○ **Or** Kfs >17,000 mm/d ○ **Or** Perc rate faster than 0.5 min/inch	F or P	Very high permeability, risk of bypass flow and reduced treatment	Uniform distribution with Timed or micro-dosing[1]
Clay loam; Sandy Clay Loam; Silty Clay Loam*	F or P	Low permeability and risk of bypass flow	Uniform distribution with Timed or micro-dosing[1]
	VP	Restrictive layer[4]	Lagoon, ET bed or ETA bed
○ Kfs 75 to 150 mm/day[2] ○ **Or** Perc rate 60 to 120 min/inch*	Any	Low permeability	○ Uniform distribution with micro-dosing ○ **Or** sand mound with Timed dosing, ○ **Or** Lagoon, ET bed or ETA bed
Sandy Clay, Silty Clay, Clay[2]	F	Low permeability, and risk of bypass flow	○ Uniform distribution with Timed or micro-dosing and Type 2 or 3, ○ **Or** sand mound with Timed dosing, ○ **Or** Lagoon, ET bed or ETA bed
Sandy Clay, Silty Clay or Clay soils[2]	P	Very low permeability and infiltration capacity	○ Uniform distribution with micro-dosing and Type 2 or 3 **and** minimum 30 cm sand media below infiltrative surface ○ **Or** Lagoon, ET bed or ETA bed
Sandy Clay, Silty Clay or Clay soils	VP	Restrictive layer[4]	Lagoon, ET bed or ETA bed
○ Kfs ≤ 75 mm/day ○ **Or** Perc rate 120 min/inch or slower	Any	Restrictive layer[4]	Lagoon, ET bed or ETA bed
Soil with significant amounts of expandable clay minerals[3]		Restrictive layer[4]	Lagoon, ET bed or ETA bed
Organic soils		Limiting layer[4]	ET bed
Soil structure and consistence category shows as "NA"		Restrictive layer[4]	Lagoon, ET bed or ETA bed
High coarse fragment (c.f.) content (in any soil type) (c.f. are soil particles larger than 2 mm)	c.f. > 35%	Reduced soil treatment	Reduce HLR and HAR, see Volume III for calculation.
	c.f. > 60%	Reduced soil treatment, risk of bypass flow	○ Reduce HLR and HAR **and** ○ Uniform distribution **and** ○ Timed or micro-dosing[1]
	c.f. ≥ 90%	Limiting layer[4]	ET bed

Notes:

[1] Use timed or micro-dosing for any fill or raised system, sand mound, or sand lined trench or bed as well as for systems dispersing directly to the native soil in these categories.

[2] Alberta At Grade (AAG) systems are suitable for low permeability soils in these categories if the site and system meet all other requirements of Table II- 6.

[3] See Volume III, Sections III- 4.1.2.2.(d) and III- 3.3.2.4 for guidance on expandable clay soils.

[4] See Glossary for definition of “restrictive” and “limiting” layer.

- Where a sand mound or sand lined trench/bed is used the soil type refers to the basal area (the native soil infiltrative surface area).
- For raised or fill systems (other than sand mounds or sand lined trenches and beds) follow standards for the native soil.
- An ET bed may be used on any soil (or on a site without soil) if climate is suitable.
- See Volume III, Section III- 4.1.2.2.(e) for guidance on soils with prismatic and Section III- 4.1.2.2.(f) for platy structured soils.
- See Volume III, Section III- 4.1.2.2.(b) for guidelines for adjusting HLR and HAR for coarse fragment content. Also see Volume III Section III- 5.2.2.2.(d) for adjustment of micro-dosing frequency.

II- 4.1.3 STEEP SLOPES

Table II- 5 and Table II- 6 indicate constraints to system types due to slope. See Volume III for further guidance on slopes and dispersal systems.

II- 4.1.4 CLIMATE

See Volume III for guidance on planning systems for cold climate and high rainfall sites.

II- 4.1.5 FLOOD PLAINS

Ensure the infiltrative surface of a trench or bed system or the basal area of a sand mound is at least 60 cm above the 1 in 20 year flood level. Place tanks and treatment facilities outside of a previously known or mapped 1 in 20 year flood level. *This restriction does not apply where the land is protected from flooding by dykes.*

Where no part of the lot is available for the dispersal area outside of the flood plain, a system can be constructed or repaired in the 1 in 20 year flood plain. However:

- Ensure any vent or electrical connection is be above the 1 in 20 year flood plain.
- Do not install a sand mound in the flood plain.
- For a BC zero discharge lagoon, ensure that the berm top elevation is a minimum of 30 cm above the 1 in 100 year flood level.

II- 4.1.6 OFF-SITE DISCHARGE

See Volume III, Section III- 2.2.5 for guidelines on locating a dispersal system on another property.

II- 4.2 Treatment method

Sewerage systems consist of two components under the SSR: a treatment method and a discharge area. The treatment method consists of a treatment system which will achieve standards for Type 1, 2 or 3 treatment method, as stipulated in the Sewerage System Regulation. The treatment method is a separate entity from the "discharge area", which also imparts treatment but has the primary function of effluent dispersal.

II- 4.2.1 TYPE 1 (SEPTIC TANK AND EFFLUENT FILTER)

See Section II- 6.4 for septic tank and effluent filter standards.

II- 4.2.2 TYPE 2 AND 3 TREATMENT SYSTEMS

II- 4.2.2.1 Selection of Type 2 or 3 treatment systems

Select an appropriate treatment system that will reliably produce the specified effluent type when operating under site specific conditions. While third party certified treatment systems provide a level of confidence that the system will perform as stated, certification alone provides no assurance of performance under site specific conditions. Consideration of other factors, such as occupancy patterns, sewage characteristics, location and climate are necessary.

See Volume III for guidance. Document how the treatment system was selected.

See Section II- 6.16 for information on combined treatment and dispersal systems (CTDS).

II- 4.2.2.2 Performance monitoring

Ensure any treatment system (including Combined Treatment and Dispersal Systems) is specified with provisions for easy access for monitoring of effluent quality. For accredited (CSA, BNQ, NSF) and non-accredited products, technologies, and components, utilize an appropriate effluent sampling protocol to verify that the required effluent quality will be achieved for the given (site-specific) conditions.

II- 4.2.2.3 Documentation in maintenance plan

Include product details and methods of monitoring and maintenance within the maintenance plan so this information is available to the maintenance provider.

II- 5 STANDARDS FOR PLANNING SYSTEMS

The standards in this section are internally linked and are linked to the system selection standards of Section II- 4 and the specification and installation standards of Section II- 6.

The standards of this Manual are intended for use with typical residential sewage and effluent **only.** (See Volume III, Section III- 5.1.3.1 for typical residential sewage strength and peak flows).

In all cases the standards are minimums; more conservative standards may be used.

Daily Design Flow

Daily Design Flow is the estimated peak daily flow to be discharged. For the purposes of the SPM this is considered to be synonymous with the SSR terms "estimated daily domestic sewage flow" and "daily design domestic sewage flow", and generally represents the maximum flow that the system will discharge.

II- 5.1.1 CONFIRMATION OF SITE USE

Contact the owner to confirm the site (building) use. See Volume III Section III- 5.1.1.1 for guidance on owner declaration. For a residence, confirm the number of bedrooms, floor area and occupancy.

Inform the owner of the DDF and allowable average flow, as well as the standards for sewage quality.

II- 5.1.2 RESIDENTIAL DAILY DESIGN FLOW RATES

Select the Daily Design Flow (DDF) for residences using either:

1. The number of bedrooms (Table II- 8), or
2. The household occupancy (Table II- 9).

These tables and the standards of this manual are for normal residential sewage, with a maximum allowable average flow for any 30 day period of 50% of the DDF.

Table II- 8. Minimum Daily Design Flow (DDF) for Residences

NUMBER OF BEDROOMS	MAXIMUM FLOOR AREA (M^2)	DDF LITRES/DAY
1	140	700
2	240	1,000
3	280	1,300
4	330	1,600
5	420	1,900
6	520	2,200
Additional bedroom, add		300
Additional 1m^2		3

Notes:

- Use the total floor area that is living space.

- If the total occupancy is expected to be higher than calculated from the minimum occupancy per bedroom in Table II- 9, then use Table II- 9 to select DDF for the projected number of occupants.
- For luxury homes use Table II- 9.

Table II- 9. Per capita Daily Design Flow for Residences

USE	PER PERSON FLOW (L/DAY)
Single family dwelling	350
Multi-family (apartment)	300
Luxury homes	700
Seasonal cottage	250
Mobile home	300
NUMBER OF BEDROOMS	**MINIMUM NUMBER OF OCCUPANTS**
1	2
2	3
3	3.75
4	4.5
5	5.5
6	6.5

II- 5.1.3 RESIDENTIAL SEWAGE AND TYPE 1 EFFLUENT CHARACTERISTICS

II- 5.1.3.1 Residential sewage and Type 1 effluent

Volume III, Section III- 5.1.3.1 provides tables of typical residential wastewater characteristics. Refer to that Section to assess whether wastewater strength, or peak flow rate, is representative of “residential sewage” or Type 1 effluent.

II- 5.1.3.2 Garburators

Where garbage grinders or garburators are used, increase the Daily Design Flow by a factor of at least 1.5.

II- 5.1.4 DAILY DESIGN FLOWS FOR NON-RESIDENTIAL BUILDINGS

Volume III provides a table sewage flow rates and strengths for some non-residential uses, for guidance.

Note that the standards of this Manual apply **only** to residential wastewater or wastewater with equivalent strength and flow characteristics.

II- 5.2 Distribution and dosing

II- 5.2.1 TYPES OF DISTRIBUTION AS USED IN THE STANDARDS

This manual refers to the following five methods of distributing effluent to the dispersal area:

- Gravity distribution, either:
  - Trickling gravity, or
  - Dosed gravity
- Uniform distribution, meaning either:
  - Pressure distribution, or
  - Subsurface Drip Dispersal (SDD), or
  - Alternate methods of uniform distribution, provided that they meet the standard defined below.

Select the type of distribution following site capability standards (Section II- 4.1.2) and vertical separation standards (Section II- 5.3), as well as the standards of Section II- 6 for the specific type of dispersal system. The simplest distribution and dosing system which meets site capability should typically be considered first.

This manual refers to the following three **options** for dosing uniform distribution systems:

- Demand dosing following Table II- 10
- Timed dosing; meaning uniform distribution using timed dosing following Table II- 11, or an equivalent level of consistent flow equalization prior to dispersal to the native soil or sand system.
- Micro-dosing; meaning uniform distribution using:
  - Low hydraulic application rate, and
  - Timed dosing, and
  - Meeting the standards of Section II- 5.2.2.3.

II- 5.2.1.1 Alternate uniform distribution system

A system which has been independently tested, following a scientifically defensible protocol, to demonstrate that distribution reliably results in no more than 20% variation in volume applied (per dose or per hour) between any two separate 0.5 square metre areas in the area of infiltrative surface. This uniformity is to be maintained for the life of the system, either by design or by provision for monitoring and adjustment.

II- 5.2.2 DOSING STANDARDS FOR UNIFORM DISTRIBUTION SYSTEMS

II- 5.2.2.1 Selection of dosing method and dose frequency

To select the dosing method option and dose frequency use the following procedure:

- Select the dosing method option following Vertical Separation standards in Section II- 5.3, and the site capability tables in Section II- 4.1.2.
- Select the minimum number of doses per day from Table II- 10 or Table II- 11 or Section II- 5.2.2.3.
- **Effluent type refers to the hydraulic loading rate (HLR) used. If Type 2 effluent is used with a Type 1 HLR, then the Type 1 minimum dosing frequency can be used.**
- See Table II- 7 (page II-17) for soil types where uniform distribution, and timed or micro-dosing, is specified.

As an option, the AP may use the low frequency dosing standards shown in the tables; these options result in a larger minimum vertical separation. Do not use the low frequency dosing options with Subsurface Drip Dispersal or Alberta At Grade systems.

For subsurface drip dispersal systems use timed or micro-dosing only; see Volume III for adjusted minimum timed dosing and micro-dosing frequencies, or calculation of micro-dose frequency.

II- 5.2.2.2 Demand and Timed dosing

If the soil type varies over the depth under consideration, then select dose frequency based on the soil layer closest to the infiltrative surface. If a blinding layer is used over a native soil, select the dose frequency based on the native soil.

Table II- 10. Minimum dosing frequency for demand dosing

SOIL TYPE OR NOTES	MIN. DOSES PER DAY AT DDF			
	Type 1 HLR		Type 2 HLR	
	Normal	Low	Normal	Low
Gravelly Coarse Sand, Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand	8	4	12	6
Clean Coarse Sand and Mound Sand, in sand mound or sand lined trench and bed systems	8	NA	NA	NA
Clean Coarse Sand and Mound Sand used as fill sand, with less than 30 cm depth of sand media fill below infiltrative surface	8	4	12	6
Other soils	8	4	8	4

Note: "Low" refers to low frequency dosing option.

Table II- 11. Minimum dosing frequency for timed dosing

SOIL TYPE OR NOTES	MIN. DOSES PER DAY AT DDF			
	Type 1 HLR		Type 2 HLR	
	Normal	Low	Normal	Low
Gravelly Coarse Sand, Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand, *Clean Coarse Sand*, Mound Sand	12	8	18	NA
Loamy Sand, Fine Sands, Loamy Fine Sands	12	6	18	12
Clean Coarse Sand, Mound Sand in sand mound or sand lined trench/bed.	12	8	Micro-dosing	NA
Other soils	8	6	12	8

Note: "Low" refers to low frequency dosing option.

II- 5.2.2.3 Micro-dosing

Micro-dosing is an optional technique that offers some advantages on some sites. When using this method, the following standards apply.

At the hydraulic loading rates specified in this manual, use the simplified dosing frequencies from Table II-12. These dosing frequencies are based on the soil or sand depth below the infiltrative surface, and on the type of soil or sand.

Alternatively, follow the procedure in Volume III to calculate micro-dosing frequency.

If the soil type varies over the depth under consideration, then select the dosing frequency based on the soil layer closest to the infiltrative surface. If a blinding layer is used over a native soil, select the dose frequency based on the native soil.

Table II- 12. Micro-dosing frequency, with SPM HLR

EFFLUENT TYPE	DOSES PER DAY, TYPE 1 HLR			DOSES PER DAY, TYPE 2 HLR		
SOIL TYPE / SOIL DEPTH	**30 CM**	**45 CM**	**55 CM**	**30 CM**	**45 CM**	**55 CM**
Gravelly Sands	36	24	18	48	34	26
Mound sand	28	18	14	48	30	24
Sands, Loamy Sands, *Clean Coarse Sand*	18	12	8	36	22	18
Loamy Fine Sand, Sandy Loam, Fine Sandy Loam	14	10	10	30	20	20
Very Fine Sandy Loam, Loam, Silt Loam, Silt, Clay Loams, Clays	12	12	12	20	20	20

II- 5.3 Vertical separation (VS)

II- 5.3.1 MINIMUM REQUIRED VERTICAL SEPARATION

The vertical separation is the vertical distance, or height, of unsaturated soil, measured from the sand or soil infiltration surface to the limiting layer. The infiltration surface may be the bottom of an infiltration trench, base of an infiltration bed, designated Point of Application for a CTDS, or a drip dispersal tube.

Select the minimum required vertical separation depending on the type of distribution, type of dosing, type of effluent and type of soil following Section II- 4.1.2 (site capability tables). See Table II- 7 (page II-17) for soil types where uniform distribution and timed or micro-dosing is specified. **Use the site capability tables together with these VS tables when selecting a system.**

Table II- 13. Key to minimum required vertical separation tables

SYSTEM TYPE	TABLE	NOTES
Gravity distribution	Table II- 14	
Uniform distribution with demand dosing, to native soil or to native soil plus less than 30 cm of sand media fill	Table II- 15	If the thickness of sand media is 30 cm or more, follow the sand mound standards, Table II- 17.
Uniform distribution with timed or micro dosing to native soil or to native soil plus less than 30 cm of sand media fill	Table II- 16	
Sand mounds and sand lined trenches/beds	Table II- 17	
Subsurface Drip Dispersal with micro dosing and up to 30 cm fill	Table II- 18	If the thickness of sand media is more than 30 cm, follow the sand mound standards, Table II- 17.

Notes:

- These vertical separation standards apply for sewerage systems that meet the other related standards in Volume II, including the maximum allowable HLRs, and the minimum allowable system contour length.
- Effluent type refers to the hydraulic loading rate (HLR) used. If Type 2 effluent is used with a Type 1 HLR, Type 1 minimum vertical separation can be used.

II- 5.3.1.2 Soil characteristics for the VS tables:

- The minimum vertical separations apply to the soil characteristics of the horizon in which the infiltration surface will be placed, as well as the characteristics of the underlying soil.
- When using the tables below, select the vertical separation (VS) based on the soil horizon within 30cm below the infiltrative surface that will result in the largest (most conservative) VS.

II- 5.3.2 VERTICAL SEPARATION FOR DISPERSAL SYSTEMS

Each vertical separation table provides standards for different soil types and permeabilities, with higher permeability soils at the top of the table, working down to less permeable soils.

To select the minimum vertical separation (VS) options from the tables II-14 to II-17:

- Check the site capability tables for any requirements for the soil type, permeability or system type.
- Work down the left hand column until a soil type or permeability matches the chosen soil.

- Select vertical separation options for that soil type or permeability from each table.
- Choose the design vertical separation and distribution and dosing methods considering the options available.

Table II- 14. For gravity distribution systems

SOIL TYPE	EFFLUENT TYPE (HLR)	MINIMUM VERTICAL SEPARATION (VS) IN NATIVE SOIL
○ Gravelly Sand or Coarse Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand ○ **Or** Kfs from 1,500 to 17,000 mm/day ○ **Or** Perc rate 0.5 to less than 5 min/inch	All types (1, 2 or 3)	150 cm
Fine Sand, Loamy Fine Sand, Sandy Loam, Loam	1 or 3	90 cm
	2	120 cm
Silt Loam, Silt	All types	120 cm

Notes:

- Gravity distribution systems may use up to 10cm of Mound Sand or *Clean Coarse Sand* fill as a blinding layer; this may be considered as part of the required vertical separation.
- With gravity distribution, do not use a blinding layer to raise the infiltrative surface above the natural ground surface.
- Do not use sand media fill below a gravity dispersal system, unless it is a blinding layer 10 cm or less in thickness.

Table II- 15. For uniform distribution with demand dosing to native soil or native soil plus less than 30 cm sand fill

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
○ Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand ○ **Or** Kfs from 1,500 to 17,000 mm/day ○ **Or** Perc rate from 0.5 to less than 5 min/inch	Demand dosing	1 or 3	60 cm	60 cm
		2	60 cm	85 cm
	Low frequency demand dosing	1 or 3	75 cm	75 cm
		2	90 cm	90 cm
Other soils	Demand dosing	All types	60 cm	60 cm
	Low frequency demand dosing	All types	70 cm	70 cm

Table II- 16. For uniform distribution with timed or micro-dosing to native soil or native soil plus less than 30 cm sand fill

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
○ Very or Extremely Gravelly Sand or Coarse Sand ○ **Or** Kfs greater than 17,000 mm/day ○ **Or** Perc rate faster than 0.5 min/inch	Timed dosing	All types	60 cm	85 cm
	Micro-dosing	All types	45 cm	75 cm
○ Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand ○ **Or** Kfs from 1,500 to 17,000 mm/day ○ **Or** Perc rate from 0.5 to less than 5 min/inch	Timed dosing	1 or 3	45 cm	60 cm
		2	45 cm	75 cm
	Low frequency Timed dosing	1 or 3	60 cm	75 cm
		2	70 cm	85 cm
	Micro-dosing	All types	45 cm	55 cm
Other soils	Timed dosing	All types	45 cm	60 cm
	Low frequency timed dosing	All types	70 cm	70 cm
	Micro-dosing	All types	45 cm	55 cm

Notes to Table II- 15 and Table II- 16:

- Confirm that the vertical separation, as planned, meets both the minimum depth of native soil specified (in column 4) **and** the minimum required total depth of soil plus sand (as constructed VS, column 5).
- The minimum required as-constructed vertical separation (column 5) may be in native soil only, or native soil plus sand media fill.
- Uniform distribution systems may use up to 10cm of Mound Sand or *Clean Coarse Sand* media fill as a blinding layer. This may be considered as part of the required native soil vertical separation.
- For planning a raised system **or** a system where more than 10 cm sand media thickness is used, any sand fill used is **not** considered part of the native soil vertical separation.
- If the sand media fill is 30 cm or thicker, then follow the sand mound standards, Table II- 17.

Table II- 17. For sand mounds and sand lined trenches and beds

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM SAND MEDIA THICKNESS	MINIMUM AS CONSTRUCTED VS
All soil types	Demand dosing	1	25 cm	60 cm	85 cm
	Timed dosing	1	25 cm	45 cm	75 cm
	Low frequency Timed dosing	1	25 cm	60 cm	85 cm
	Micro-dosing	1 or 3	25 cm	30 cm	60 cm
		2	25 cm	45 cm	75 cm

Note: Confirm that the vertical separation, as planned, meets the minimum depth of native soil specified (in column 4) **and** the minimum depth of sand (sand media thickness, column 5) **and** the minimum required total depth of soil plus sand (as constructed VS, column 6).

Table II- 18. For Subsurface Drip Dispersal (SDD) systems with micro-dosing

SOIL TYPE	INSTALLED IN	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
○ Very or Extremely Gravelly Sand or Coarse Sand ○ **Or** Kfs greater than 17,000 mm/day ○ **Or** Perc rate faster than 0.5 min/inch	Native soil	All types	60 cm	
	Fill material	All types	45 cm	60 cm
Other soils	Native soil	All types	45 cm	
	Fill material	All types	30 cm	60 cm

Note:

- If the SDD system does not dose frequently enough to be defined as micro-dosing, then select the vertical separation using Table II- 16.
- If sand media fill layer is thicker than 30 cm, follow the sand mound standards in Table II- 17.

II- 5.3.3 VERTICAL SEPARATION FOR BC ZERO DISCHARGE LAGOONS AND ETA BEDS

For a lagoon or ETA bed, plan the system to provide at least the following vertical separation distance:

- 90 cm to the seasonal high water table (SHWT).
- 90 cm to a soil layer of type or permeability that is unsuitable for a lagoon or ETA bed (see Table II- 6).

II- 5.4 Horizontal separation

The horizontal separation is the minimum horizontal distance from the edge of the infiltrative surface to the boundary.

Depending on the type of system, the infiltrative surface edge is defined as follows:

- The wall of an infiltration trench.
- For Seepage Beds, sand mounds, and subsurface drip dispersal systems, the edge of an infiltration bed.
- For an Alberta At Grade system, the edge of the required basal area.
- For a CTDS, the edge of the required basal area.
- For a lagoon, the edge of the maximum water level (the inside top of the berm).

II- 5.4.1 MINIMUM HORIZONTAL SEPARATION

Select the horizontal separation using either Table II- 19 or Table II- 20.

For horizontal separation to reduce risk of damage or encroachment see Volume III, Table III- 16 (page III-72).

Table II- 19. Minimum required horizontal separation distances

MINIMUM HORIZONTAL DISTANCE TO	FROM DISPERSAL SYSTEM	FROM WATERTIGHT TREATMENT OR PUMP TANK
	METRES	METRES
Water sources and wells		
Surface source of drinking water	30	15
Domestic water supply well[1]	30	30
Domestic water supply well, high pumping rate[2]	60	30
Domestic water supply well, high pumping rate, in unconfined aquifer[2]	90	30
Irrigation well or open loop geothermal well	15	7.5
Deep monitoring well or closed loop geothermal well[3]	6	6
Shallow monitoring well[4]	3	0
Drinking water lines and cisterns		
Drinking water suction line	30	15
Drinking water suction line, sleeved[5]	7.5	3
Drinking water line, under pressure	3	3
Drinking water line, under pressure, sleeved[5]	1	1
Drinking water supply cistern, below ground	15	3
Water bodies and surface breakout		
Permanent fresh water body[6]	30	10
Intermittent fresh water body[7]	15	10
Marine water body[8]	15	7.5
Break-out point or downslope drain[9]	7.5	0

Notes:

[1] For drinking water well, see the SSR s3.1 and Section II- 2.1.2.2 of this Manual for special considerations. Domestic water supply wells include excavated or dug wells.

[2] For definitions of "high pumping rate well" and "unconfined aquifer" see the glossary.

[3] The horizontal separation to a deep monitoring well or to a closed loop geothermal well is based on a well with an annular seal that complies with the Ground Water Protection Regulation (GWPR). If the well does not comply with the GWPR, follow horizontal separation standards for drinking water wells.

[4] The horizontal separation to a shallow monitoring well is based on a well which is shallower than 4.6 m and constructed with an annular seal that complies with the GWPR.

[5] Sleeved water lines (suction or pressure) use continuous pipe sleeving within the normal standard HS to allow reduced HS, see Volume III for details.

[6, 7, 8] For separation to a water body, measure the separation distance to:

- the mean high tide for marine water.
- the high water mark for fresh water.

[7] See glossary. A watertight culvert is not a water body. See Section III- 5.4.1 for guidance on ditches.

[9] Downslope drains include building perimeter drains. If the drain in question will discharge directly to a water body, then use the relevant separation distance for the water body. A drain is not considered to be a breakout point if there is an impermeable barrier between the drain and the dispersal area. See Section II- 6.19.

Adherence to the horizontal separation distances for water supply sources does not imply that the water sources are potable.

For adjacent domestic water supply wells, particularly for wells situated in unconfined aquifers, care should be taken to place the dispersal area as far away as practical from the well.

Table II- 20. Minimum required horizontal separation for BC Zero discharge lagoons

MINIMUM HORIZONTAL DISTANCE TO	FROM LAGOON
	METRES
Wells	
Surface source of drinking water	30
Domestic water supply well[1]	30
Domestic water supply well, high pumping rate[2]	60
Domestic water supply well, high pumping rate, in unconfined aquifer[2]	90
Irrigation well or open loop geothermal well	15
Deep monitoring well or closed loop geothermal well[3]	6
Shallow monitoring well[4]	3
Drinking water lines and cisterns	
Drinking water suction line	30
Drinking water suction line, sleeved	15
Drinking water lines, under pressure	7.5
Drinking water lines, under pressure, sleeved[5]	7.5
Drinking water supply cistern, below ground	30
Water bodies and surface breakout	
Permanent fresh water body[6]	30
Intermittent fresh water body[7]	15
Marine water body[8]	30
Break-out point or downslope drain[9]	15
Other	
Building, dwelling	60
Building, other than dwelling	15
Property line	15

Notes from Table II- 19 also apply to this table.

II- 5.5 Hydraulic Loading Rate (HLR)

The hydraulic loading rate is a measure of the volume of effluent (litres) applied each day, per unit area of infiltrative surface (AIS).

In this Manual, the maximum allowable hydraulic loading rate is based on maintaining the permeability of the infiltrative surface and treating the effluent within the unsaturated sand and soil.

To select a hydraulic loading rate for the soil under the dispersal system, use the following method:

1. Select the soil structure and consistence category based on the soil evaluation using Table II- 21.
2. Select a soil HLR based on the soil texture and the consistence category using Table II- 22.
3. Select a soil HLR based on the soil permeability or percolation rate using Table II- 23.
4. Use the lower of the two HLR values from steps 2 and 3, above, as the maximum allowable soil HLR
    a. Adjust the HLR according to the site capability tables, see Section II- 4.1.2.
    b. If the HLR value from Table II- 22 or Table II- 23 is “Not Allowed”, the soil is considered unsuitable, regardless of the value obtained from the other table.
5. Use the selected HLR to calculate the minimum allowable Area of Infiltrative Surface (AIS) for the dispersal system, using the following formula.

$$\textbf{Minimum Area of Infiltrative Surface (AIS) needed } (m^2) = \textbf{DDF (L/day)} \div \textbf{HLR } (L/day/m^2)$$

Evapotranspiration (ET), Evapotranspiration Absorption (ETA) beds and BC zero discharge lagoons do not use the HLRs in this section. See Sections II- 6.17 & II- 6.18.

II- 5.5.1 SOIL CHARACTERISTICS FOR THE HLR TABLES:

- The allowable HLR applies to the soil characteristics of the horizon in which the infiltration surface will be placed, as well as the characteristics of the underlying soil.
- When using the tables below, select the HLR based on the soil horizon located within 30cm below the infiltrative surface that has the most limiting soil characteristics.
- The HLR tables divide soils into texture groups. See Volume III, Table III- 1 (page III-12) to determine which soil texture group a particular soil texture class falls into.

Table II- 21. Soil structure and consistence categories

MOIST CONSISTENCE	LOOSE TO FRIABLE	FIRM	VERY FIRM OR STRONGER
OR CEMENTATION	NON CEMENTED EXTREMELY WEAKLY CEMENTED	VERY WEAKLY CEMENTED	WEAKLY CEMENTED OR STRONGER
OR DRY CONSISTENCE	LOOSE TO SLIGHTLY HARD	MODERATELY HARD	HARD OR STRONGER
STRUCTURE			
Single grain (structure-less) soils	F	P	NA
Strong or moderate grade: Granular, Blocky or Prismatic	F	P	NA
Weak grade: Granular, Blocky or Prismatic	P	VP	NA
Weak grade Platy structure (and Sandy Loam or Loam)	P	VP	NA
Weak grade Platy structure, all other soils	VP	VP	NA
Moderate or Strong grade Platy structure	NA	NA	NA
Massive (structure-less) soils	VP	VP	NA
F=Favorable, P=Poor, VP=Very Poor, NA=Not allowed.			

Note: If the category is "Not allowed", an ET bed, an ETA bed or a BC zero discharge lagoon may be used, if appropriate to the site and climate.

II- 5.5.2 HYDRAULIC LOADING RATE TABLES

If building sewage quality is typical of residential sewage (see Section III- 5.1.3.1), and the Daily Design Flow complies with this Manual; then use the following tables to select the maximum allowable soil hydraulic loading rate.

If the expected building sewage quality is not typical of residential sewage, or if the Daily Design Flow does not comply with this Manual, then the hydraulic loading rates in these tables **do not apply**.

If the HLR table shows "NA" (not allowed) an ET bed, an ETA bed or a BC zero discharge lagoon may be used, if appropriate to the site and climate.

II- 5.5.2.1 Hydraulic Loading rates for Subsurface Drip Dispersal

For Subsurface Drip Dispersal, select the maximum allowable HLR from Table II- 22 and Table II- 23 (or, for sand mounds, sand lined trenches or beds, from Section II- 5.5.3) and then reduce the table value by multiplying by:

- A factor of 0.5 for Type 1 effluent.
- A factor of 0.7 for Type 2 or 3 effluent.

Alternately, use the HLR recommended by the manufacturer. Confirm that the HLR is suited to the climate and soils, and to the DDF standards of this Manual.

Table II- 22. Maximum allowable HLR based on soil type

SOIL TEXTURE GROUP	STRUCTURE AND CONSISTENCE CATEGORY	TYPE 1 (L/DAY/M^2)	TYPE 2 (L/DAY/M^2)	TYPE 3 (L/DAY/M^2)
Very or Extremely Gravelly Sands	F or P	45	65	150
Gravelly Sands and Coarse Sand	F	40	65	130
	P	35	65	120
Sand, Loamy Sand	F	30	60	90
	P	27	50	80
Fine Sands, Loamy Fine Sands, Sandy Loams	F	27	50	80
	P	23	45	70
	VP	17	40	50
Loam, Silt Loam, Silt	F	23	40	70
	P	15	30	50
	VP	12	25	35
Clay Loam, Sandy Clay Loam, Silty Clay Loam	F	15	25	40
	P	12	15	20
	VP	NA	NA	NA
Sandy Clay, Silty Clay, Clay	F	12	15	20
	P	NA	15	15
	VP	NA	NA	NA

Note: See Section II- 4.1.2 for adjustments for coarse fragment content and for special soil and system selection considerations.

Table II- 23. Maximum allowable HLR based on permeability or percolation rate

KFS RANGE (MM/DAY)	PERCOLATION TEST RANGE (MIN/INCH)	TYPE 1 (L/DAY/M^2)	TYPE 2 (L/DAY/M^2)	TYPE 3 (L/DAY/M^2)
> 8000	< 1.0	45	65	150
4000 – 8000	1 – 2	45	65	130
2000 – 4000	2 – 4	35	65	100
1000 - 2000	4 – 7.5	30	60	90
550 – 1,000	7.5 – 15	27	50	80
300 - 550	15 – 30	23	40	70
150 – 300	30 – 60	15	25	40
75 – 150	60 – 120	12	15	20
< 75	> 120	NA		

II- 5.5.3 HYDRAULIC LOADING RATES FOR SAND MOUNDS AND SAND LINED TRENCHES OR BEDS

Sand mounds, sand lined trenches and beds use two hydraulic loading rates, one for the sand media to size the distribution bed and one for the native soil, to size the basal area.

II- 5.5.3.1.(a) Basal area (native soil area under the sand media)

- If Type 1 or Type 2 effluent is applied to the sand media infiltrative surface, select the maximum allowable basal (soil) HLR from Table II- 22 and Table II- 23 (above), based on Type 2 effluent at the soil surface.
- If Type 3 effluent is applied to the sand media infiltrative surface, then select the maximum allowable basal (soil) HLR from Table II- 22 and Table II- 23, based on Type 3 effluent at the soil surface.

II- 5.5.3.1.(b) Sand media

Select HLR for sand media from Table II- 24. See Table II- 25 for sand media specification.

Table II- 24. Maximum allowable sand Media Hydraulic Loading Rates

SAND MEDIA TYPE	EFFLUENT TYPE		
	TYPE 1 (L/DAY/M^2)	TYPE 2* (L/DAY/M^2)	TYPE 3* (L/DAY/M^2)
Clean Coarse Sand	30	50	90
Mound Sand	40	65	120
Sand filter coarse sand**	50	90	150

Notes:

- *If using Type 2 or 3 sand media HLR, use micro-dosing.
- **If using sand filter coarse sand, then use micro-dosing.

Table II- 25. Sand media specifications

SIEVE SIZE	PERCENT PASSING THE LISTED SIEVE SIZE			
	CLEAN COARSE SAND	MOUND SAND	SAND FILTER COARSE SAND	ASTM C33 SPECIFICATION*
9.5 mm (3/8 ")	100	100	100	100
4.75 mm (No. 4 sieve)	95 to 100	95 to 100	95 to 100	95 to 100
2.36 mm (No. 8)	80 to 100	80 to 100	80 to 100	80 to 100
1.18 mm (No. 16)	50 to 85	50 to 85	45 to 85	50 to 85
600 µm (No. 30)	25 to 60	25 to 60	15 to 60	25 to 60
300 µm (No. 50)	10 to 30	10 to 30	3 to 15	10 to 30
150 µm (No. 100)	< 7	< 4	< 2	< 10
75 µm (No. 200)	< 3	< 1	< 1	not specified
Effective particle size (D_{10})	not specified	> 0.25 mm	> 0.3 mm	not specified
Coefficient of Uniformity(D_{60}/D_{10})	not specified	not specified	< 3	not specified

Note: * C33 sand specification included for comparison **only**, do not use C33 specification sand for sand mounds, sand lined trenches or beds, or as a blinding layer, unless the sand also meets *clean coarse sand* or mound sand specification.

II- 5.6 Minimum system contour length and Linear Loading Rate

II- 5.6.1 SYSTEM CONTOUR LENGTH

In all cases, long narrow dispersal systems are preferred. System contour length is the total system length.

II- 5.6.2 MINIMUM SYSTEM CONTOUR LENGTH

Select the minimum required system contour length, which is the system length measured along the contour of the land, following Table II- 26. *Evapotranspiration, ETA beds and BC zero discharge lagoons do not use the system contour length and LLR tables standards in this section. See Sections II- 6.17 & II- 6.18.*

Table II- 26. Minimum required contour length for dispersal system

SYSTEM AND SOIL TYPE	AND THE SOIL DEPTH BELOW THE INFILTRATIVE SURFACE IS	SYSTEM CONTOUR LENGTH
For a DDF of 2400 L/day or less and soil with Kfs > 150 mm/day or Perc rate faster than 60 min/inch	More than 150 cm	Use **7.5 m minimum** or use LLR tables
For a DDF more than 2400 L/day or soil with Kfs < 150 mm/day or Perc rate slower than 60 min/inch		Use the LLR tables
For an at-grade bed, Alberta At Grade system, sand mound, or any raised system.		Use the LLR tables

Note: The measurement of soil depth below the infiltrative surface in this table applies to both the dispersal area **and** the receiving area. The **receiving area** is the area extending to 7.5m downslope from the infiltration surface. On a dispersal site with a slope of less than 2%, the receiving area extends to 7.5m in all directions from the infiltration surface. See Volume III for guidance on selection of soil depth.

II- 5.6.3 SELECTING AND USING LINEAR LOADING RATE (LLR)

The linear loading rate (LLR) is a measure of the volume of effluent (litres) applied each day, per unit length of the overall system on contour. To select a maximum allowable LLR and calculate the minimum allowable system contour length, follow these steps:

1. Determine the soil structure and consistence category using Table II- 21. Select the LLR based on the soil horizon(s) in which water will flow from the dispersal area. See Volume III for guidance on selecting the appropriate soil horizon for use with the LLR tables.
2. Select a LLR, based on the soil texture and the consistence category using Table II- 27.
3. Select a LLR, based on the soil permeability or percolation rate using Table II- 28.
4. Use the lower of the two LLR values from steps 2 and 3, above, as the maximum allowable LLR.
5. Use this maximum LLR to calculate the minimum system contour length, using the following formula:

Minimum system contour length (m) = DDF (L/day) ÷ LLR (L/day/m)

6. Adjust the effective length of the planned system for any concave contour (following Section II- 5.6.4).

If either LLR table shows "NA" then select another dispersal location. Alternately an ET bed, an ETA bed or a BC zero discharge lagoon may be used, if appropriate.

Table II- 27. LLR based on soil type (L/day/m)

SOIL TEXTURE GROUP	**CATEGORY**	**SLOPE 0 TO < 5%**				**SLOPE 5 TO < 10%**				**SLOPE 10% TO < 15%**				**SLOPE ≥ 15%**			
		SOIL DEPTH BELOW INFILTRATIVE SURFACE (CM)				**SOIL DEPTH BELOW INFILTRATIVE SURFACE (CM)**				**SOIL DEPTH BELOW INFILTRATIVE SURFACE (CM)**				**SOIL DEPTH BELOW INFILTRATIVE SURFACE (CM)**			
		25 – 45	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**
Very or Extremely Gravelly Sands	F or P	150	260	340	400	290	400	400	400	400	400	400	400	400	400	400	400
Gravelly Sands and Coarse Sand	F	85	140	180	250	150	250	330	400	260	400	400	400	360	400	400	400
	P	50	80	110	140	80	140	180	250	140	240	310	400	200	330	400	400
Sand, Loamy Sand	F	45	60	70	90	55	85	110	150	90	140	180	240	120	190	240	340
	P	45	55	70	70	50	60	75	90	60	90	110	140	80	120	150	200
Fine Sands, Loamy Fine Sands, Sandy Loams	F	45	55	70	70	50	60	75	75	60	75	90	100	75	90	110	130
	P	40	45	55	55	45	50	55	60	50	55	60	65	60	65	75	80
	VP	25	30	35	35	25	35	40	40	30	35	40	40	35	45	50	50
Loam, Silt Loam, Silt	F	40	45	55	55	45	50	55	60	50	55	60	65	60	65	75	80
	P	30	35	40	40	35	40	45	45	35	45	50	55	45	50	60	65
	VP	17	22	26	26	19	24	28	28	21	25	30	30	25	30	35	35
Clay Loam, Sandy Clay Loam, Silty Clay Loam	F	30	35	40	40	35	40	45	45	35	45	50	55	45	50	60	65
	P	25	30	35	35	25	35	40	40	30	35	40	40	35	45	50	50
	VP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sandy Clay, Silty Clay, Clay	F	25	30	35	35	25	35	40	40	30	35	40	40	35	45	50	50
	P	17	22	26	26	19	24	28	28	21	25	30	30	25	30	35	35
	VP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table II- 28. LLR based on permeability or percolation rate (L/day/m)

KFS (MM/DAY)	PERCOLATION RATE (MIN/INCH)	SLOPE 0 TO < 5%				SLOPE 5 TO < 10%				SLOPE 10% TO < 15%				SLOPE ≥ 15%			
		(CM) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(CM) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(CM) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(CM) SOIL DEPTH BELOW INFILTRATIVE SURFACE			
		25 – 45	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**	**25 – 45**	**45 – 60**	**60 – 90**	**≥ 90**
> 17,000	< 0.5	150	260	340	400	290	400	400	400	400	400	400	400	400	400	400	400
8000-17000	0.5 – 1.0	85	140	180	250	150	250	330	400	260	400	400	400	360	400	400	400
4000 – 8000	1 – 2	50	80	110	140	80	140	180	250	140	240	310	400	200	330	400	400
2000 – 4000	2 – 4	45	55	70	90	55	85	110	150	90	140	180	240	120	190	240	340
1000 - 2000	4 – 7.5	45	55	70	70	50	60	75	90	60	90	110	140	80	120	150	200
550 – 1,000	7.5 – 15	45	55	70	70	50	60	75	75	60	75	90	100	75	90	110	130
300 - 550	15 – 30	40	45	55	55	45	50	55	60	50	55	60	65	60	65	75	80
150 – 300	30 – 60	30	35	40	40	35	40	45	45	35	45	50	55	45	50	60	65
75 – 150	60 – 120	25	30	35	35	25	35	40	40	30	35	40	40	35	45	50	50
< 75	> 120	NA															

II- 5.6.4 SLOPES WITH CONCAVE CONTOUR

When planning a dispersal system for land with concave elevation contours, calculate the effective contour length as the bowstring length of the system or bed; that is, a straight line between the two ends of the system or bed.

II- 5.6.5 MINIMUM SYSTEM CONTOUR LENGTH FOR AT GRADE AND RAISED SYSTEMS

The following standard applies for all at-grade or above grade systems; that is, systems where the infiltrative surface (or, for CTDS systems, the Point of Application) is at or above grade. For these systems, the system contour length for calculating the linear loading rate is equal to the length on contour of the dispersal system. Ensure that this length meets or exceeds the minimum contour length standards of Section II- 5.6.2.

For a single bed or CTDS system this is the length on contour of the bed, or CTDS bed or the base of the CTDS treatment unit. For a trench or multiple bed system, the contour length is the system length on contour.

For calculating the contour length of the system, there is no allowance for lateral spreading of effluent along the contour within the sand media placed under the dispersal cell. Consider the example of a sand mound: the system contour length for linear loading rate calculation is the length of the dispersal bed.

The total outside length of the dispersal system will be longer than this contour length, because of the need for cover soil and side slopes.

II- 5.6.6 MINIMUM CONTOUR LENGTH FOR BELOW GRADE SYSTEMS USING SAND MEDIA

For sand lined trenches or beds and for any system using sand media below the infiltrative surface or Point of Application (for CTDS), the contour length of the system is measured as for at grade and raised systems. That is, there is no allowance for lateral spreading of effluent along the contour within the sand media.

II- 6 SPECIFICATION AND INSTALLATION STANDARDS

Tables in this section have the following general format:

Component or item to be considered	Action or standard specification to meet standards

II- 6.1 Flow monitoring

Ensure all dosed systems are provided with a reliable method of measuring effluent flow to the dispersal area. At minimum, provide a method to calculate average daily flow.

II- 6.2 Access provisions for maintenance and monitoring

Specify and install systems to provide maintenance providers with safe access to all system components that need routine maintenance. See Volume III for guidance on safety.

II- 6.3 Connections, piping and collection systems

II- 6.3.1 SEWERS

II- 6.3.1.1 Gravity sewers

Table II- 29. Gravity sewers from building to first tank

Grade for 4" (100 mm) sewer	Minimum grade of 1% (⅛ inch per foot)
Grade for 3" (75 mm) sewer	Minimum grade of 2% (¼ inch per foot)
Restriction to direction changes between cleanouts	o No more than 5° every 3 m, or o Use fittings with a cumulative change in direction of not more than 45°

Table II- 30. Cleanouts for gravity sewers

SIZE OF DRAINAGE PIPE (INCHES)	MINIMUM SIZE OF CLEANOUT (INCHES)	MAXIMUM SPACING OF CLEANOUTS (METRES)
3 and 4	3	15
> 4	4	20

Notes:

- Cleanouts to be in the direction of flow.
- Bring cleanouts to grade or provide suitable access.

Seal all collection components and piping to prevent infiltration of groundwater as well as leaks to the environment.

See Volume III for guidance on alternative collection systems.

II- 6.3.1.2 Pumped discharge to the septic tank

Table II- 31. Pumped discharge of sewage to the septic tank

Grinder or macerator pumps	o Increase the septic tank capacity by a factor of 2 o If only part of the sewage flow is pumped, increase that proportion of the tank size by multiplying by a factor of 2.
Dose volume from pump, and surge flow to the septic tank or treatment system	o Ensure peak flow to the tank will be less than the peak flows defined for normal residential sewage (Volume III, Section III- 5.1.3.1), or specify flow equalization. o When selecting a treatment system, ensure that the manufacturer has rated it capable of treating the expected peak flow.
Alarms and pump chamber	Provide alarms and pump control following pump chamber standards Section II- 6.12 and tank following standards of Section II- 6.4
Tank venting	Specify vents to receiving tanks and intermediate pump tanks, following Table II- 34 (page II-45).

II- 6.3.2 SPECIFICATION AND INSTALLATION

See Volume III for specification and installation guidelines.

II- 6.4 Tanks, septic tanks and effluent filters, treatment systems

For standards specific to Combined Treatment and Dispersal Systems (CTDS) see Section II- 6.16.

Table II- 32. Septic tanks and effluent filters

Effluent filter mesh	Filter particles greater than or equal to 3.2 mm (1/8"). For pumped discharge from a septic tank, provide a screen with a minimum wetted open area of 0.25 m^2.
Effluent filter intake (center of clear zone).	Center the filter intake at 60 – 70% of the working volume depth of the tank, measured from tank floor.
Effluent filter alarm	Provide a filter alarm on all systems where sewage is pumped into the septic tank. Specify an alarm that meets the dosing system standards in Section II-6.12
Effluent filter minimum capacity	Specify a filter that needs be cleaned once every two years, or less often.
Pumped discharge from septic tank	For systems that pump effluent from a septic tank, specify: o A filtered (screened) vault with the inlet at the center of the clear zone. o A maximum pumping rate of 190 L/min. o A maximum drawdown of 10% of the tank working volume. o An alarm reserve volume of at least 50% of the DDF, measured to the tank lid base (without backup into building). Alternately, a second or third compartment of a septic tank may be used as a pump chamber, provided that compartment is not counted as part of the septic tank working volume.
Tank specification	Specify the following: o Inlet and outlet baffles or tees. o For tanks with 2 compartments, use tanks with 3/4 to 1/2 of the total working volume in the first compartment. o Tanks with no air space may be used as an alternate to the CSA B66 air space standard, provided the tank is vented.
Septic tank working volume, for a DDF of up to 9100 L/day	Specify a tank with working volume at least 3 times the DDF.
Septic tank working volume, for a DDF over 9100 L/day	Specify a tank with a working volume of at least 15,000 L + (DDF in litres × 1.34), or as otherwise determined by the design professional.

Note: The effluent filter may be at the tank outlet, in a separate filter chamber or as a screened vault for the pump or siphon. A secondary filter may also be used after the pump (in the discharge line).

Table II- 33. Tanks and tank access

Pre-manufactured tanks	○ Ensure all tanks are structurally sound and watertight. ○ Check that tanks meet CSA B66 structural and watertight standards.
Access risers	○ Provide a riser for access to each chamber or compartment, and for each baffle, tee or effluent filter. ○ Provide primary opening(s) of at least 50 cm internal diameter, or 60 cm when over a divider or if needed to access a pump etc. ○ Extend each riser to finished grade, and seal with a child resistant lid.
Access, effluent filter, pump and float attachments.	Provide access via riser, with any handle, attachment or union or disconnect within 15 cm of the top of the riser.

Note: For treatment plants in enclosures, specify an enclosure which is safe and protects health during the life of the system.

Table II- 34. Tank installation

Tank bedding and backfilling	○ Follow the tank manufacturer's standards, including maximum depth of burial. ○ Ensure any bedding layer below the tank is compacted before installing the tank.
Tank inlet and outlet piping	Support pipes so they do not settle.
Access	Extend access risers to finished grade; slope the ground away from the riser lid; insulate the riser in cold climates
Watertight testing	○ Test all tanks using water, to verify a rate of leakage less than 0.1% of volume per day. Alternately use vacuum testing. ○ Test the tank, penetrations and the lid seal.
Infiltration	Seal all penetrations through the walls of tanks and risers.
Risk of tank floating	For tanks installed with the tank base below the seasonal high water table, drain the tank area, or if this is not practical specify effective measures to prevent the tank from floating when empty.
Tank venting	○ Vent all tanks, either via the building sewer or separately. ○ Use vent pipes with a minimum inside cross section area equal to that of the tank inlet pipe, or a minimum of 7800 mm^2, whichever is greater. ○ For treatment plants, follow manufacturer standards for venting. ○ Ensure venting does not create an odour nuisance or explosion hazard. ○ Protect vents from animal or insect access using corrosion resistant screens. ○ Provide access to vent screens and outlets for maintenance.

II- 6.5 Dispersal systems, general

II- 6.5.1 SIZING

Calculate sizing following Section II- 5.5 and Section II- 5.6 plus any system specific considerations.

II- 6.5.2 SPECIFICATION AND INSTALLATION

II- 6.5.2.1 Aggregate and other materials

Table II- 35. Aggregate, separation and cover soil layer

Coarse aggregate, specify and install:	o Aggregate that will not biodegrade or break down over time, concrete rubble is not an acceptable aggregate. o Aggregate that will not shrink or swell. o If using stone or glass aggregate, specify a hardness >3 on the Standard Measurement of Hardness (MOH's) scale of hardness. o Aggregate with less than 1% by weight passing the #200 (75µm) sieve, and without silt or clay coating (normally, washed and screened).
Separation layer (between aggregate and cover soil) options	o Lightweight non-woven geotextile. o Untreated building paper. o Graded aggregate and sand filter layers.
Cover soil	o For trench or Seepage Bed systems use permeable native soil or Loamy Sand, Loamy Fine Sand or Sandy Loam. o For at-grade beds, sand mounds and sand lined trenches or beds use Loamy Sand, Loamy Fine Sand or Sandy Loam. o Crown and grade the cover soil to shed water. o Provide a soil depth of 10 cm to 30 cm, after settling (15 to 40 cm before settling). o If providing soil cover deeper than 30 cm, use *Clean Coarse Sand* or Mound Sand to add depth prior to placing the cover soil. o See Volume III Section III- 6.5.2.1.(d) for depth of cover guidance.
Blinding layer	o See the glossary, Section I- 1.1. o Use sand that meets *Clean Coarse Sand* or Mound Sand standards of Table II- 25 (page II-37)
Permeable fill for toe blankets or between raised trenches	o Use fill that is as permeable as, or more permeable than, the adjacent native soil. o See Volume III, Section III- 6.8.4 for information on toe blankets.

Notes:

- The table above applies for trenches, beds, at-grade beds and sand mound and sand lined trenches and bed systems.
- For aggregate sizing and depths; see individual sections of this Volume (trench, bed etc.).
- See Volume III for guidance on trench maximum cover depth.

II- 6.5.2.2 Site, Soil and Ecosystem Considerations

Do not construct systems when the soil moisture content is high enough that the construction will damage soil structure or consistence. Do not construct a system on or in cohesive soils with water content above the plastic limit. Before construction, assess the soil moisture at the soil surface, or at the infiltrative surface level, and also at 200 mm below the infiltrative surface.

During and after installation, protect the soils in the dispersal area and in the receiving area from damage to soil structure and consistence. Provide physical barriers that will protect the dispersal and receiving areas from vehicle traffic.

II- 6.5.2.3 Gravelless infiltration systems

Table II- 36. Gravelless systems

The effective width for calculating area of infiltrative surface (AIS) is defined as:	o For pipe systems, use the outside dimensions of pipe or pipe bundles. o For geocomposite systems, use the outside dimensions of the bundles. o For infiltration chambers, use the outside dimension of base of the chamber.
General specifications	o Use systems with a load bearing capacity of at least AASHTO H-10. o Install the system following manufacturer's instructions, where these are consistent with this Manual.
Void ratio or side wall open area	Use only systems with a void ratio, or a side wall open area, equal to at least 35% of the bottom infiltrative area (maintained for the life of the system).
Separation layer	Avoid using a geotextile, or other separation layer, unless recommended by the manufacturer.
Backfill	o Follow manufacturer recommendations. o Use soil that is as permeable, or more permeable than, the native soil. o Use soil that complies with Table II- 35 (page II-46). o See Volume III Section III- 6.5.2.1.(d) for depth of cover guidance.
Observation ports	Install one observation port on each lateral, following manufacturer recommendations for installation.
Blinding layer	o Use a blinding layer for Loam and finer soils with pressure distribution. o Use a blinding layer where the soil is prone to crust capping (sealing). o Specify a blinding layer that complies with Table II- 35 (page II-46)

Note: Gravelless systems may be used in place of coarse aggregate for trench systems, Seepage Beds, sand mounds and sand lined trenches and beds.

II- 6.5.2.4 Observation ports

See Volume III for guidance on observation ports.

II- 6.5.2.5 Venting

Dispersal system chambers, gravity distribution piping and distribution boxes (D – Boxes or drop boxes) can be vented.

If using vents, ensure vents extend at least 30 cm above grade (or higher if average snow depth will be greater than 30 cm). Specify a vent opening that faces downward and has a stainless steel insect screen. Vents may be plugged in winter in extreme cold climate conditions.

II- 6.6 Trench infiltration systems

II- 6.6.1 DESCRIPTION

See Volume III for description of trench infiltration systems.

II- 6.6.2 SIZING

- Size trench systems so that the horizontal basal area **only** (**not** including the sidewall area) is at least equal to the Area of Infiltrative surface (AIS) (AIS = DDF ÷ HLR)
- Trench infiltrative bottom area needed = AIS
- Total length of trenches = AIS ÷ the trench width

II- 6.6.3 SPECIFICATION AND INSTALLATION

Table II- 37. Trench dispersal systems, general

Trench width	o 30 cm to 90 cm (12 to 36 in.) o On slopes greater than 15%, use specify a trench width of 30 to 60 cm.
Lateral length, gravity distribution	Limit laterals to 15 m (50 ft.) or less
Level and alignment	o Install trenches on level, or sloping in the direction of flow at no greater than 5 cm in 30 m (0.2%). o Install along the contour of the land
Trench spacing (measured horizontally)	o Space trenches a minimum 1.8 m from centre line to centre line (c/c). o On slopes greater than 15%, space trenches at least 3 m c/c. o Provide at least 0.9m between adjacent trench edges.
Trench base	o Scarify the trench base. o Scarify any smeared sidewalls. o Do not over excavate and backfill (except for a blinding layer). o Do not compact the soil.
Blinding layer	o Use a blinding layer if the soil has large pores or cracks. o Comply with specifications of Table II- 35 (page II-46)
Aggregate (if used)	o Use aggregate in the size range of 12 mm – 63 mm (½"– 2 ½"); o Comply with specifications of Table II- 35 (page II-46).
Aggregate depth	Install aggregate to at least 15 cm (6 in.) depth below the distribution pipe and at least 5 cm (2 in.) above the pipe.
Cover soil	o Install to at least 15 cm depth. o Comply with specifications of Table II- 35 for trench systems. o *See Table II- 35 (page II-46) for cover depth.*
Observation ports	o Install at least two infiltrative surface observation ports per drainfield. o Use 100 mm (4") or larger diameter pipe. o Place observation ports 10 – 15 cm from the distribution pipe, and near the midpoint of the lateral.

II- 6.7 Seepage Bed systems

II- 6.7.1 DESCRIPTION

Seepage Beds are similar to trench systems, but are more than 90 cm in width.

II- 6.7.2 SIZING

Follow trench system sizing standards, Section II- 6.6.2.

II- 6.7.3 SPECIFICATION AND INSTALLATION

Table II- 38. Seepage Bed dispersal systems

General	o Limit the bed width to a maximum of 3.0 m (10 ft.). o Avoid slopes steeper than 15%.
Level	o Install the bed level from side to side ± 1.25 cm, and o Level, or sloping in the direction of flow at no greater than 5 cm in 30 m (less than 0.2% slope).
Bed spacing	o Provide at least 2.0 m between edges of adjacent beds o For above grade beds, provide at least 1.8 m between edges of cover soil.
Distribution laterals, spacing to edge of bed	Minimum distance from pipe to outer edge of bed: 30 cm (12 in.)
Observation ports	Provide at least 2 observation ports using 100 mm (4") or larger diameter pipe, located 10 - 15 cm from the outermost lateral pipes.
Cover soil	o Install to at least 15 cm depth. o Comply with specifications of Table II- 35 (page II-46) for Seepage Beds. *See Table II- 35 (page II-46) for cover depth.*
Other specifications	Follow Trench systems standards. Section II- 6.6.3.

II- 6.8 Shallow, at grade and raised systems

II- 6.8.1 DESCRIPTION

Trenches or Seepage Beds may be installed at a shallow depth below surface (with cover over and fill around) or at grade and may be installed above grade if using a uniform distribution method.

If the thickness of sand media fill is 30 cm or more depth, follow sand mound standards.

Standards of this section do not apply to “at-grade beds” (Section II- 6.13) and “Alberta At Grade systems” (Section II- 6.14) which are specific techniques in which a system is installed directly on native grade.

II- 6.8.2 SIZING

- Determine the minimum bed length based on minimum system contour length following Table II- 26 (page II-38)
  - When using LLR table values calculate the length as = DDF ÷ LLR. Use LLR values for the native soil, not the sand. Adjust the contour length for a concave contour if applicable.
- Use the HLR for native soil or the sand media (**whichever is lower**) to size the system. (AIS = DDF ÷ HLR)
- For at grade or raised systems the effective area of infiltrative surface area (AIS) is the area directly below the trench aggregate (i.e. there is no allowance for lateral spreading of effluent in the sand media).

II- 6.8.3 SPECIFICATION AND INSTALLATION

Table II- 39. Shallow, at grade, raised trench and Seepage Bed systems

Cover soil	Refer to Table II- 52 (page II-64). Cover soil placed between trenches may be placed over *Clean Coarse Sand* or other fill material of similarly permeability.
Cover soil width	Extend a minimum of 60 cm horizontally beyond the sides of the infiltrative surface and at maximum 2h: 1v slope.
Infiltrative surface level for at or above grade trenches or beds	○ Level to ± 1.25 cm (± 0.5 in.). ○ Not necessary for subsurface drip dispersal systems.
Fill media below infiltrative surface	Use media meeting standards of Table II- 25 for *Clean Coarse Sand* or Mound Sand.
Fill installed between cells and toe blanket fill	○ Comply with specifications of Table II- 35 (page II-46) for permeable fill. ○ See Volume III Section III- 6.8.4 for guidance on toe blankets.
Surface water diversion	○ Prevent run-on from upslope (swale or other method). ○ Cover soil is to slope away from cell.
Other specifications	Follow Trench and bed systems standards. Sections II- 6.6.3 & II- 6.7.3

II- 6.8.4 TOE BLANKETS

See Volume III Section III- 6.8.4 for guidance on toe blankets

II- 6.9 Gravity distribution

II- 6.9.1 DESCRIPTION

In gravity distribution systems effluent is distributed in non-pressurized pipe laterals, or allowed to discharge directly into a chamber or other gravelless system.

II- 6.9.2 SIZING

II- 6.9.3 SPECIFICATION AND INSTALLATION

Table II- 40. Gravity system piping

Lateral pipe size and termination	o Minimum 75 mm (3") nominal diameter. o Capped at end, or with cleanout or looped to adjacent lateral if level.
Use perforated pipe that:	o Has perforations of minimum 12.5 mm (1/2"), maximum 25 mm (1") diameter and minimum 125 mm (5"), maximum 250 mm (10") separation between perforations. o Has two rows of perforations, facing at 4 and 8 O'clock (60 degree separation). Or use pipe that meets CSAB182.1-M92 or CGSB 41-GP-31
Lateral pipe slope	Install pipe level, or with a positive slope in the direction of flow not exceeding 5 cm in 30 m (0.2%).
Lateral pipes from flow splitter to dispersal trench or bed	Use solid walled pipe installed with a minimum 1% slope.
Gravelless systems	Follow the manufacturer's recommendations for pipe specification and installation.
Seepage Bed below CTDS	For a seepage bed below a Combined Treatment and Dispersal System, there is no requirement for additional pipes.

Table II- 41. Trickling gravity systems

To split the flow specify either:	o Distribution Box with flow adjusting devices (e.g. speed levellers), or o Tipping Distribution Box, or o Splitter tee(s)
Installation of flow splitters	o Install Distribution Box or splitter tee level on a compacted soil or gravel base. o Use Distribution Boxes that are watertight and resistant to corrosion. o Provide access for maintenance using a riser or valve box extended to finished grade.
Lateral length variation	Specify gravity distribution laterals of approximately equal length (± 10%).
Setup of flow splitters	When commissioning the system, adjust the flow splitters to provide even division of flow.

Table II- 42. Dosed Gravity systems

To split the flow specify either:	o Dose to a distribution box (D – Box) (see restrictions in Table II- 5 (page II-14)), or o Dose to a Splitter tee (see restrictions in Table II- 5), or o Pressure manifold, or o Dose to Sequential trenches
Reduction of flow velocity for dosing flows	Provide a system to reduce the effluent flow velocity entering D – Boxes or drop boxes, to prevent short circuiting.
Installation of flow splitters	Provide maintenance access to all flow splitters, including pressure manifold orifices.
Lateral length variation	Specify gravity distribution laterals of approximately equal length (± 10%), except for pressure manifold systems.
Setup of flow splitters	When commissioning the system, adjust the flow splitters to provide even division of the flow.
Dosing method	Specify a pump or other device, with control and tank sizing complying with Section II- 6.12
Dose frequency	Specify at least one dose per day, based on DDF.
Dose volume	Plan for the volume of each dose to be equal to at least 67% of the draining volume of the dispersal and distribution piping.
Pipe	As for trickling gravity systems.

II- 6.10 Pressure distribution

II- 6.10.1 DESCRIPTION

In pressure distribution systems effluent is distributed in pressurized pipe laterals.

II- 6.10.2 SIZING

Undertake and document full hydraulic calculations for the system.

II- 6.10.3 SPECIFICATION AND INSTALLATION

Table II- 43. Pressure distribution systems

Variation in Orifice discharge	Plan and adjust the system for a maximum variation of 15% across the network, and a maximum of 10% along any single lateral.
Residual pressure (squirt)	Plan and adjust for a minimum 60 cm (24") of residual pressure, when using 4.8 mm ($^3/_{16}$") and larger orifices. Plan for a minimum residual pressure of 150 cm (60") if using orifices smaller than 4.8 mm.
Dosing frequency	Plan and adjust to provide a dosing frequency (doses per day) that complies with Section II- 5.2.2.
Distribution uniformity	Meet minimum standards for uniform distribution, per Section II- 5.2.1.
Infiltrative surface per orifice	Specify a maximum of 0.56 m^2 (6 ft^2) of infiltration surface area per orifice.
Orifice size	Use a minimum orifice diameter of 3.2 mm (1/8").
Orifice shields	Provide for orifice shields on all orifices, except for upward-facing orifices inside of infiltration chambers or inside other gravelless systems that act as orifice shields.
Lateral pipes	o Install laterals level, or with a positive slope in the direction of flow not exceeding 5 cm in 30 m. o For laterals that drain back into the manifold, and have all orifices facing up, the laterals may slope toward the manifold at a grade of 2% or less. o Provide access for testing and maintenance using cleanouts constructed with 45 degree elbows or sweeps.
Sloping sites	Specify layout to avoid drain down to lower laterals.

II- 6.11 Subsurface Drip Dispersal

II- 6.11.1 DESCRIPTION

Subsurface Drip Dispersal (SDD) systems use timed dosing of filtered effluent to pressurized small diameter tubing laterals with drip emitters (dripline).

II- 6.11.2 SIZING

- Select HLR following the standards of Section II- 5.5.2.1
- Determine the minimum area of infiltrative surface (AIS) for the dispersal bed (AIS = DDF ÷ HLR)
- Determine the minimum dripline length, based on 0.6 m effective width for the dripline,
  - Dripline length (m) = AIS (m^2) ÷ 0.6 m
- Determine the minimum number of emitters, based on 0.6 m emitter spacing (= dripline length (m) ÷ 0.6 m)
- Adjust the line and emitter spacing, where appropriate, but **do not** reduce the AIS
  - Line spacing may **only** be decreased to less than 0.6m **if** additional line is used (i.e. do not reduce the AIS).

Undertake and document full hydraulic calculations for the system, including all phases of operation (pressurizing, dosing, flushing and (if used) drain back). See Volume III for guidelines

II- 6.11.3 SPECIFICATION AND INSTALLATION

Table II- 44. Subsurface drip dispersal

Type 1 emitters	o For Type 1 effluent, increase the number of emitters to 4 times the minimum number calculated. o Specify a maximum emitter flow rate of 2.5 L/hour (0.66 USgal/hour).
Raised systems	o For dispersal systems raised above grade, follow either (1) the sand mound standards in Section II- 6.15, or (2) the raised system standards in Section II- 6.8. o The dripline "bed" does not need to be level.
Fill sand for raised systems	For SDD to raised systems specify fill sand to either: o Meet Table II- 25 (page II-37), or o Meet manufacturer recommendations. If using manufacturer recommended fill sand, use the manufacturer recommended HLR for that sand, see Section II- 5.5.2.1.
Dripline and emitters	Use driplines specifically designed for wastewater use, with a purple stripe or purple colour, and designed to prevent root intrusion.
Dripline installation depth or cover	Install driplines for a finished cover thickness of 15 to 30 cm over the driplines.
Dripline minimum pressure at flush manifold	To meet manufacturer specifications during dosing, and, for continuous flush systems, during flushing.
Air valves in the dispersal system	Specify and install according to manufacturer recommendations.

Table II- 45. Subsurface drip dispersal, filtration, dosing and flushing

Fine filter	o Use a maximum aperture size recommended by the manufacturer. o For screen filters, use a maximum pressure differential of 2 psi (14 kPa) at peak flow. o For disc filters, use a maximum pressure differential of 7 psi (50 kPa) at peak flow. o If a filter requires manual cleaning, then specify a filter that is large enough to allow for at least 12 months between cleaning.
Dosing	o Specify timed dosing or micro-dosing following Section II- 5.2.2 o See Section II- 6.12for dosing systems. o See Volume III Section III- 5.2.2.3 for dosing frequency tables.
Distribution uniformity	Meet minimum standards for uniform distribution, per Section II- 5.2.1
Flushing	Provide for automatic intermittent flushing or continuous flushing.
Dripline minimum flushing velocity	o 0.15 m/sec (0.5 ft./sec) for dripline with antimicrobial lining o 0.6 m/sec (2 ft./sec) for other dripline o Is to be maintained for all lines during flushing for all systems
System flush return	o Ensure flush return will not cause scouring or disturbance in the tank if returned to a septic tank. o For continuous flush systems that return the flushed water to a septic tank or treatment plant, increase the tank or plant capacity to accommodate the additional flow into the tank. o Any flow adjustment is to be contamination resistant and readily cleaned (a standard ball valve is not suitable).
Intermittent flushing	o Use a contamination resistant control valve. o For Type 1 systems, flush at least once per day at DDF.

Notes: Follow manufacturer recommendations only where consistent with SPM standards.

II- 6.12 Dosing systems

II- 6.12.1 DESCRIPTION

Dosing systems provide doses of effluent to gravity or pressure distribution systems or subsurface drip dispersal systems using pumps or other devices.

II- 6.12.2 SIZING

For dosing of distribution laterals, use a pump, siphon, floating outlet device or any other method that adequately pressurizes or doses the system.

II- 6.12.3 SPECIFICATION AND INSTALLATION

Specify tanks and access provisions according to Section II- 6.4 standards.

Table II- 46. Pump chambers (tanks)

Pump disconnect	o Install a pump disconnect fitting so that the maintenance provider can remove the pump. o Install a rope (>1 cm diameter), cable or chain to remove the pump.
Float switch or level sensor	To attach the float switch or level sensor, install a bracket, float tree, or other independent support.
Access	Install the fittings, rope, and bracket (above) so that that a maintenance provider can reach them within 15 cm of the top of the riser.
Pump and float wiring connections	o Connect all wiring according to the BC Electrical Code. o Seal all openings where cables enter the riser. o Provide an adequate length of cable to allow removing the float switches and pump without disconnecting the wiring.
Alarm	o Install a system to trigger an alarm when the fluid level reaches a specified height. o Use an alarm that is visible (usually a flashing light) and audible over a distance of at least 30 metres. o Connect the alarm to a different electrical circuit from the pump.
Timed dose systems, override (lag) event	o Specify the override event so that dosing does not exceed DDF unless the override event is triggered with or after the alarm. o Specify the override event as a timed dose event (not as demand dosing).
Timed dose systems, equalization volume	Install the dosing pump controls so that the equalization volume is at least 67% of the Daily Design Flow, for DDF less than 9100 L/day.
Alarm reserve	For demand dosing and timed dosing, plan for the tank holding volume, above the high level alarm, to be at least 50% of the Daily Design Flow volume.

Note: The alarm reserve volume may include surcharge volume in treatment tanks, if the tanks are suitably vented. The “alarm reserve” is the holding volume of the tank, or connected tanks, that is above the high level alarm and is below the point at which the sewage would back up to the building sewer, or overflow.

Table II- 47. Siphons and floating outlet devices

Cycle counter	Use a float switch, or other method, to count the number of cycles (and to help detect trickling failure).
Overflow and alarm reserve (above alarm)	If an overflow is specified to the discharge line, then the alarm reserve may be set at 25% of DDF. Otherwise, set the alarm reserve for at least 50% of DDF.
Alarm*	o Specify an alarm triggered by a level sensor or a float switch. o Use an alarm that is visible (usually a flashing light) and audible over a distance of at least 30 metres. o Alarm to be on prior to overflow of the dosing chamber.
Installation	Follow manufacturer recommendations.

Notes:

- *For residences without a reliable power supply, the dosing system can be installed without an alarm, if using a gravity collection system, and provided that the owner is informed of the risk of backup and is prepared to respond appropriately.
- The alarm reserve volume may include surcharge volume in treatment tanks, if the tanks are suitably vented. The "alarm reserve" is the holding volume of the tank, or connected tanks, that is above the high level alarm and is below the point at which the sewage would back up to the building sewer, or overflow.

II- 6.13 At-grade beds

II- 6.13.1 DESCRIPTION

An at-grade bed is an aggregate bed placed on prepared topsoil of a site, into which effluent is distributed by pressure.

II- 6.13.2 SIZING

- Determine the minimum system contour length (Length = DDF ÷ LLR). Adjust the length if the bed is to be installed on a concave contour. Select a bed length that exceeds this minimum length and fits the site.
- Determine minimum required area of infiltrative surface (AIS) for the bed (AIS = DDF ÷ HLR)
- Calculate the minimum effective bed width needed, (AIS ÷ selected length), adjust the bed length to keep the bed width 3 m or less
- For a low slope or flat site (≤2% slope), the minimum total bed width needed is = effective bed width
- For a sloping site, the minimum total bed width = effective width + 60 cm
- Calculate the overall minimum system width = bed width + 3m
- Calculate the overall minimum system contour length = bed length + 3 m

II- 6.13.3 SPECIFICATION AND INSTALLATION

Table II- 48. At-grade beds

Effective bed width	Not to exceed 3.0 m (10 ft.)
Bed spacing	Install only one long bed.
Distribution	o Pressure distribution only. o Specify at least one orifice per 60 cm (24 in.) of a lateral.
Distribution laterals, flat site	o With one lateral, locate at bed centerline. o If there is more than one lateral, space evenly in bed. o Lateral spacing 60 cm (24 in.) maximum. o Minimum spacing 30 cm (12 in.) from lateral to bed edges.
Distribution laterals, sloping site	o Lateral or first lateral placed at 60 cm (24 in.) from upper edge of bed o Lateral spacing 60 cm (24 in.) maximum. o Do not place lateral pipes in the down slope half of bed effective width.
Aggregate	o Pea gravel (3–12 mm, ⅛ – ½" stone), washed and with <1% by weight passing the #200 (75µm) sieve and meeting the standards of Table II- 35 (page II-46). o Alternatively, use aggregate meeting the standards of Table II- 35 (page II-46).
Aggregate depth	Provide at least the following depths of aggregate: o 15 cm (6 in.) (at bed edges). o 23 cm (9 in.) below the lateral pipes. o 5 cm (2 in.) above the lateral pipes.
Aggregate installation	Follow installation procedure for sand mound media, but do not scarify aggregate into soil. If blinding layer is used, this can be scarified into soil.
Cover soil	o Install cover soil to a depth of 15 to 30 cm, soil to meet standards of Table II- 35 (page II-46) for at-grade beds. o Around the perimeter of the pea gravel bed, install cover soil extending horizontally at least 150 cm (60 in.) from the edge of the bed. o Install and grade side slopes according to sand mound standards.
Observation ports	o Minimum two along the downslope edge of the bed (10 – 15 cm from the distribution pipe). o For flat sites, install at opposite edges of the bed at same spacing.

Note: This technique does not apply for gravelless systems or CTDS.

II- 6.14 Alberta At Grade system (AAG)

II- 6.14.1 DESCRIPTION

An "Alberta At Grade system" is a gravel-less chamber system placed on and undisturbed native topsoil L-F-H horizon, into which Type 2 or Type 3 effluent is distributed by pressure. Note that Alberta At Grade systems are restricted to certain sites and soil type, see Table II- 6 (page II-16).

II- 6.14.2 SIZING

- Determine the minimum system contour length (Length = DDF ÷ LLR). Adjust the length if the bed is to be installed on a concave contour. Select a bed length that exceeds this minimum length and fits the site.
- Determine the minimum required area of infiltrative surface (AIS) for the chambers only, using:
  AIS = DDF (L/day) ÷ 35 (L/day/m^2)
- Select a soil HLR for the native soil that underlies the L-F-H (organic) soil horizon.
- Determine minimum required basal area (effective native soil AIS) for the entire Alberta At Grade system using this soil HLR, (AIS = DDF ÷ HLR):
  - Calculate the distance that the cover material needs to extend downslope, to provide the full effective basal AIS calculated in the step above.
  - For slopes of 1% or less, consider cover material in all directions from the chambers as part of the effective basal (native soil) AIS.

II- 6.14.3 SPECIFICATION AND INSTALLATION

Table II- 49. Alberta At Grade systems

Effluent type	Type 2 or type 3 only
Maximum allowable HLR to base of chambers	35 L/day/m^2
Infiltrative surface	This system is only to be used where surface has at least 5 cm thick L-F-H horizon (or equivalent loose organic material layer) prior to installation.
Chamber bed width	Not to exceed 3.0 m.
Chamber level	o Install chambers with the long axis level to within 2%, end to end, and in any 3 m long segment. o Also, install chambers level within 10 cm for any 60 cm long segment.
Bed spacing	Install only one long bed.
Distribution	o Distribute by pressure with enough orifices to provide a maximum infiltration area inside the chamber of 0.56 m^2 (6 ft^2) per orifice. o Provide at least one orifice per 60 cm linear of chamber.
Dosing	Use timed dosing or micro-dosing, according to Table II- 43 (page II-53).
Observation ports	Provide two infiltrative surface observation ports per chamber lateral.

Table II- 50. Alberta At Grade systems, cover and installation

Cover material	o Wood chips (not cedar). o A mixture of wood chips with up to 50% Loamy Sand or Loamy Fine Sand soil. o May add up to 15 cm cover soil over wood chips and seed the cover soil.
Cover material dimensions	Cover the system to the following minimum dimensions: o 30 cm minimum height above chamber, maintained after settling o A minimum of 60 cm measured horizontally from the edge of the chamber to the edge of the cover chips. o Cover the entire native soil infiltration surface and side slopes o Finish side slopes at a maximum slope of 3h:1v, or up to 2h:1v with erosion control matting.
Protection during installation	o Do not disturb the L-F-H horizon in the chamber bed or basal area prior to or during installation. o Avoid machine travel on the bed, basal or receiving areas.
Traffic protection	Protect the bed and receiving area from heavy machinery at all times.

Note: This technique is only to be used with gravelless chambers, see Table II- 36 (II-47).

II- 6.15 Sand mounds and sand lined trenches and beds

II- 6.15.1 DESCRIPTION

This section applies to sand-based systems where effluent is dispersed to a bed on the sand using either pressure distribution or subsurface drip dispersal with timed dosing (not gravity distribution or CTDS).

Note that Type 1 sand lined beds and Type 1 bottomless sand filters (above grade sand lined beds) are restricted to certain soil types; see Table II- 6 (page II-16.

II- 6.15.2 SIZING

- Select the bed length based on the minimum required system contour length following Table II- 26 (page II-38).
    - If using the LLR table, then the minimum bed length = DDF ÷ LLR. Use LLR values for the native soil, not the sand. Adjust the length for concave ground surface, if necessary.
- Calculate the minimum required area of infiltrative surface (AIS) for the bed using AIS = DDF ÷ the sand media HLR. Select the sand media HLR following II- 5.5.3.
- Select a bed length that matches the site and exceeds the minimum required.
- Calculate the minimum required bed width (AIS ÷ selected system contour length).
- Select the minimum required sand depth from Table II- 17 (page II-28).
- Select the basal HLR for the native soil following Section II- 5.5.3.
- Calculate the minimum required basal area (native soil area of infiltrative surface) (AIS) for the base of the sand mound (AIS = DDF ÷ basal HLR).
- Check that the effective basal area is larger than the minimum required basal area. Adjust the layout as needed to meet requirements.

II- 6.15.2.1 Basal area

Calculate the effective basal (native soil area of infiltrative surface) AIS as follows:

- For a sand mound on a sloping site:
    - The effective basal area is the area directly below the dispersal bed, plus the area below sand media directly downslope from the dispersal bed.
- For a sand mound on a low slope (≤2% slope) or a flat site or for sand lined trenches and beds:
    - The effective basal area is the area directly below the dispersal bed, plus the area below sand media around the perimeter of the dispersal bed within a 3h:1v slope.
- The base of the sand mound is considered part of the effective infiltration area only where the depth of sand exceeds 15 cm, plus cover soil (total minimum depth 25 cm).
- Adjust the basal AIS in proportion to the surface area covered by obstructions.

II- 6.15.3 SPECIFICATION AND INSTALLATION

Table II- 51. Sand Mounds and sand lined trenches or beds

Maximum dispersal bed width	o 3.0 m (10 ft.) for a sand mound or sand lined bed. o 90 cm (36 in.) for a sand lined trench.
Bed level	o Bed level to ± 1.25 cm (± 0.5 in.). o Not necessary for subsurface drip dispersal.
Spacing, minimum	o For trenches, follow the trench spacing standards in Table II- 37 (page II-48). o For sand lined beds, follow the seepage bed standards in Table II- 38 (page II-49). o For sand mounds, provide 2 m spacing between the edges of the cover soil. o Except provide 6 m spacing between the edges of cover soil for mounds on Clay Loam and Clay textured soils.
Aggregate for bed (note that gravelless systems may also be used)	o Use drain rock or pea gravel. o For drain rock, use a nominal gravel size of 19 mm (3/4”) and meeting the standards of Table II- 35 (page II-46). o For pea gravel, use a size range of 3 to 12 mm (⅛ – ½"), washed and with <1% by weight passing the #200 (75µm) sieve, and meeting the standards of Table II- 35 (page II-46).
Aggregate depth (pressure distribution system)	Install aggregate to the following minimum depths: o For pea gravel, provide min. 10 cm (4 in.) under the distribution piping and 2.5 cm (1 in.) over the piping. o For drain rock, provide min. 15 cm (6 in.) under the distribution piping and 5 cm (2 in.) over the piping.
Sand media	Specify and supply sand meeting Table II- 25 (page II-37).
Permeable fill media for sand mound toe, toe blanket or mantle	o Test the sand to confirm a minimum Kfs of 3000 mm/day or a perc rate faster than 3 min/inch after settling. o Install the sand following the same procedure as for Mound Sand o See Volume III for guidance on toe blankets and sand mantle sand mounds.
Observation port, completed to aggregate bed infiltrative surface	Minimum two ports, install at minimum 10 cm from the distribution pipe.
Observation port, completed to the soil infiltrative surface	o Minimum 2, located $^1/_6$ of length of bed from ends of bed, on downslope side of bed (or on opposing sides for flat site), and half way between the bed and the toe of the mound. o Place observation ports at least 30 cm from the nearest orifice.

Table II- 52. Sand mounds and sand lined trenches or beds, cover

Separation and cover soil	Supply cover soil meeting standards of Table II- 35 (page II-46) (Sandy Loam or Loamy Sand).
Cover depth	o Install a minimum 15 cm (6 in.) soil cover over the aggregate bed. o Limit the thickness of cover to a maximum of 45 cm (18 in.). o For any cover thicker than 15 cm (6 in.), make up the additional depth with sand media and top with cover soil.
Cover slope over bed	Install cover to provide at least 15 cm (6 in.) fall from the center of the bed to the outside edges.
Edge of sand mound bed	Provide at least 30 cm (12 in.) from the edge of the gravel bed to the finished surface of the sand mound.
Maximum side slope	Limit the side slopes to no steeper than 2h:1v

Table II- 53. Bottomless sand filters

Edge of liner unit above grade	Extend the liner to at least 15 cm above grade, and slope the ground away from the sand filter.
Liner	o Seal the sand filter walls with an impermeable liner of minimum thickness 0.76 mm (0.030" or 30 mil), fabricated from PVC, HDPE or EPDM, with seams sealed or welded. o Seal all penetrations using a waterproof boot. o Extend the bottom of the liner at least 15 cm (6 in.) into the native soil.
Separation to trees/shrubs	Provide a minimum 3 m separation to the nearest tree or shrub, or use a root barrier fabric.

Table II- 54. Sand mounds and sand lined trenches and beds, dosing and distribution

Type of distribution	o Use only pressure distribution or subsurface drip dispersal (SDD). o Follow pressure distribution or SDD standards, Section II- 6.10 or II- 6.11.
Orifice spacing	Provide enough orifices for at least one orifice for every 0.56 m^2 (6 ft^2) of infiltration bed area.
Orifice or drip emitter separation	Install orifices or emitters at least 30 cm (12 in.) from the outside and end of the infiltration bed.
Type of dosing	Use demand or timed dosing only if sand hydraulic loading rate is less than or equal to the Type 1 HLR in Table II- 24 (page II-37). Otherwise, use micro-dosing.
Demand dosing	Limited to: o Type 1 HLR, and o soils which are not identified in Table II- 7 (page II-17) as needing timed or micro-dosing.
Micro-dosing	If using micro-dosing, then follow Section II- 5.2.2.3. Base the dosing frequency on the depth of sand.

Table II- 55. Sand mounds and sand lined trenches and beds, installation

Moisture content and soil damage	o Check the soil moisture content following Section II- 6.5.2.2 o Do not use wheeled machinery on the soil surface or sand surface.
Clearing land (sand mounds)	o Cut the vegetation close to the ground. o Remove heavy sod. o Remove any deep organic litter layer to expose the underlying mineral soil. o Do not remove large stumps or boulders.
Scarification	o Scarify the soil surface over the entire area where sand fill will be placed. o Scarify to a minimum 15 cm depth, sand may be gently mixed into the native soil. o Do not move machinery over the scarified area until at least 20 cm (8 in.) of sand has been placed and keep a minimum of 15 cm (6 in.) below the tracks at all times. o Used only tracked machinery with a maximum 7 psi (50 kPa) ground pressure.
Installing sand, (including mantle or toe blanket) installation	o Settle the sand. o Do not compact the sand. o Keep sand and aggregate clean before and during placement.

II- 6.16 Combined Treatment and Dispersal Systems (CTDS)

Combined Treatment and Dispersal Systems (CTDS) are systems that provide treatment to Type 2 or 3 standards using media or through other processes in the same cell or unit that disperses effluent to the native soil. These systems discharge effluent at their base (or around an up-flow treatment unit) to native soil, or to sand above native soil.

In some cases a sand layer is used as part of the treatment system.

As with other systems, a sand layer may be used to increase vertical separation where this is allowed by the standards.

For proprietary CTDS systems, follow the manufacturer's guidelines when sizing and specifying the treatment system. See Volume III, Section III- 4.2 for guidance on treatment system selection.

Where the treatment system is installed in an enclosure, ensure the enclosure meets the standards of Section II- 6.4.

Follow the standards of this Manual when sizing and specifying dispersal to native soil or sand media fill plus native soil. As with all dispersal systems, the dispersal component of the CTDS system is to follow the standards of this manual.

II- 6.16.1 POINT OF APPLICATION

The "Point of Application" is the location at which the treatment system meets the effluent quality standards of the SSR for the defined treatment method (Type 2 or Type 3). This is the same point at which monitoring is carried out. Vertical separation is measured from this point.

This "point" will typically be an elevation in the system and will typically be a horizontal plane at that elevation. The AP will specify this point of application, and draw an elevation schematic that shows the point of application and the vertical separation.

For an example and diagram illustrating the Point of Application, see Volume III.

II- 6.16.2 BASAL AREA AND DISPERSAL SIZING

Select the basal (soil) HLR from Table II- 22 and Table II- 23 (page II-36), based on the treatment type (1, 2 or 3) to be claimed at the Point of Application.

Size the soil dispersal system following the standards of this Manual (Section II- 5.5), based on the level of treatment specified at the point of application. Use the standards in Section II- 5.6 to select the minimum required contour length for the dispersal system.

If the CTDS Point of Application is defined as the interface to the native soil, and no coarse aggregate or gravelless bed is installed below the CTDS, then the effective basal area (native soil area of infiltrative surface) is the area directly below the CTDS.

If a coarse aggregate or gravelless bed is installed below the CTDS then the native soil area of infiltrative surface and system contour length is determined as for Seepage Beds.

When sizing the dispersal system:

- Select the soil HLR and calculate the minimum required basal area (AIS) following the same procedure as for Seepage Beds (Section II- 6.7.2) or raised Seepage Beds (Section II- 6.8).
- Bed spacing is to meet Seepage Bed standards.

- Select the infiltration surface width following the same procedure as for Seepage Beds (II- 6.7) or raised Seepage Beds (Section II- 6.8). Limit the effective width of the infiltration surface to 3.0 m or less.

II- 6.16.2.1 Gravity distribution below CTDS

For a CTDS which is placed on a coarse aggregate or gravelless bed (a Seepage Bed), gravity distribution to the bed (beyond the base of the CTDS) does not require perforated pipe in the bed.

In all other respects, follow the Seepage Bed standards in Section II- 6.7. The maximum bed or “trench” length is 15 m as for Seepage Bed or trench gravity laterals, in this case measured from the centerline of the CTDS unit along the bed.

II- 6.16.3 CTDS CONSTRUCTED WITH SAND MEDIA FILL BELOW THE POINT OF APPLICATION

II- 6.16.3.1 Basal area

II- 6.16.3.1.(a) With 30 cm sand layer thickness or greater below the Point of Application and uniform distribution

For a CTDS which results in **uniform distribution at the Point of Application** (meeting the standard of Section II- 5.2.1.1); **if** the CTDS is constructed on sand media fill (meeting Table II- 25 (page II-37)) with a minimum 30 cm thick sand layer below the Point of Application; **then** calculate the effective basal area (native soil AIS) as for sand mounds, following Section II- 6.15.2.1.

This is the same as for application of effluent to the bed of a sand mound. Contour length is calculated as for sand mounds, with no allowance for lateral spread in the sand media.

II- 6.16.3.1.(b) With less than 30 cm sand layer thickness or where distribution does not meet uniform distribution standards

Otherwise (if the distribution to the sand at the Point of Application does not meet uniformity standards or if the sand layer is less than 30 cm thick below the Point of Application) then the effective basal area is determined following the same procedure used for a raised Seepage Bed; see Section II- 6.8. Contour length is calculated as for Seepage Beds or raised Seepage Beds, with no allowance for lateral spread in the sand media.

II- 6.16.3.2 Hydraulic Loading Rates

II- 6.16.3.2.(a) With 30 cm sand layer thickness or greater below the Point of Application and uniform distribution

If the CTDS results in a hydraulic application rate at the Point of Application which meets micro-dosing standards of Section II- 5.2.2.3; **and if** the CTDS is constructed on sand media fill (meeting Table II- 25 (page II-37) with a minimum 30 cm thick sand layer below the Point of Application; **then** use II- 5.5.3 to select allowable HLR to the sand. Select the basal (soil) HLR from Table II- 22 and Table II- 23 (page II-36) based on the effluent quality at the Point of Application.

This is the same as for application of Type 2 or 3 effluent to the bed of a sand mound or sand lined bed.

If the CTDS does not result in a hydraulic application rate at the Point of Application meeting micro-dosing standards, then select the sand HLR using the same procedure as for a raised Seepage Bed **or** alternatively use a Type 1 HLR for the sand from II- 5.5.3 and select the basal (soil) HLR from Table II- 22 and Table II- 23 (page II-36) based on the effluent quality at the Point of Application.

II- 6.16.3.2.(b) With less than 30 cm sand thickness

If the sand fill is less than 30 cm, select HLR using the same procedure as for a raised Seepage Bed in all cases.

II- 6.16.3.3 Up-flow CTDS

For a CTDS that disperses effluent to sand, or some other media, around the perimeter of the treatment system, the effective basal area (effective native soil AIS) is the plane area of sand or media at the Point of Application.

If the up-flow CTDS relies on spread of effluent in additional media to an area beyond 1v:3h below the Point of Application to achieve the required effective basal AIS, then it is necessary to demonstrate uniform distribution, as for CTDS on sand media fill, see Section II- 5.2.1.1 for uniform distribution standard.

II- 6.16.3.4 Sand media specification and installation

- If a CTDS is raised or placed on sand or other media, then level the media at the Point of Application, and keep the CTDS level (similar to a Seepage Bed or sand mound).
- If sand is placed below the Point of Application, then use *Clean Coarse Sand* or Mound Sand that complies with Table II- 25 (page II-37). Alternately, the sand is to be as specified by the manufacturer or by a Professional.
- Prepare the site and place the sand media according to the standards for sand mounds (or sand lined trenches or beds where applicable), see Section II- 6.15.3.

II- 6.16.4 MONITORING

For a system that claims Type 2 or Type 3 effluent quality, specify and install equipment for collecting unbiased effluent samples at the Point of Application, for compliance monitoring.

II- 6.17 Evapotranspiration (ET) and Evapotranspiration Absorption (ETA) beds

II- 6.17.1 DESCRIPTION

The use of ET bed and ETA bed systems is restricted to certain sites and climates. ETA beds are restricted to certain soil types and soil permeability limits; see Table II- 6 (page II-16). ETA beds have specific vertical separation conditions, see Section II- 5.3.3.

II- 6.17.2 SIZING

- Where water budget calculations show that the bed will not pond to a depth greater than 15 cm during parts of the year for more than 21 consecutive days, then follow the Seepage Bed sizing standards (Section II- 6.7).
- For ETA beds, select the basal soil HLR using tables in Section II- 5.5.2 (if the tables provide a HLR value).
    - Where anaerobic conditions will occur in the ETA bed for extended periods, multiply the HLR by a factor of 0.3 (i.e.: Use a soil HLR that is 30% of the value in the table).
    - In cases where the tables of Section II- 5.5.2 do not provide a soil HLR, or where the soil structure and consistence category is “NA” (not allowed), consider the following options for use of ET or ETA beds:
        - Use an ETA bed with a selected basal HLR of zero, or
        - use a lined ET bed.

In all cases, mark out and protect a reserve bed area, of equal size to the constructed bed. Locate the reserve area so that it does not add to flow downslope from the primary bed.

II- 6.17.3 SPECIFICATION AND INSTALLATION

Table II- 56. ET and ETA beds

Reserve area	See requirement above.
Liners for ET beds	o Provide a watertight membrane liner, minimum thickness 0.76 mm (0.030" or 30 mil), fabricated from PVC, HDPE or EPDM. o Use boots to seal any penetrations of the liner. o Do not damage the membrane liner.
Infiltrative surface, for ETA beds	Prepare the infiltrative surface in the same way as for Seepage Beds. Scarify any smeared sidewalls.
Distribution	Gravity distribution (including trickling sequential) may be used for any size of bed and any type of effluent.
Water budget calculations	o Ensure that effluent will not saturate to grade at any time o Document the water budget calculations.
Layout	ET and ETA beds do not need to meet the minimum system contour length or LLR standards.
Sand media	Select the sand to ensure effective capillary rise greater than depth of bed. Consider the need for oxygen transport.
Protection	Provide physical barriers to keep vehicle traffic off the bed. Do not compact snow on the bed.
Observation ports	Minimum of four, nominal 100 mm (4") or larger diameter pipe, at least one in each quarter of the bed, and 10 - 15 cm from outermost laterals.
High level alarm (freeboard) for bed	Set and alarm to trigger when the ponded effluent level rises to within 20 cm of finished grade, in the lowest part of the bed.

II- 6.18 BC Zero Discharge Lagoons

II- 6.18.1 DESCRIPTION

A BC zero discharge lagoon system consists of one or more large excavated lagoon cells surrounded by a berm. BC zero discharge lagoons disperse effluent by infiltration to soil and by evaporation from the lagoon surface.

These systems are restricted to certain soil types, sites and climates, see Table II- 6 (page II-16), and have specific vertical and horizontal separation conditions.

II- 6.18.2 SIZING

For typical residential sewerage systems, size the lagoon following the Table II- 57, or Table II- 58, or Table II-59. Lagoons do not use conventional HLR tables or system contour length standards of the SPM. In all cases:

- The total surface area is calculated from the top inside edge of the berm, not the water surface.
- The lagoon depth is measured from the top of the berm to the inside floor.

The volume is the water volume in the lagoon, when the water level is 0.6 m below the top of the berm (0.6 m of freeboard).

Ensure the lagoon berm has:

- Outside of berm slope of 3h:1v or flatter, seeded with grass.
- A height above original grade of more than 0.9 m and maximum 1.5 m, and minimum top width of 1.2 m.

II- 6.18.2.1 Alternate sizing

- Lagoons may be sized based on retention volume of one to two years average sewage flow depending on the area in which they are installed and a with a minimum surface area meeting the above tables to facilitate evaporation.
- For a larger DDF, increase lagoon size accordingly. If the average flow is anticipated to be greater than 50% DDF, increase size (area and volume).
- Where lagoons are sized to hold less than 2 years average sewage flow, reserve an area next to the installed cell for a second cell large enough to bring the total volume to 1 year DDF.

Table II- 57. Rectangular Lagoon Cell Sizing—Wetter Northern Interior BC

BEDROOMS	ESTIMATED DDF (L/DAY)	VOLUME (CUBIC METRES)	DEPTH (METRES)	BOTTOM INSIDE (METRES)	TOP INSIDE (METRES)	TOTAL SURFACE AREA (SQUARE METRES)
1-2	1000	415	3	14 x 4	26 x 16	416
3	1300	508	3	16 x 5	28 x 17	476
4	1600	661	3	20 x 6	32 x 18	576
5	1900	777	3	22 x 7	34 x 19	646
6	2200	972	3	24 x 9	36 x 21	756

Notes:

- Side slope internal 2h: 1v
- Surface area: Volume ratio is 0.55 to 0.65.

Table II- 58. Rectangular Lagoon Cell Sizing—Drier Northern Interior BC

BEDROOMS	ESTIMATED DDF (L/DAY)	VOLUME (CUBIC METRES)	DEPTH (METRES)	BOTTOM INSIDE (METRES)	TOP INSIDE (METRES)	TOTAL SURFACE AREA (SQUARE METRES)
1 – 2	1000	185	3	6 x 4	15x 13	195
3	1300	255	3	7 x 6	16x 15	240
4	1600	305	3	8 x 7	17x 16	272
5	1900	389	3	10 x 8	19x 17	323
6	2200	445	3	12 x 8	21x 17	357

Notes:

- Limit the berm internal side slope to no steeper than 2h: 1v, except for excavated slopes. For excavated slopes, use a maximum slope of 1:1. The table above is based on a berm inside slope of 1.5h: 1v.
- Surface area: Volume ratio is 0.8 – 1.7.
- Reserve an area large enough to install a second cell of the same size.

Table II- 59. Circular Lagoon Cell Sizing Standards—Northern B.C.

BEDROOMS	ESTIMATED DDF (L/DAY)	VOLUME MAX. WATER LEVEL (CUBIC METRES)	DEPTH (METRES)	TOP INSIDE DIAMETER (METRES)	BOTTOM DIAMETER (METRES)	TOTAL SURFACE AREA (SQUARE METRES)
1 – 2	1000	542	4	22	6	380
3	1300	619	4	23	7	415
4	1600	791	4	25	9	490
5	1900	985	4	27	11	572
6	2200	1,260	4	29.5	13.5	683

Note: Limit the internal berm side slope to 2h: 1v.

II- 6.18.3 SPECIFICATION AND INSTALLATION

Table II- 60. BC zero discharge lagoons, general

Septic tank (optional)	o If planning a system with a septic tank, use a tank with a working volume at least 2 times DDF. o Specify an effluent filter. o Required for pumped discharge systems.
Gravity discharge from a septic tank to the lagoon, small diameter pipe systems	o Select the pipe to achieve a minimum flow velocity of 0.15 m/sec. o Use a pipe size of 50 mm to 100 mm (2″ to 4″). o Cleanouts are not required. o Ensure there is minimum 30 cm elevation drop from the septic tank outlet pipe invert to the top of the berm, at the lowest point of the berm.
Gravity discharge to a lagoon (without a septic tank)	Provide cleanouts per Table II- 29 (page II-42). Install sewer pipes with a minimum grade of 1.5 % for a 3'' pipe, or 1% for a 4" pipe.
Pipe outlet (gravity)	Extend the pipe a minimum of 2 m into the lagoon, and 30 cm above the lagoon bottom.
Pumped discharge	o Dosing, see Section III- 6.12 for specification of pump, tank and controls o There is no specific dose size or frequency requirement. o Fit the force main with a backflow preventer, with unions and a shut off valve for maintenance (unless the force main drains back to the pump tank after each dose). o At the lagoon berm, provide a siphon break in the force main above the berm overflow level; provide access for maintenance inspection.
Fencing	o Install a fence around the full perimeter of the lagoon, with a locking gate. o Post warning signs.

II- 6.19 Site drainage

Table II- 61. Site drainage (interception or relief drains)

Barrier membrane (where used)	o For a barrier membrane on an interceptor drain, use a PVC, HDPE or EPDM membrane of minimum thickness 0.76 mm (0.30″ or 30 mil). o Seal the membrane at the seams o To be installed to avoid damage to the membrane. o Extend the membrane under the drainpipe.
Discharge, if subsurface	Provide an observation port and cleanout at the point of discharge.
Discharge, if to surface	Provide a corrosion-resistant animal guard; and provide access for maintenance.
Observation ports and maintenance access	o Provide at least one observation port extending to the base of drain. o Provide at least one drain cleanout.

II- 7 MAINTENANCE AND MONITORING STANDARDS

II- 7.1 Maintenance and monitoring frequency

As maintenance is critical to the proper functioning of a sewerage system, the homeowner is responsible under the SSR to ensure that the appropriate maintenance and monitoring is carried out for all components of the system. Accordingly, emphasize to the homeowner the importance of regular maintenance by or under the supervision of an AP, following the schedule in the maintenance plan. Effective maintenance becomes increasingly critical as system complexity increases.

Specify the initial schedule of system maintenance in the maintenance plan. Table II- 62 shows minimum intervals for maintenance visits and testing for the first 12 to 14 months of operation. Local government bylaws (where they exist) may also stipulate maintenance intervals.

After that time, consult with the maintenance provider to jointly establish the maintenance and monitoring frequency for the next 5 to 10 years of operation. Then, file an amended maintenance plan with the Health Authority. The minimum long term maintenance frequency is 2 years for systems with Type 2 or 3 treatment systems and 5 years for all other systems.

Table II- 62. Minimum initial frequencies for maintenance and monitoring

SYSTEM OR TREATMENT TYPE	INSPECTION (BY MAINTENANCE PROVIDER)	FLOW	BOD AND TSS	FECAL COLIFORMS	NOTES
Type 1	12 months	12 months			
ET or ETA	6 months	6 months			During the wet season
Type 2	6 months	6 months	6 months		
Type 3	1 month, 7 months, 13 months	1 month, 7 months, 13 months	1 month, 7 months, 13 months	1 month, 7 months, 13 months	
Lagoon	12 months				Flow monitoring for diagnosis only

II- 7.1.2 MAINTENANCE PLAN

See Section II- 3.7.1for maintenance plan requirements.

II- 7.1.3 TREATMENT SYSTEM MONITORING

For Type 2 and 3 systems, plan a safe method to collect effluent samples for laboratory testing. During operation, collect and test samples according to the maintenance plan.

Confirm that each sample complies with the effluent quality standards in the Sewerage System Regulation, and with any additional standards established for that system.

II- 7.2 Maintenance procedures

During maintenance, examine and test components of the sewerage system. Monitoring is part of maintenance. See Volume III for guidance on documentation and on maintenance procedures.

SEWERAGE SYSTEM
STANDARD PRACTICE MANUAL

VOLUME III - GUIDELINES

VERSION 3 SEPTEMBER 2014

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

BRITISH
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TECHNOLOGY
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QUALIFIED. REGISTERED. ACCOUNTABLE.

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III- 1 INTRODUCTION

This volume is intended to be used as a companion to Volume II (standards). It contains explanatory material to support the standards as well as guidelines for planning, installation and maintenance of onsite systems. This volume is not intended to be read without reference to Volume II.

The main headings of this volume correspond to main headings in Volume II (e.g. III-2.1 corresponds to II-2.1). In some cases minor headings in this volume may be stand-alone (e.g. III-4.1.3.1 does not have a corresponding section in Volume II).

This volume contains some simplified rationale statements; refer to Volume IV for further details of rationale and for the performance base used to develop the standards.

Nothing in this volume should be taken to overrule the standards set out in Volume II.

III- 1.1 Departure from Volume III guidelines

When departing from the **guidelines in this volume**, write out a rationale for that departure. In the rationale, explain the following:

- The reasons for departing from the SPM guidelines.
- Which SPM guideline is being varied or departed from.
- Why compliance with the guideline is deemed impractical.
- Reference to another source of standard practice or to a professional opinion that supports the alternative approach.
- Any other changes made to design or installation to compensate for the departure.
- How performance objectives have been considered.

III- 2 GENERAL GUIDELINES

III- 2.1 Existing systems and system repair

III- 2.1.1 EMERGENCY MEASURES

Notify the Health Authority of all situations that may present a health hazard (for example, sewage surfacing on the land or discharging into a body of water or a water supply). This allows the Health Authority to provide guidance on measures to prevent or contain the hazard.

Emergency measures to reduce a health risk could potentially include:

- Placing cover soil over a breakout area; or
- building a temporary dispersal trench or bed to divert flows during repair.

If it is not practical to reduce the risk from a malfunctioning system, then recommend to the owner that they use pump and haul until the system can be repaired.

Inform the owner that the system should be permanently repaired as soon as is feasible, and in any case within 12 months. The Health Authority may issue an order to repair sooner than 12 months, depending on the circumstances.

III- 2.1.2 REPAIR OF AN EXISTING SYSTEM

III- 2.1.2.1 Re-use of system components

In some circumstances, as an alternative to replacing or rebuilding the system, an AP may consider continued re-using some components or portions of the system. When re-using components:

- Obtain original documentation (example permit or filing) for the system, if available.
- Inspect and document the system. Including the following:
  - Assess the vertical separation below the dispersal area.
  - Assess system components, to find if they are operating as intended by the original design.
  - Assess tanks for leakage and treatment components for performance.
  - Assess the dispersal area for soil clogging.
  - Consider the potential lifespan of a component which is re-used.

For older systems, full system replacement, rather than partial replacement or repair, may serve the owner's interests. Inform the homeowner about alternatives for replacement and repair.

A tank with capacity 10% less than that specified by the standards of this Manual may be considered adequate for re use when upgrading the dispersal area, as long as it meets all other standards of this Manual.

III- 2.1.2.2 Sewage Disposal Regulation and permits

When assessing sewerage systems constructed under permit under the Sewage Disposal Regulation (SDR), a copy of the SDR may be obtained from the Health Authority.

Obtain an "authorization to operate" for the system from the owner's records or at the Health Authority. If no authorization can be found, then assess the system based on the standards of this Manual.

III- 2.1.3 SYSTEM UPGRADES

If the system is being upgraded to serve a new or expanded use (with a different Daily Design Flow than the original design) then this is an upgrade, not a repair, and the sewerage system should meet all standards of this Manual.

III- 2.1.4 NEW USE OF EXISTING SYSTEMS

As an option, an existing sewerage system may be considered suitable for re use if:

- The system is less than 15 years old, and
- the system is operating under an authorization to operate issued under the Sewage Disposal Regulation, or the system has a filing and Letter of Certification submitted under the SSR, and
- the system met the standards of the day for the proposed new Daily Design Flow, and
- the system is functioning to current performance standards.

If the system does not meet all four conditions above, then complete an evaluation. This should include site and soil evaluation.

III- 2.1.5 PROPERLY FUNCTIONING DISPERSAL AREA

A properly functioning dispersal area provides:

- Infiltration and dispersal of effluent, without surfacing and without breakout occurring within the defined minimum Horizontal Setback to breakout.
- Treatment of effluent in the soil (or sand media and soil) to meet the performance standards of this manual.

For this reason, when assessing a system it is not adequate to consider only whether the dispersal field is satisfactorily "disposing" of the effluent. For discussion, see Volume IV Section IV- 2.2.2.4.

As testing soil treatment performance is difficult, vertical separation is used as a secondary indicator of adequate soil treatment performance for installed dispersal systems.

When assessing a dispersal system, confirm that the vertical separation meets the standards of this manual.

III- 2.2 Special circumstances

III- 2.2.1 SEASONAL USE

Seasonal use systems should be installed in compliance with the Sewerage System Standard Practice Manual.

Type 2 or Type 3 systems may not be suitable for some seasonal dwellings, such as a vacation cottage, because these treatment systems typically run on electricity, and may rely on biological processes that cannot be sustained under seasonal use. When specifying a treatment system at a seasonal dwelling, provide measures to maintain the operation of the system during periods of intermittent power supply and limited water use.

III- 2.2.1.1 Operation and Maintenance of Systems Serving Seasonal Dwellings

Seasonal dwellings can pose unique challenges for operation and maintenance. Owner's manuals and maintenance plans should include operating instructions, safety precautions, and maintenance procedures for intermittent or seasonal use. Consider the following examples where owner action or inaction could cause risk:

- Lack of use can increase risk of freezing due to lack of warm water discharge and reduced heat generated in the tank from reduced biological activity.
- Freezing can cause backups, pump damage and other problems on start up. The owner may attempt to use or fix the system when it is frozen, and may attempt to thaw the frozen component.
- The water supply may need to be shut off, and certain lines and components may need to be drained.
- Electrical service may need to be disconnected. Treatment hardware such as blowers and re-circulating pumps may need to be shut down and restarted properly, and may need special storage when not in use.

APs should inform the owner that the adjustments listed above are, in fact, part of the maintenance. Therefore, the SSR restricts these activities to APs, or owners working under the supervision of APs. Owner's manuals should include appropriate cautionary notes and safety warnings, and maintenance plans should include proper procedures related to these issues.

III- 2.2.2 ISOLATED AND RESTRICTED ACCESS AREAS

If the property is difficult to access (for example, a water access only lot), plan the system considering:

- Minimize maintenance and increase the interval between maintenance visits, for example:
  - Increased septic tank size.
  - Use the simplest workable system.
  - Automation, or remote system management for complex systems.
- Increase system reliability, for example:
  - Redundant (duplex) pumps.
  - Spare components on site.
  - Floating outlet device or siphon instead of a pump discharge.
  - Installed reserve dispersal area.
- Ease of installation considering the difficult access (for example, hand installation of dispersal system if machine access is not practical).

III- 2.2.3 OFF GRID SYSTEMS AND POWER OUTAGES

For a property that is off the power grid, consider the system reliability, if electricity is required for system operation. Also, assess what will happen if the power fails for a long period. For example, the internal batteries in an electrical control panel may need more frequent replacement.

For sites with unreliable power, consider the potential impact of longer power outages, and plan the system to reduce the risk caused by brown outs and voltage surges. This might include, for example, using pumps and controls that are protected against voltage surges and brown outs.

III- 2.2.4 MULTIPLE HOMES ON SAME PROPERTY

When a sewerage system serves two or more buildings on one property, the Authorized Person should confirm that the owner has established that the single or combined sewerage system complies with the local land use by-laws as well as this Manual.

Where two or more homes share a common sewerage system, confirm that the owners have a legal agreement to deal with operation and maintenance of the system. For a strata system, this is typically contained in the strata bylaws.

Under the SSR, any number of single-family dwellings or duplex units situated on one lot, each serviced by and connected to its own individual system, is covered by the Regulation, regardless of the number of these individual systems on that lot, provided that each individual system has a daily sewage flow of less than 22,700 L/day.

Multiple houses on a property served by a common domestic water source may constitute a water supply system under the Drinking Water Protection Act. Such a water system may require Health Authority approval. This may impact the sewerage system location. In this case, the AP should contact the Health Authority for guidance.

For common sewerage systems or where more than one sewerage system is located on the same property, advise the owner(s) to set aside reserve area(s) to allow for future dispersal system replacement.

III- 2.2.5 USE OF ADJACENT PROPERTY (OFF-SITE DISCHARGE)

In some situations, a sewerage system could be constructed on adjacent property. This applies if there is no suitable area for construction or repair on the primary property, subject to the following principles:

- There is approval by the adjacent landowner;

- the system must meet all conditions of the Sewerage System Regulation (SSR); and,
- the person installing the system has obtained legal advice about protecting the system by easements, covenants, or other legal instruments.

If easements and or covenants are to be used, these instruments should be registered against the land title before installing the sewage system.

III- 3 PROCEDURE GUIDELINES

III- 3.1 Sewage source characterization and site use

Several of the steps in initial site evaluation and the questions for the owner in the owner declaration are aimed at characterizing the use of the site. See the appendix, Section III- 8.1for an example checklist.

III- 3.1.1 OWNER RESPONSIBILITIES

APs should inform the owner of their responsibilities under the SSR. It is recommended that APs obtain a signed Owner’s Declaration before the design is completed as well as an Acknowledgement by Owner before the Letter of Certification is filed.

III- 3.1.2 OWNER DECLARATION

Ensure the owner declaration form includes all items relevant to the proposed site use and about the site and ownership. See the appendix, Section III- 8.1 for an example checklist.

III- 3.1.3 DAILY DESIGN FLOW

See Section III- 5.1 for guidance on selecting Daily Design Flows. Note that in some cases local government may have bylaws establishing design flows for collection systems.

III- 3.1.4 TYPE OF SOURCE OF SEWAGE

The source of the sewage (example residential, commercial) should be described in sufficient detail to understand the sewage flow rates and the characteristics of the sewage, with a focus on identifying sewage with unusual or problematic characteristics.

Unusual or problematic sewage flows may include:

- High organic-strength, greasy wastewater from restaurants and food and beverage production.
- Wastewater containing high levels of pharmaceutical drugs and medications or antibiotics.
- Wastewater with unusual amounts of cleaning agents and other process chemicals that may be toxic to microorganisms.
- Sources not covered under the SSR.

III- 3.1.5 PATTERN OF USE

Standards in Volume II are based on typical residential patterns of water use. If the sewage source is unusual, then the sizing, specification and operation of the system should consider the unusual water use and sewage characteristics.

Examples of unusual patterns of water use include the following:

- Occasional or rare water use (example: small warehouse).
- Wide variations in water use throughout the day (high peaks may warrant more flow equalization).
- Wide variations in water use during the week (examples include schools, meeting halls or churches); these systems usually benefit from flow equalization.
- Seasonal buildings (such as summer or winter residences and resorts). For example, for a winter cabin, there is a high risk of freezing due to sudden high use when the dispersal area and effluent is very cold.

- Buildings commonly used for special events, such as meeting or banquet halls.

III- 3.2 Administrative and regulatory requirements

III- 3.2.1 OTHER REGULATIONS AND POLICIES WHICH MAY AFFECT SEWERAGE SYSTEMS

When planning an onsite system under the SSR, the AP may need to also consider one or more of the following regulations and policies:

- *Public Health Act*.
- *Public Health Act* - Health Hazard Regulation.
- *Drinking Water Protection Act*, which covers all water systems other than single-family dwellings (and systems excluded through the regulation). It outlines requirements for water suppliers in terms of ensuring that the water supplied to their users is potable.
- Ground Water Protection Regulation, which governs the drilling, construction, flood-proofing, sealing, and closing of water wells, including domestic water supply wells.
- *Environmental Management Act,* which regulates certain discharges to the environment, with the notable exception of discharges regulated under the Sewerage System Regulation.
- Municipal Wastewater Regulation (MWR). Municipal wastewater (sewage) systems with daily design flows of more than 22,700 L/day will be registered under the MWR. The MWR also regulates wastewater discharges to water bodies and the reuse of reclaimed water, regardless of flow rate.
- Waste Discharge Regulation and applicable codes of practice: This regulation governs industrial waste discharges including disposal of solid wastes from sewerage systems.
- Agricultural Waste Control Regulation.
- The Industrial Camps Regulation, this regulation governs sewage facilities serving industrial camps.
- Federal jurisdiction. Onsite systems on Federal First Nation reserve lands are overseen by the First Nations Health Authority (FNHA). ROWPs must follow the requirements of the Standard Practice Manual and file with the Environmental Health Officer at the local FNHA office. See: http://www.fnha.ca/
- *Riparian Area Regulation* for areas near streams or water bodies:
    - If the sewerage discharge site is within a specified distance from a stream or water body, then the Riparian Area Regulation may apply to activities in that area. In case of doubt, the owner should retain a Qualified Environmental Professional to determine and stake out the riparian area. In these areas, local government may also have requirements; this may include lakeshore development guidelines or development permit areas.
- *Local Services Act* - Subdivision Regulations and related best practices guidelines.
- Health Authority policies regarding subdivision of land.
- Local bylaws and zoning, including development permit areas and maintenance bylaws which may affect the specification, siting, construction and maintenance of systems.
    - Zoning, land use bylaws and development permit areas can be checked with the local government.

- Restrictive covenants, rights of way, un-gazetted roads and easements: These may restrict or affect the siting or use of sewerage systems. The Authorized Person should check that the siting of the sewerage system complies with any restrictions that are registered against the land title:
    - Check that regulations; covenants and easements will not impact placement or use of the sewerage system.
    - Some covenants and easements may be checked via BC Online. It is necessary to read the actual documents. If unsure, obtain advice from a lawyer or BC land surveyor.

III- 3.3 Site and soil evaluation

III- 3.3.1 SITE EVALUATION

III- 3.3.1.1 Identify potential boundaries for horizontal separation from system components

A horizontal separation boundary is a point or location to which a separation distance for the dispersal area or tanks is defined by the standards. For example, a drinking water well or a stream.

The standards provide minimum separations. Locate and show on the site evaluation plan all the boundaries that might be within these minimum distances.

Check horizontal separation boundaries on the property **and** on neighboring properties.

If a drain is identified as a potential breakout, then the discharge of the drain (example to surface or to a water body) should be determined.

III- 3.3.1.2 Site characteristics

Assess and describe site characteristics and configuration, including topography, bedrock outcrops, vegetation and drainage.

III- 3.3.1.3 Climate and environment

Consider potential environmental constraints that may affect how the system is planned, including the following:

- High rainfall, which may mean reducing the selected soil hydraulic loading rate (HLR).
- Low rainfall and high evapotranspiration, which may provide an opportunity for an ET bed, ETA bed, or a BC Zero Discharge lagoon system, but and also may create a risk of salt accumulation in the soil.
- Extreme cold, which could freeze system components.
- Flood plains and riparian areas; consider the risk of flooding, and also how the Riparian Area Regulation affects siting of the system.
- Lakes or other water bodies that may be sensitive to sewage contamination.

III- 3.3.2 SOIL EVALUATION

The soil conditions should be investigated in the dispersal **and** receiving areas. The receiving area is the area at least 7.5 m downslope of the potential dispersal area. The number of soil tests performed and the location depend on the variability of the soils in these areas.

However, take care to avoid excavating so many pits that the excavations themselves alter the character of the site and soils.

When determining soil texture, consideration may be given to collecting and submitting representative soil samples to a laboratory to confirm field determined soil texture descriptions.

When assessing soil conditions, determine whether boundary conditions requiring special care are present (see Section III- 5.3.2.2.(c) (Boundary conditions)).

III- 3.3.2.1 Test pits (observation holes)

Excavate a minimum of two test pits (observation holes):

- In some cases, two pits will not be enough to describe the soil conditions:
    - If platy structure is found, site investigation should include a minimum of 4 observation test pits in the dispersal area and two in the receiving area in order to more accurately determine the extent and uniformity of the platy soil layer(s).
    - If soils are variable or the area is large, excavate additional test pits.
- Test pits should minimize the impact on dispersal and receiving areas from pits and machinery
- Auger holes can be used to investigate soil conditions. This may be preferred on some sites to minimize the number of test pits. A minimum of two observation test pits should be excavated to confirm the auger test results.
- The test pit should be dug to a depth that provides the soil and water table information for designing the sewage system. In all cases test pit depth may be limited by refusal—rock or other layer which cannot readily be excavated. If feasible, considering the hardness of the ground, excavate to:
    - A minimum of 1.2m depth in total.
    - A minimum of 0.9 m below the proposed infiltrative surface.
    - A minimum of 1.5 m below the proposed infiltrative surface, if Volume II standards specify a larger vertical separation. This would apply, for example, in the case of gravity dispersal to gravelly sand soil (the standards specify a vertical separation of 150 cm).
    - A minimum of 3 m overall depth and a minimum of 1.2m below the planned base elevation, for a proposed BC zero discharge lagoon. If sand lenses or rock outcrops are suspected, consider investigation to greater depth.
    - A minimum of 1.2 m below the base of a proposed ETA bed.

In some cases, nearby water well logs, where available, can provide an indication of the water table elevation and soil conditions below the depth feasibly assessed by test pits. Water well logs are accessible through the BC Water Resources Atlas (http://www.env.gov.bc.ca/wsd/data_searches/wrbc/index.html).

III- 3.3.2.1.(a) Safety and test pits

The Occupational Health and Safety Regulation include specific requirements when a worker enters an excavation over 1.2 m deep. Refer to the Regulation and WorkSafeBC for full information on excavation safety. http://www.worksafebc.com/

Consider the risk of people or animals falling into test pits and securely cover or backfill test pits after the soils profile is logged.

III- 3.3.2.2 Soils profile

Include in the log of the soils profile:

- A description of the soil profile, including the soil texture, structure, moist or dry consistence (resistance to deformation or rupture), colour, for each soil layer.

- A description of key measured depths, including mottling and gleying, roots, and total depth of each pit.
- The depth of the restrictive layer (flow restrictive horizon(s)), the water table and the expected seasonal high water table (SHWT) including evidence of a perched high water table:
    - On some sites the planner may monitor standpipes or test pits during wet season conditions (typically October through May in coastal regions or during snow melt in other areas) in order to confirm the SHWT. See Section III- 3.3.2.2.(a).
    - For systems with Daily Design Flow of less than 9,100 L/day, characterization of the water table to 30 cm below the specified VS for the proposed system is sufficient, except where other factors lead to a need for deeper investigation.
- The limiting layer will be interpreted from the soils profile, considering the shallowest of the restrictive layer, water table, SHWT or extremely permeable material such as fractured rock or gravel. See Table II- 7 (page II-17) for specific soil conditions considered to be a limiting layer.

A blank form that can be used in recording the soil profile is provided in the appendix, Section III- 8.3.1.

III- 3.3.2.2.(a) Estimation of Seasonal High Water Table (SHWT) and observation of water table

The SHWT is the upper limit of the soil water table which persists for more than 21 consecutive days or 30 total days, during a period of normal precipitation.

i) Estimation

The SHWT may be estimated using secondary methods of soil and site assessment. These include:

- Identification of the shallowest occurrence of ≥ 2% by volume of chroma 2 or less (Munsell Colour Chart) iron depletions, that is, localized redox depletions of soil colour to chroma ≤ 2 formed through reduction and oxidation processes.
- Redoximorphic features (soil mottling).
- Root penetration.

ii) Monitoring

The SHWT may be determined from observation of piezometers (shallow water table observation standpipes) which are monitored over the period of 6 to 12 months.

For measuring the depth of the water table over time, a simple observation standpipe can be made by inserting a length of 100 mm (4") PVC sewer pipe (perforated) vertically in a soil test pit prior to backfill.

Normal precipitation for any 30 day period is considered to be the 30 day total precipitation falling between the 25th and 75th percentile range for the nearest weather station with more than 30 years of climate records.

In order to assess the results of water table monitoring one option is to develop a hydrograph showing water level fluctuation and to remove from consideration those periods where the 30 day running total of precipitation is outside the "normal" range.

In some cases, including for sites where the SHWT is at a maximum during snow melt, it may be preferable to consider seasonal precipitation. In this case the season (e.g. winter or winter and spring) would be considered "normal" if total precipitation falls between the 25th and 75th percentile.

III- 3.3.2.3 Describing soils

The more detailed and complete the soil description the better. However, the basic objective is to describe the soil in sufficient detail to plan and install the sewerage system; the **minimum** standards reflect this purpose:

- **Soil profile**; important for identifying usable soil depth and appropriate level for infiltrative surface, at minimum depth from surface to each distinct layer (or horizon).
- **Texture**; critical for permeability, should be described within one of the soil texture groups established in Table III- 1 (below).
- **Structure**; critical for permeability, should be described within one of the categories shown in Table III- 2 (below).
- **Consistence**; (moist **or** dry **or** cemented class), critical for permeability, should be described within one of the categories shown in Table III- 2 (below).
- **Coarse fragment content**; important for permeability and soil treatment, should identify any soil layers with more than 35% coarse fragments and any soil layers with more than 60% coarse fragments.
- **Root quantity**; a useful indicator of permeability and changes between soil layers.
- **Rooting depth**; a useful indicator for estimating the SHWT, log should identify the maximum rooting depth.
- **Moisture or seepage**; important for estimating the SHWT and for consistence description. The log should identify whether a layer is dry, moist or wet and should record depth to seepage.
- **Restrictive layer**, important for vertical separation and water flow, identify the depth and log the characteristics of this layer. See Table II- 7 (page II-17) and Section II- 5.5.3 for specific soil conditions considered to be a restrictive layer.
- **Limiting layer,** important for vertical separation, establish the depth of this layer based on interpretation of the soil profile. See Table II- 7 (page II-17) for specific soil conditions considered to be a limiting layer.
- **Colour**, a useful indicator of oxygen status of the soil layer and saturation, the log should identify colour in simplified terms (see Section III- 3.3.2.5).
    - Gleying and mottling; important indicators for estimating the SHWT and water table, record the depth to top and bottom of any mottled soil layer. Note that a soil layer below a mottled layer is typically gleyed.

Bearing in mind these minimum criteria, soil characteristics should be evaluated and described in accordance with the following recognized USDA method:

- P. J. Schoeneberger, D. A. Wysocki, E. C. Benham, and Soil survey staff, Field Book for Describing and Sampling soils, Version 3.0. National Soil Survey Center, Natural Resources Conservation Service, US Department of Agriculture, 2012.
    - Available at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054184

Optionally, soil characteristics may be evaluated and described in accordance with CanSIS:

- Canadian System of Soil Classification, 3rd Edition;
- C. E. F. Service and J. H. Day, Canada Soil Information System (CanSIS)-Manual for Describing Soils in the Field. Research Branch, Agriculture Canada, 1982.
  Available at: http://sis.agr.gc.ca/cansis/publications/manuals/1982-forms/index.html

The USDA soil description terms are used in this manual. Particularly, note that this manual uses the USDA consistence (rupture resistance) classes, **not** the CanSIS.

The site and soil evaluation report should say which (USDA or CanSIS) method was used, and the chosen method should be used consistently. More detailed descriptions than the minimum criteria are encouraged.

The CANSIS and USDA manuals include description of the specialized soils terms used in the SPM, including, for example, particle size ranges for determination of texture. Refer to the appendix, Section III- 8.3.1, for a sample test pit log.

III- 3.3.2.3.(a) Soil texture groups and soil structure and consistence categories

In this Manual, HLR and LLR tables group soils with the same loading rate together, these groups are termed "soil texture groups". Table III- 1 indicates which group the USDA soil texture classes and sub classes fall into.

i) Texture groups

Table III- 1. Soil texture groups and texture classes

SOIL TEXTURE GROUP (HLR AND LLR TABLES)	TEXTURE CLASS OR SUBCLASS
Gravel and Very or Extremely Gravelly Sands	Gravel Very or Extremely Gravelly Coarse Sand Very or Extremely Gravelly Sand
Gravelly Sands and Coarse Sand	Gravelly Coarse Sand Gravelly Sand Coarse Sand Loamy Coarse Sand
Sand, Loamy Sand	Sand Loamy Sand Coarse Sandy Loam
Fine Sands, Loamy Fine Sands, Sandy Loams	Fine Sand Very Fine Sand Loamy Fine Sand Loamy Very Fine Sand Sandy Loam Fine Sandy Loam
Loam, Silt Loam, Silt	Very Fine Sandy Loam Loam Silt Loam Silt
Clay Loam, Sandy Clay Loam, Silty Clay Loam	Sandy Clay Loam Clay Loam Silty Clay Loam
Sandy Clay, Silty Clay, Clay	Sandy Clay Silty Clay Clay

Note: In this table Very Fine Sandy Loam is grouped with Loam and Silt Loam soils. Distinguishing Very Fine versus Fine Sandy Loam is difficult by hand texturing. However, this soil texture sub class will typically have lower permeability, in which case the selection of loading rates will be limited by soil permeability if the soil is mistakenly placed in the Fine Sand group.

ii) Structure and consistence categories

Soil structure and consistence categories have been established to simplify selection of HLR and LLR values and to guide system selection (used in the site capability tables). These categories are defined by a table in the standards which is repeated here for convenience in Table III- 2.

Table III- 2. Soil structure and consistence categories

MOIST CONSISTENCE	LOOSE TO FRIABLE	FIRM	VERY FIRM OR STRONGER
OR CEMENTATION	NON CEMENTED EXTREMELY WEAKLY CEMENTED	VERY WEAKLY CEMENTED	WEAKLY CEMENTED OR STRONGER
OR DRY CONSISTENCE	LOOSE TO SLIGHTLY HARD	MODERATELY HARD	HARD OR STRONGER
STRUCTURE			
Single grain (structure-less) soils	F	P	NA
Strong or moderate grade: Granular, Blocky or Prismatic	F	P	NA
Weak grade: Granular, Blocky or Prismatic	P	VP	NA
Weak grade Platy structure (and Sandy Loam or Loam)	P	VP	NA
Weak grade Platy structure, all other soils	VP	VP	NA
Moderate or Strong grade Platy structure	NA	NA	NA
Massive (structure-less) soils	VP	VP	NA
F=Favorable, P=Poor, VP=Very Poor, NA=Not allowed.			

Note that this table does not imply any direct correlation between moist and dry rupture resistance, so a soil with Firm rupture resistance when moist may not necessarily have Moderately Hard rupture resistance when dry.

Structure-less soils are divided to two categories:

- Single Grain, soils with no structural units which are non-coherent, e.g. Sand.
- Massive, soils with no structural units where the material is a coherent mass (not necessarily cemented).

III- 3.3.2.3.(b) Soil consistence (rupture resistance)

i) Reassessment of dry consistence

The effect of soil consistence on suitability for effluent infiltration is most strongly associated with moist consistence.

If a soil horizon has a dry rupture resistance of Moderately Hard or stronger but is considered to be potentially usable (for example, due to favorable permeability test results), then the soil can be moistened and the moist consistence assessed.

Care is necessary when moistening soil, particularly where clay content is high. Refer to the USDA Soil Survey Field and Laboratory Methods Manual, pg. 30, for a recommended method:

- R. Burt, Soil survey field and laboratory methods manual. National Soil Survey Center, Natural Resources Conservation Service, US Department of Agriculture, 2009.
  Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1244466.pdf

ii) Cementation

Cementation is not a field test. If cementation is suspected then a specimen similar in size to one used for moist consistence is taken from the horizon.

To test for cementation, the specimen is air-dried and then submerged in water for at least 1 hour. If the sample slakes (falls apart) then it is considered to be un-cemented. If it does not slake, the rupture resistance is then tested (when wet) and the consistence category reported as one of the cemented classes following the USDA field manual.

III- 3.3.2.3.(c) Prismatic and columnar structure

Prismatic and columnar structures, and particularly columnar structure, are often associated with expanding clay soils (see Section III- 3.3.2.4). Prismatic structure in humid region soils is sometimes found in poorly drained soils. Columnar structure is often associated with high sodium content in the soil.

For these reasons, although prismatic structure is shown in the soil structure and consistence category table as usable, prismatic or columnar structure types should be considered a warning of potential risk.

In many cases these soils will have a consistency that results in "not allowed" from the table.

III- 3.3.2.4 Expanding clay soils

The tendency of a clay-rich soil to shrink and swell is related to the type of clay minerals in the soil and also closely related to the total clay content of the soil; soils with a higher percentage of clay will tend to shrink and swell. This can be an issue for structures, and also can result in very low permeability as the soil swells.

In general, soil horizons that are Very Firm, Very Sticky or Very Plastic may have significant amounts of expansive clay and are not suitable for effluent dispersal. For description of these terms, see the USDA Field Book for Describing and Sampling soils, referenced in Section III- 3.3.2.3

In terms of risk for dispersal areas, the standards of this manual include three main checks that will often result in these soils being considered a restrictive layer:

- These soils typically have Very Firm or Hard (or stronger) consistence, rendering them "not allowed" based on soil structure and consistence category.
- For these clay-rich soils, permeability or percolation testing will usually show very low permeability, as long as the test follows the proper procedure, and particularly is continued for long enough to fully wet the soil. This will result in the HLR table identifying the soil as "not allowed" based on permeability or percolation rate.
- These soils may show a perched seasonal high water table (SHWT) above the clay rich layer.

As for any clay-rich soil, it is important to adequately pre-soak the soil prior to percolation testing, and to allow adequate time to establish a stable rate of fall during permeameter testing.

If expanding clay soil is suspected on the site, the following simplified version of the Coefficient of Linear Extensibility (COLE) test procedure allows initial assessment of risk for expanding soil:

> Mix a soil/water solution to the point where the clay soil is almost saturated, but can still be formed into a "worm" or rod-shaped lump. Form a rod and measure its length. Place the rod in an oven to dry (250 degrees for about an hour should be enough), then re-measure. If the length of the rod decreases by more than 3 – 5%, there is probably enough expanding clay to affect soil drainage potential.

This simplified test does not accurately measure the extensibility of the soil. A more accurate approach is to use two or more factors, including the COLE test, liquid limit and soil cation exchange capacity. A soils laboratory can undertake these tests. These laboratory tests provide useful information about the soil, but will seldom be necessary or required for planning small sewerage systems.

See Section III- 4.1.2.2.(d) for guidance on site capability and expanding clay soils.

III- 3.3.2.5 Simplified colour terms for soil

Soil colour is best described using Munsell colour charts.

However, for the purpose of simple onsite system design a simplified description may be used, following Table III- 3:

- First identify light, medium, or dark tone in reference to the main colour (column 1).
- Identify the main colour (column 2).
- If necessary, add an appropriate descriptor (column 3).
- The resulting description will be similar to the following examples:
  - Medium brown.
  - Light reddish brown.
  - Dark bluish grey.
  - Black.
  - Light yellowish grey.
- For mottled soils, describe the matrix colour (the main background colour).

Table III- 3. Simplified colour terms

1. TONE	2. MAIN COLOUR	3. DESCRIPTOR
Light	Pink	Pinkish
Medium	Red	Reddish
Dark	Orange	Yellowish
	Yellow	Brownish
	Brown	Greenish
	Green	Bluish
	Blue	Greyish
	White	
	Grey	
	Black	

Adapted from: D. Burns, G. Farqhuar, M. Mills, and A. Williams, *Guideline For The Field Classification And Description Of Soil And Rock For Engineering Purposes*. New Zealand Geotechnical Society, 2005.

III- 3.3.2.6 Soil permeability

Permeameter or percolation tests are part of standard practice. These tests should be performed in accordance with the methods described in the appendix, Sections III- 8.3.2 (percolation test) and III- 8.3.3 (permeameter test). When testing, consider the following:

- The tests should be repeated in four different locations, within the planned dispersal area, to arrive at a reliable typical permeability or percolation rate representative of the soil at the proposed infiltrative surface.
- On some sites, it will be appropriate to conduct more than four tests, to understand the variation in soil permeability. Refer to guidance in the test instructions.
- Where a zero discharge lagoon is planned, the AP should determine soil permeability at the appropriate depths for the lagoon base and the berm area.
- If soils within 30cm of the proposed infiltrative surface are Firm or Moderately Hard consistence, or if platy structure is found, then complete at least 6 permeability tests (or percolation tests).
- In some situations, it may be beneficial to test the permeability or percolation rate of deeper soil layers for consideration of linear loading rate (LLR). To make these easier, tests may be conducted in the base of test pits.

III- 3.3.3 SITE AND SOIL EVALUATION REPORT

The standards (Volume II) provide a checklist for writing a site and soil evaluation report.

For the site evaluation report, the site plan or sketch should show the following existing and proposed features:

☐ Surface water features, riparian areas, sources of drinking water and water wells.
☐ Buried utility services.
☐ Potential breakout points, including retaining walls, subsurface drains, existing and proposed excavations (and the discharge point for any drains).
☐ Sewerage systems.
☐ Paths and driveway, parking areas.
☐ Structures.
☐ Animal husbandry areas.
☐ Property lines.

Any setback triggers should be identified on the lot and also on neighbouring lots. Show on the plan separation distances from horizontal separation boundaries (e.g. a water well) to system components; this may be by setback lines or circles, by measurements or by notes. For simple systems this information can be shown on the construction drawing.

III- 3.4 Selecting a system based on site conditions

When using the checklist in Volume II, the AP should refer to Section III- 4.1 for guidance on selecting a system and conceptual design.

III- 3.4.1 SOIL TYPE AND PERMEABILITY FOR SYSTEM SELECTION AND SIZING

Using the standards tables of this Manual involves selecting a soil type or a representative permeability. For example, selection of a soil HLR involves selecting a soil texture class, structure and consistence category and a soil permeability or percolation rate.

Since the soil profile is likely to consist of more than one horizon between the infiltrative surface and the limiting layer, the AP to will need to choose the most appropriate soil type or permeability to use in the tables.

The standards provide a procedure for this selection. In the majority of cases, the choice is the soil horizon within 30 cm below the infiltrative surface that will result in the most conservative value or result from the particular table.

However, this should not be applied blindly. Consider the purpose of the standard. In some cases it may be preferable to use a more conservative choice of soil type, based on a more limiting horizon.

For example, Table II- 6 (page II-16) limits the use of Type 1 below grade Seepage Beds to certain soil types "at the infiltrative surface". If a site had Clay Loam with Poor structure and consistence to 30 cm depth, with a Sandy Loam with favorable structure and consistence below, choosing the Sandy Loam soil as the soil type for this particular consideration would result in no constraint for application of a Seepage Bed. However, the Clay Loam would restrict oxygen flow to the bed and the system might have a limited life. In this case, the AP should consider the impact of the Clay Loam in context and either use a different system type, or remove the Clay Loam soil for an adequate distance around the bed.

Also, the soil type for one table may not be the appropriate type for another. For example, micro-dosing specification may use a different soil type than that used for HLR selection.

III- 3.5 Plans and specifications

When using the checklist in Volume II, the AP should refer to Section III- 4.1 for conceptual design and system selection, and Section III- 4.1.1 for guidance on system selection and conceptual design.

"Record of design" means a record of design rationale, including a record of system selection to meet site conditions. See Section III- 4.1.1 for guidance.

III- 3.5.1 FILING

Before construction, alteration, or repair to a sewerage system may begin, the SSR requires that, as a minimum, the Authorized Persons file the information specified in the SSR section 8 with the Health Authority, in a "form acceptable to the Health Authority".

This filing is valid for 2 years from date of acceptance.

III- 3.6 Installation

The AP should refer to Section III- 6 for guidance on installation of the specific system.

III- 3.6.1 SIGNIFICANT CHANGES TO DESIGN DURING INSTALLATION

Prior to or during installation, the SSR requires that if any material changes are made to the information filed, the AP must file an amendment with the Health Authority to update the filing.

Minor changes do not require that the AP file an amendment. These are simply recorded as part of the final record drawings and documentation.

For amended designs, the AP should retain documentation, including design rationale, as for any other design.

Changes significant enough to require filing an amendment include the following:

- Change to treatment method (example type 1 to type 2).
- Relocation of the dispersal system to a different area of the lot.
- Change in lot legal description or owner name.
- Change in the use of the building, or in the Daily Design Flow (DDF).
- Change to the distribution type or the dosing type.
- Changes to the system design that result in departures from SPM standards (e.g. a vertical separation that does not meet the minimum standard).

III- 3.6.2 COMMISSIONING

At system commissioning, it is critical to record key system operational parameters. The following checklist is provided for guidance. It is preferable if the AP who filed the system is on site for commissioning. The AP should prepare a checklist or table to help them record important information for the type of system being commissioned.

Example general commissioning checklist:

☐ Set float switches or transducers, and test the system operation, including alarms.

☐ Set the pump control panel (timers, data loggers and programmable controls) and test operation.

☐ Test pumps, fan and blower operation, and measure the voltage and run amperage.

☐ Check the force mains, including the pressure effluent collection mains, for leaks.

☐ Flush all lines in the treatment and pumping systems, transport lines and dispersal system.

☐ Test back-flow preventers (i.e. check valves).

☐ Test and adjust the D-box and outlet controls (gravity system with D-box).

☐ Test the pressure distribution residual pressures (a.k.a. “squirt test”). This may include the final pressure distribution system, and treatment system distribution piping (i.e. sand and textile media filters). Adjust valves, as required, to equalize pressure. Record distal pressures (squirt heights).

☐ Test and record pump discharge flow rate or draw down. Record pump run amperage.

☐ Record the initial control panel settings, system operating parameters, and the start-up data logs. Note any changes to the design or operational settings.

☐ Complete a general review of the system operation to verify that it is operating as intended, and in accordance with the manufacturer’s specifications.

☐ Perform baseline monitoring if applicable, (e.g. record water table levels in observation standpipes, collect and test samples of water from drainage system).

☐ Put the sewerage system into service. Ensure that the breakers, switches and valves are in operating position, the tank lids are secure and that the site has been left in a safe and tidy condition.

Commissioning is a good opportunity to communicate with the owner about the use and operation of the sewerage system, source control, alarms, power outages, maintenance and monitoring, dos and don'ts, etc. Also, inform the owner of requirements for maintenance under the SSR, and provide them with a contact for establishing a maintenance contract.

III- 3.6.3 POST INSTALLATION

After installation, the installer should provide the filing AP with:

- Record of the installation including photos.
- Component information & manuals.
- Useful information for writing the maintenance plan.
- An Installers Letter of Certification.
- A record drawing showing all measurements and locations for system components (if this is not prepared by the filing AP).

These should be provided within 15 days of completion of the installation.

III- 3.7 Letter of certification, record drawing and as installed specifications

Refer to the Sewerage System Regulation and the local Health Authority for legislated requirements for letters of certification, record drawings, installed specifications, maintenance plan, and other documents forming part of the final filing package.

Within thirty days of completing construction of the sewerage system, the Authorized Person must file with the Health Authority a letter of certification (LOC) (in a form acceptable to the Health Authority), record drawings and specifications and a Maintenance Plan. The AP must also provide the owner with a copy of these same documents.

The AP should check with the Health Authority whether there are any written Orders on file for the system, and verify that the system meets Order requirements prior to submitting the LOC.

Systems falling under the SSR which are encountered operating without a letter of certification should be referred to the local Health Authority.

The system is not considered complete until such a time as the Authorized Person has completed a final inspection, and is satisfied that the system is complete and ready to operate. This will include verification that any deficiencies identified by the AP have been fixed or completed. All electrical connections should be complete.

III- 3.7.1 RECORD DRAWING

The record drawing will be used by the maintenance provider to locate system components. For this reason the drawing may need actual measurements from fixed control points (e.g. the corner of a building or a property pin) if the components will otherwise be difficult to locate.

III- 3.7.2 MAINTENANCE PLAN

The maintenance plan is submitted with the letter of certification. It is intended to provide information and direction to a maintenance provider AP, and may therefore be written in a form not suited for a lay person, that is, including industry terminology and technical detail.

The standards indicate the minimum items to be included in the maintenance plan. This section provides additional information and guidance on some of those checklist items.

The plan should also include a section written for the owner, which provides system information that is understandable by the owner. Given the importance of proper maintenance and operation to the function of the sewerage system, it is critical that the owner is educated on the maintenance and operation of their system, and understands that adherence to the maintenance plan and maintenance schedule is necessary.

III- 3.7.2.1 Operation manual

The operation (instruction) manual should include a summarized description of the system including the following:

- Treatment type, method of distribution, configuration and size of dispersal system, type and number of observation ports, type of pump control system and method of flow monitoring, alarms, pump size, and model (if applicable).
- The Design Daily Flow and the average daily flow allowance (50% of DDF) that will be used for flow monitoring.
- If a cycle counter is used to measure the flows, the measured volume discharged per dose. The cycle count multiplied by the dose volume should be less than the average flow allowance.
- A troubleshooting guide for the system, if appropriate.
- expected system component lifespan, and a recommended routine replacement timetable, if appropriate
- Information on how to use the system.

III- 3.7.2.2 Maintenance provisions in the plan

Maintenance provisions should include the following:

III- 3.7.2.2.(a) Recommended frequency of maintenance service and monitoring

- Maintenance instructions, tables and checklists:
    - Data to be recorded at intervals and how that data will be collected
    - Tables for data recording and checklists or tables for maintenance steps
    - Schedule for component replacement and expected component lifespan
- monitoring plan, with tables or forms for recording monitoring data:
    - *Instructions for sample collection and analysis (for Type 2 and 3 systems)*
    - Instructions for general inspection of the dispersal and receiving area
    - Flow monitoring instructions
    - Instructions for actions based on monitoring data

III- 3.7.2.2.(b) Commissioning details

The maintenance plan should include details from system commissioning. These can be provided separately or can be filled into the maintenance tables.

For example, the commissioning information for a simple dosed pressure system would include:

- Panel records at commissioning such as cycle count, pump run time, number of alarm events, timer override, lag events, and float errors.
- Dispersal field residual head (squirt heights).
- Pump chamber calibration expressed as volume of fluid per depth of fluid (litres per cm).

- Pump draw down per minute or draw down per dose.
- Pump start and run amp draw and voltage.
- Float or transducer settings for each event, measured as a height from inside tank bottom (at point of activation). For demand dosing: pump off, pump on and alarm on. For timed dosing: redundant off, timer enable, alarm on, and lag (override) event.
- Pump run time and off time (rest period) for timed dosed system.
- Actual volume discharged per dose if to be used for flow monitoring.

III- 3.7.2.2.(c) Maintenance tasks and troubleshooting guidance

Refer to Section III- 7.3 (maintenance tasks) for general maintenance tasks and details regarding the expectations for maintenance and monitoring procedures for specific system types.

With advanced systems and proprietary equipment, manufacturers may recommend additional specialized maintenance. Include these special tasks in the maintenance plan.

For any systems where troubleshooting may not be clear to the average maintenance provider, provide simple troubleshooting guidance.

III- 3.7.2.3 Information for the system owner

The maintenance plan is to include information for the owner, presented in a way that they will find easy to understand. This information should include:

- Explanation of general system function and operational expectations
- Contact information and emergency contacts
- Owner responsibility under the SSR
- Any special skills needed by the maintenance provider
- Any items remaining to be completed after commissioning
- A simple list of system "Dos and Don'ts"
- A sewage source control guideline

Provide for the owner to acknowledge they have received and understood the plan ("sign off").

III- 3.7.2.4 Review

The maintenance plan should instruct the maintenance provider on how to review the maintenance and monitoring records, and how to respond to sub-standard monitoring results.

If maintenance is not provided by the AP who originally filed the system, there should be provision for regular review by that AP or another qualified AP.

III- 3.7.2.5 Local maintenance bylaws

The local government may have a bylaw requiring maintenance, and this bylaw may specify maintenance intervals and reporting requirements. If this is the case, include relevant information in the maintenance plan and inform the homeowner of the bylaw requirements.

In case of a difference between maintenance requirements of a bylaw and those in the maintenance plan, the most stringent requirements take precedence.

If a local government maintenance bylaw is in place, it is good practice to forward a copy of the summary table(s) of maintenance requirements and schedule to the local government.

III- 3.7.2.6 Updates to the maintenance plan

If the operation, maintenance or monitoring procedures are changed, then the maintenance plan should be updated and the updated plan filed with the Health Authority. This should be done by the AP who originally filed the system, or by another qualified AP.

III- 3.8 Maintenance and monitoring

See Section III- 7 for guidelines on maintenance procedures and reporting.

III- 4 GUIDELINE TO SELECTING A SYSTEM FOR A SITE

III- 4.1 Dispersal system selection

III- 4.1.1 CONCEPTUAL DESIGN

The AP is expected to document how the sewerage system was selected to match the site and how the system solves problems relating to site and soil constraints. The System Selection Worksheet (Section III-4.1.1.2) is one option for documenting this process.

For more complex situations, write additional rationale statements. This can be an expanded table following the same format at the System Selection Worksheet.

III- 4.1.1.1 Procedure for conceptual design

III- 4.1.1.1.(a) Establish Daily Design Flow for the system

Daily Design Flow (DDF) and any special considerations for the site use form the basis for system sizing.

III- 4.1.1.1.(b) Site and soil capability tables and vertical separation tables

Check the site and soil capability tables for constraints that restrict the type of system that can be used, for opportunities for particular solutions, and for design procedures. Start with the simplest options first.

Use the vertical separation (VS) tables to establish the minimum VS for each type of system **option** considered. This may limit the types of systems that can be used on that site.

Several VS options may be available for the site, depending on the soil type, type of system, type of distribution and type of dosing.

In general, uniform distribution, then timed dosing, then micro-dosing are options that allow the use of shallower soil depth. However, there are few sites where a demand dosed uniform distribution system cannot be used.

In cold climate conditions, the dosing standards have a particular effect on pressure distribution systems, because of the risk of freezing of distribution laterals. It is not always practical to plan or design a system with pressure laterals that drain back between doses and dose volume may need to be large. As a result, the system may not be able to achieve a large enough number of doses per day to meet micro-dosing standards.

III- 4.1.1.1.(c) Area available for the dispersal and receiving areas

The size of area available is determined by the site and soil characteristics, and also by the horizontal separation standards and any covenants, easements etc. or planned developments that affect use of the site.

Once the available area is known, the planner can consider area constraints and length constraints for the system.

III- 4.1.1.1.(d) System type and system selection

The combination of these considerations, in turn, helps in deciding (for example) between a Seepage Bed and a trench system, selecting a type of effluent (e.g. to reduce the area needed), and choosing a system or features to fit the system to the space available.

There is likely to be more than one system option for the site.

In general the recommended approach is to start with the simplest system and work from there, generally considering two or more potential options for the site.

When selecting a treatment and dispersal system, consider additional points, including the following:

- Owner priorities for landscaping.
- Owner plans for developing the site (including access roads and trails).
- System capital and operating costs.
- System reliability.
- Access for installation and for maintenance.
- Specialized skills needed to maintain the system.
- Reduction in site and soil impact.
- Drainage or diversion of water.
- If repairing a system, the reasons for failure of the existing system.

III- 4.1.1.2 System Selection Worksheet to summarize conceptual design

The following pages introduce a System Selection Worksheet that follows the basic steps of system selection and conceptual design.

This worksheet can be used to summarize the planning process, including selecting the DDF, identifying site and soil constraints and potential solutions, comparing vertical separation options, sizing the distribution system, and selecting the recommended system and components.

- Table III- 4 is a System Selection Worksheet with instructions on filling it in.
- Table III- 5 is an example of a System Selection Worksheet filled in for an example site.

These tables may be used as templates.

A blank table is available for copying; see the appendix, Section III- 8.4.

Table III- 4. System Selection Worksheet with instructions

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil texture	*Soil texture*	*From site evaluation*	*Soil horizon chosen*
Soil structure and consistence	*Soil structure and consistence*	*Category from Table II- 4*	
Other soil notes	*Coarse fragments or other factors relevant*	*Constraint from Table II- 7* *% adjustment for HLR*	*Other notes*
Kfs	*Kfs, mm/day*		*Any notes on selection*
Percolation rate	*Percolation rate, min/inch*		*Any notes on selection*
Soil depth	*Soil depth for VS selection*	*Type of restrictive layer* *Soil depth for LLR selection*	*Any notes on depth in receiving area*
Slope %	*>15%, >25%, >45%?*	*Tables II-5 and II-6, and guidance from Table III- 7*	*Notes on restrictions to system type*
Slope shape, location	*Concave?* *Unfavorable location?*		*Adjust system contour length to bowstring length if concave contour*
Elevation house sewer to dispersal area	*Up, down, vertical distance*	*Gravity possible?* *Non pump dose possible?*	
Temperature	*Extreme cold?*		*May need to adjust design*
Net positive evapotranspiration?	*> 0 mm/year?* *> 600 mm/year?*	*Opportunity for BC zero discharge lagoons and ETA beds,* *Opportunity for ET beds.* *Check Table II- 6 for suitability of techniques*	*Source of data*
Rainfall?	*> 1800 mm/year, > 3000 mm/year?*	*Reduced HLR calculation, Section III- 4.1.3*	*Source of data*
Soil constraints?	*From Table II- 5*		
	From Table II- 6		
	From Table II- 7		
House bedrooms	*Enter bedroom number*	*DDF from Table II- 8*	
House area	*Enter total living area*	*Additional DDF from Table II- 8*	*Based on floor area*
Occupants	*Enter expected occupancy*	*DDF from Table II- 9*	*Only if occupancy method to be used*
Daily Design Flow	*Chosen DDF in L/day*	*Calculation summary*	*Method chosen, statements for owner sign off*

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil depth and VS options, distribution and dosing options	*VS option 1*		*Notes on dosing and constraints to design*
	VS option 2		
Horizontal separation constraints?	*Relevant separations from Table II-19 or 20*		*Notes on potential constraints to system*
	Relevant separations from Table III- 16		*Rationale for any departure*
HLR Type 1	*Soil type: Table II- 22* *Kfs or perc: Table II- 23*	Chosen:	*Adjust for coarse fragments, rainfall or for use with SDD*
HLR for sand	*Type of sand and effluent Table II- 24*	Chosen:	*For sand mound etc.*
HLR Type 2	*Soil type: Table II- 22* *Kfs or perc: Table II- 23*	Chosen:	*Adjust for coarse fragments, rainfall or for use with SDD*
Minimum system contour length	*LLR from soil type:* *From Kfs or Perc:*	Chosen:	*Or minimum system contour length (Table II- 26)*
	System contour length	Length = DDF ÷ LLR	
Dispersal area size and options	*AIS for Type 1*	*AIS = DDF ÷ HLR*	
	AIS for Type 1 to sand		
	AIS for Type 2	*AIS = DDF ÷ HLR*	
	AIS and min. basal area for other system types	*AIS = DDF ÷ HLR*	*E.g. minimum basal AIS for a sand mound*
	Area available		*Consider setbacks*
	Option 1		
	Option 2		
Length constraint?	*Minimum system contour length to meet standard*	*AIS = DDF ÷ LLR or minimum system contour length*	*Adjust for any concave contour*
	Length available on contour	*From site evaluation*	*And potential solutions*
Other considerations	*Owner priorities*		
	Other site constraints	*Or opportunities*	
System summary			*Rationale summary*

Table III- 5. Example of filled System Selection Worksheet

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil texture	*Sandy Loam*		*For 30 cm below infiltrative surface*
Soil structure and consistence	*Angular blocky, strong Friable*	*Favorable*	
Other soil notes	*Coarse fragments 10%*	*No constraint (<35%)*	*No HLR adjustment needed to meet standard*
Kfs	*1200 mm/day*		*2nd lowest of 4 tests* *At 25 cm depth*
Percolation rate	*Not used*		
Soil depth	*30 cm*	*Low permeability restrictive layer (depth consideration for LLR and VS the same)*	*Same depth for receiving area*
Slope %	*12 %*	*No restriction on type of system*	
Slope shape, location	*Linear Linear, in Backslope location*	*No constraints*	*No adjustment needed*
Elevation house sewer to dispersal area	*Estimated 3 m up from house*	*Gravity to field not possible*	
Temperature	*Not extreme cold*		*System freezing not severe constraint*
Net positive evapotranspiration?	*120 mm/year net positive*	*Table II-6 shows Kfs too high for lagoon or ETA bed, ET too low for ET bed.*	*Farmwest data (water deficit)*
Rainfall?	*1200 mm/year*	*No HLR reduction needed*	*Environment Canada*
Soil constraints?	*Not suitable for gravity*	*Except lagoons, ET and ETA*	*Soil depth, From Table II-5*
	Not suitable for:	*BC zero discharge lagoon* *ETA bed (Kfs)* *ET bed (net ET< 600 mm/year)*	*Climate (ET) From Table II-6*
	Soil not constrained		*From Table II-7*
House bedrooms	*3*	*1300 L/day*	*Table II-8*
House area	*270* m^2	*No additional flow for area*	*Table II-8*
Occupants	*Occupancy method not used*		*Occupancy declared to be normal*
Daily Design Flow	*Table II-8*	*1300 L/day*	*Standard DDF*

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil depth and VS options, distribution and dosing options	*Type 1 to sand mound, demand dosing*	*60 cm min. sand depth* *Total VS 90 cm, OK*	*Receiving area OK* *Demand dosing OK**
	Type 1 to sand mound, timed dosing	*45 cm min. sand depth* *Total VS 75 cm, OK*	*Receiving area OK Timed dosing OK**
	Type 1 to sand mound, micro-dosing	*30 cm min. sand depth* *Total VS 60 cm, OK*	*Advantage for micro-dosing (less sand needed)***
	SDD with fill, micro-dosing, Type 1 or 2	*30 cm sand depth Total VS 60 cm, OK*	
Horizontal separation constraints?	*Downslope perimeter drain, discharge to rock pit*	*7.5 m minimum separation*	*Ensure rock pit does not affect field.*
	Property lines	*3 m separation recommended in Table III- 16*	*No departure needed*
HLR Type 1	*Soil type: 27* L/day/m^2 *Kfs: 30* L/day/m^2	Chosen: 27 L/day/m^2	*HLR adjusted, 27 x 0.5 = 13.5* L/day/m^2 *for SDD*
HLR for sand	*Type 1 to* Mound Sand	Chosen: 40 L/day/m^2	*For sand mound*
HLR Type 2	*Soil type: 50* L/day/m^2 *Kfs: 60* L/day/m^2	Chosen: 50 L/day/m^2	*HLR adjusted, 50 x 0.7 = 35* L/day/m^2 *for SDD*
Minimum system contour length or LLR	*LLR: soil type: 60 L/day/m* *Kfs.: 60 L/day/m*	Chosen: 60 L/day/m	*Table II-26 specifies use of LLR tables*
Dispersal area size and options	*AIS for Type 1*	48 m^2 96.3 m^2 for SDD	*1300 ÷ 27* *1300 ÷ 13.5 for SDD*
	AIS for Type 1 to sand	32.5 m^2	*1300 ÷ 40, mound bed*
	AIS for Type 2	26 m^2 37 m^2 for SDD	*1300 ÷ 50 for Type 2* *1300 ÷ 35 for SDD*
	Sand mound minimum basal area	26 m^2 (< bed area)	*Based on Type 2 at basal area*
	Area available	>300 m^2	*Setbacks OK*
	Type 1 to sand mound	Initial calc. < 100 m^2 needed	*Including toe areas*
	SDD with fill	Initial calc. < 100 m^2	
Length constraint?	*Minimum system contour length needed*	21.7 m	*1300 ÷ 60*
	Length available on contour	35 m to property lines	*Setbacks OK*
Other considerations	*Owner priorities*	*No concern over sand mound*	*Prefers lower mound.*
	Other site constraints	*No other constraints*	

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
System summary	*Type 1 to sand mound* *Pressure distribution and timed dosing*	*VS 30 cm in sand, 60 cm as constructed* *Dose 28 x per day at DDF minimum (Table II-12).*	*Chosen after consideration of sand cost and owner priorities for landscaping*

Notes on the example:

- Some options are not shown, following the principle of "simplest option first"—for example, Type 3 options are not shown and Type 2 options are only shown if considered to confer an advantage.
- *Demand dosing is OK for soil based on soil constraints table. For simplicity in this example, low frequency demand dosing option is not shown. This option is less likely to be used for this site, since the site does not have high risk of freezing.
- *Timed dosing or micro-dosing is not a constraint to design since non-freezing conditions allow keeping distribution lateral pipes full. If there was a risk of freezing, notes would be added on design options (for example, using cold climate dosing standards from Table II-13). As for demand dosing, low frequency option is not shown.
- Adjustment to SDD HLR is made following SPM standards; see Section III- 6.11.2 for an example.
- ** "Advantage" (in terms of sand depth) for micro-dosing to a sand mound, because less sand depth is needed to meet minimum total vertical separation.

- If sand cost was low and owner did not prefer a lower mound, demand dosing might be a lower cost option. However, timed dosing confers other advantages for system flow management and will improve reliability of the sand mound.

III- 4.1.2 SITE CAPABILITY AND SYSTEM SELECTION

III- 4.1.2.1 Potential solutions and system types

This Manual offers a wide and varied toolbox of potential techniques and systems to meet the needs of almost all sites. Often the decision is simple, because the site is not seriously constrained. However, some situations warrant specialized techniques.

Table III- 6 summarizes the following:

- Application: Projects, sites, and soils where this type of system is generally suitable.
- Limitation: Projects, sites, and soils where this type of system is generally unsuitable.

Table III- 6. System applications and limitations

TYPE OF SYSTEM	APPLICATIONS	LIMITATIONS AND UNSUITABLE CONDITIONS
Type 2 treatment	Small available dispersal area	o Higher maintenance than Type 1 o May need electrical power o Some systems need special measures for seasonal use
Type 3 treatment	o Small available dispersal area, when used with high HLR o VS constraints when used with lower HLR o As part of design by a professional	o Higher maintenance than Type 1 o Higher monitoring costs than Type 2 o May need electrical power o Some systems need special measures for seasonal use o Professional design required by SSR
Seepage Beds	Small available dispersal area	Unsuitable for: o Slopes > 15% o Low permeability soils
At grade and raised systems	o Limited vertical separation o System contour length constraints (may need toe blanket)	Unsuitable for steep slopes (range depends on system type)
Gravity distribution	o Simple o No electrical power needed for trickling gravity systems o Sites where dispersal area is at lower elevation than the septic tank	Unsuitable for: o Shallow soil depth o High or low permeability soils o Slopes > 15% (trickling) o AIS > 100 m^2 (trickling) o Raised systems
Pressure distribution	o Shallower soil depth than for gravity distribution o Wider range of soil types than for gravity distribution	o Demand dosing may need power o Timed dosing needs power o Additional components needed
Pressure distribution with timed dosing	o Shallower soil depth than for demand dosing for some soil types o Wider range of soil types than for demand dosing o Allows strict control of system flows	o Timed dosing needs power o Larger pump tank needed than for demand dosing
Pressure distribution with micro-dosing	o Shallower soil depth than for timed dosing for some soil types o Wider range of soil types than for timed dosing o Allows strict control of system flows	May be difficult to achieve dose frequency in freezing conditions
Subsurface Drip Dispersal	o Shallow soil depth o Small available dispersal area o Very steep or complex slopes o Forested landscape o Low impact	o Type 1 restricted to more permeable soils o Complex system design and additional components needed o Needs electrical power o Standards specify timed dosing

TYPE OF SYSTEM	**APPLICATIONS**	**LIMITATIONS AND UNSUITABLE CONDITIONS**
At-grade beds	o Small available dispersal area o Limited vertical separation o Bed system on steeper slopes than Seepage Beds	o Unsuitable for slopes > 25% o Bed may be long o Restriction if site has concave contour o Standards specify pressure distribution
Alberta At Grade systems	o Limited vertical separation o Low impact o Low permeability soils	o Limited to forested sites with LFH horizon o Unsuitable for slopes > 15% o Bed may be long o Type 2 or Type 3 effluent o Restriction if site has concave contour o Needs electrical power o Standards specify pressure distribution with timed dosing
Sand mounds	o Limited vertical separation o Soils with structure not suitable for infiltration of effluent o Very high and very low permeability soils o High permeability soils without use of micro-dosing	o Not suitable for slopes > 25% o Bed may be long o Restriction if site has concave contour o High site impact o Standards specify pressure distribution with timed dosing
Sand mantle sand mound	Sites which might otherwise suit a sand mound but have insufficient contour length to meet LLR standards.	As for sand mounds
Sand lined trenches/beds	o Very high permeability soils o Favorable soil underlying less favorable soils o Shallow vertical separation (bottomless sand filters)	o Beds not suitable for low permeability soils and slopes > 15% o Standards specify pressure distribution with timed dosing
ET or ETA beds	o Simplicity o May operate without electrical power o Suitable for very low permeability soils o An alternative to lagoons o Suited to summer seasonal use o ET beds do not require soil	o Limited to suitable climates o Complex system design
BC zero discharge lagoons	o Simplicity o May operate without electrical power o Suitable for very low permeability soils	o Limited to suitable climates o Limited to large lots o Not suitable for slopes > 12% o May be aesthetically displeasing
Site drainage	o Lowers the water table, improving vertical separation o Deeper water table may increase the range of system options o May allow for a shorter system	o Drains should meet the setback distances from the dispersal o It is difficult to predict, beforehand, how much the water table will drop as a result of the drain

For sites with system contour length constraint, see Section III- 5.6.3.2 for guidance and solutions.

III- 4.1.2.2 Guidance on soil constraints to site capability (Table II- 7)

As guidance, the following tables and examples expand on the soil capability standards Table II- 7 (page II-17) and footnotes, and offer some suggested options. See Volume IV for rationale.

III- 4.1.2.2.(a) Very high permeability soils

Soil type or condition	○ Gravel and very gravelly sand ○ Or Kfs >17,000 mm/d ○ Or percolation rate faster than 0.5 min/inch
Constraining factor	Very high permeability
Potential solution	○ Uniform distribution with timed or micro-dosing. ○ Note that the vertical separation standards are different for demand dosing versus timed dosing versus micro-dosing options.
Alternative solutions (where appropriate)	○ Sand mound or sand-lined trench or bed, with timed or micro-dosing options, ○ or ET bed.
Notes	Reduce the soil HLR based on the proportion of coarse fragments (> 2 mm) in the soil.

III- 4.1.2.2.(b) Coarse fragments

Soil type or condition	More than 35% total gravel and other rock fragments (particles larger than 2 mm).
Constraining factor	Reduced soil area for dispersal and treatment. Reduced water holding capacity.
Potential solution	Reduce the soil HLR and increase the dosing frequency (which reduces HAR).
Notes	○ Base the soil HLR on the non-gravel portion of the soil and reduce the loading rate by the percentage of rock fragments over 35%. ○ Calculate the dose frequency following Section III- 5.2.2.2.(d) if using micro-dosing.

Example of HLR adjustment:

The soil HLR selected from the tables is 25 L/day/m^2. The coarse fragment content in the soil is 55% (0.55 as proportion)

The calculated proportion for adjusting the soil HLR

= 1 – (proportion of coarse fragments – 0.35)

Proportion for adjusting the HLR = 1 - (0.55 – 0.35) = 0.8

The adjusted HLR = 25 x 0.8 = 20 L/day/m^2

The soil hydraulic loading rate is decreased; the infiltration area is increased.

Soil type or condition	More than 60% total gravel and other rock fragments larger than 2 mm
Constraining factor	o Risk of effluent short circuiting due to large fractures and voids o Severely reduced soil area for dispersal and treatment. o Reduced soil water holding capacity.
Potential solution	Uniform distribution with Timed or micro-dosing.
Alternative solutions (where appropriate)	o Sand mound, sand-lined trench, sand-lined bed with timed or micro dosing, o or ET bed.
Notes	o Calculate the soil HLR based on the non-gravel portion of the soil, and reduce the soil loading rate by the percentage of rock fragments over 35%. o Calculate the dose frequency following Section III- 5.2.2.2.(d) if using micro-dosing.

Example of HLR adjustment:

The soil HLR selected from the tables is 25 L/day/m^2. The soil coarse fragment content is 75% (0.75 as proportion)

The proportion for adjusting the HLR is 1 - (0.75 – 0.35) = 0.6

The adjusted HLR = 25 x 0.6 = 15 L/day/m^2

Soil type or condition	90% or more total coarse fragments larger than 2 mm.
Constraining factor	o Risk of effluent short circuiting due to large fractures and voids. o Very severely reduced soil area for dispersal and treatment. o Negligible soil water holding capacity.
Notes	o Not suitable for soil based treatment and dispersal. o Defined as a limiting layer.

III- 4.1.2.2.(c) Very low permeability soils

Soil type or condition	Kfs is 75 to 150 mm/day or percolation rate 60 to 120 min/inch
Constraining factor	Low permeability, low infiltration rates.
Potential solution	Uniform distribution with micro dosing or sand mound with timed dosing.
Alternative solutions (where appropriate)	o Sand-lined trenches penetrating below the unfavorable soil layer (if underlain by an unsaturated favourable soil). o Alberta at Grade system (requires Type 2 or 3 effluent). o ET or ETA bed. o BC zero discharge lagoon.

Soil type or condition	Sandy clay, silty clay or clay soils with structure and consistence category "Favorable".
Constraining factor	Low permeability, low infiltration rates, susceptible to structural damage if compacted when wet.
Solution	Type 2 or 3 effluent, with uniform distribution with timed or micro dosing or sand mound with timed dosing.
Alternative solutions (where appropriate)	o Sand-lined trenches penetrating below the unfavorable soil layer (if underlain by an unsaturated favourable soil). o Alberta at Grade system (requires Type 2 or 3 effluent). o ET or ETA bed. o BC zero discharge lagoon.

Soil type or condition	Sandy clay, silty clay or clay soils with structure and consistence category "Poor".
Constraining factor	Very low permeability, very low infiltration rates, susceptible to swelling, susceptible to structural damage if compacted when wet.
Solution	Type 2 or 3 with minimum 30 cm sand media depth below infiltrative surface or Point of Application, with timed or micro dosing. Typically a sand mound with sand mantle and drainage improvements.
Alternative solution (where appropriate)	o Sand-lined trenches penetrating below the unfavorable soil layer (if underlain by an unsaturated favourable soil). o Alberta at Grade system (requires Type 2 or 3 effluent) o ET or ETA bed. o BC zero discharge lagoon.

Other very low permeability soils are identified as restrictive layers, that is, flow restrictive horizons. In some cases these soils may be suitable for BC zero discharge lagoons or ETA beds, as indicated in Table II- 7 (page II-17).

III- 4.1.2.2.(d) Soils with significant amounts of expandable clay minerals

Some soils can shrink and swell significantly with changes in water content depending on the expansive characteristics of certain clay minerals.

Wet conditions cause clay minerals to expand, so permeability the soil below the dispersal system will decrease as the soil gets wet. In general this results in the clay rich horizon being identified as a limiting (restrictive) layer for dispersal system design. See Section III- 3.3.2.4. for further information.

For these soils it is particularly important to ensure that permeability or percolation testing is carried on long enough for the soil to fully wet.

Shrinking and swelling can also impact structures, including tanks and other sewerage system structures.

If these soils are a problem in your area, and you think that they are present on a site you are planning for then consult a professional with expertise in soil science.

As an initial check for risk, follow the simplified test procedure in Section III- 3.3.2.4.

III- 4.1.2.2.(e) Prismatic soils

See Section III- 3.3.2.3.(c) for further information on prismatic structure. Prismatic structured soils which have permeability high enough to be considered usable for effluent dispersal may have a high risk of bypass (preferential) flow, that is, where effluent travels rapidly down through the soil without adequate treatment.

To reduce this risk, avoid using soils with prismatic structure for the infiltrative surface. Use a 30 cm or thicker layer of sand media fill above the native soil (for example, a sand mound system) or ensure the infiltrative surface is in a soil layer at minimum 45 cm above the prismatic soil. To further reduce the risk of bypass flows, consider the use of micro-dosing.

III- 4.1.2.2.(f) Platy soils

A soil with weak platy structure is prone to damage during construction, or by applied effluent. A soil with moderate or strong platy structure will have low vertical hydraulic conductivity, making it unsuitable for conventional dispersal systems.

This Manual offers the following strategies which should be used together for soils which have platy structure of weak grade:

- Infiltrative surface above the platy layer (30 to 45 cm minimum above the platy layer), or sand media used for infiltrative surface, and
- Uniform distribution, and
- Micro-dosing.

Soils with platy structure of moderate or strong grade are identified by Table II- 4 as "not allowed" and are considered to be a limiting layer. The AP may either:

- Treat the platy soil as a restrictive layer; or
- Use an ET bed, ETA bed or BC zero discharge lagoon (where appropriate); or
- Seek advice from a Professional with particular expertise in soil.

III- 4.1.2.2.(g) Sink holes and piping

When water is applied as a relatively large point source flow to some Silt, Silt Loam, Silty Clay and Clay Loam soils there may be a risk of sink holes forming.

Sink holes or pipes are formed when water seeping along vertical and/or horizontal fractures carries away silt or clay particles, forming a thin tubular channel. With time the channel enlarges, and may cave in, resulting in collapse of the ground surface.

Risk from onsite systems is highest from leaking pipes or tanks, from associated drainage and with uneven distribution in gravity dispersal systems.

Areas at risk are normally well known locally. If a particular site is considered to be at risk, take precautions with drainage systems, piping, tanks and dispersal areas to reduce flow concentration. Take particular care with ETA bed systems that rely on effluent ponding for their operation.

III- 4.1.3 STEEP SLOPES

Table III- 7 summarizes slope constraint standards and guidelines.

Table III- 7. Slope considerations

SLOPE	CONSTRAINT	NOTES
0 to 1%	Flat or low slope site	Alberta At Grade systems, consider the basal area of cover material on all sides (not just down slope).
0 to 2%	Flat or low slope site	o Refer to special sizing and layout provisions for sand mounds and at-grade beds (in Volume II) o If a toe blanket is used, install the toe blanket all around the system, not just down slope.
> 15% to 25%	These slopes are not suitable for: o Trickling gravity systems o Dose to D-box or splitter tee gravity systems o Seepage Bed systems o Alberta At Grade systems	These slopes may be suitable for: o Dosed gravity (other splitting methods). o Trickling gravity, with an ETA beds. o Infiltration trenches with narrow trenches. o Subsurface drip dispersal. On these slopes, consider the following: o Increase the trench spacing to 3 m o Increase dripline spacing for subsurface drip dispersal to 90 cm, if the VS less than 90 cm.
> 25% to 45%	These slopes are not suitable for: o Dose to D-box or splitter tee gravity systems o At-grade beds o Raised systems o Sand mounds o Trenches if the VS is less than 90 cm	These slopes may be suitable for: o Dosed gravity. o Infiltration trenches with narrow trenches. o Subsurface drip dispersal. On these slopes, consider the following: o Increase trench spacing to at least 3.0 m. o Increase dripline spacing for subsurface drip dispersal to at least 90 cm.
> 45%	Not suitable for trench systems	These slopes may be suitable for: o Subsurface drip dispersal, with special dripline spacing considerations. o Selective excavation of level benches, provided that the vertical separation meets standards after excavation.

Notes:

- Protection of the downslope receiving area from impact is particularly important on steep slopes. The AP could consider the use of a covenant area to prevent disturbance or excavation in the receiving area.
- Where slope is greater than 15% the AP should consider slope stability.

III- 4.1.4 CLIMATE

Condition	Site in area which has an average annual rainfall of more than 1800 mm/year.
Constraining factor	HLR values may not be suitable due to the infiltration of rainfall
Adjustment of HLR	Reduce the standard HLR. Multiply the HLR by a factor of: ○ 0.85 if the precipitation is 1800 to 3000 mm/year, ○ 0.75 if the precipitation is more than 3000 mm/year.
Notes	Obtain rainfall data from Environment Canada.

Example:

The soil HLR selected is 25 L/day/m^2. The average annual rainfall is 2100 mm/year

The adjusted HLR = 25 x 0.85 = 21 L/day/m^2

Condition	High net positive evapotranspiration.
Opportunity	Annual evaporation and transpiration exceed annual rainfall, so that a significant part of the discharged effluent may evaporate, and hence does not need to infiltrate into the soil.
Potential solutions	Consider using dispersal or discharge systems that rely on evaporation, such as an ET bed, ETA bed, or a BC Zero Discharge Lagoon.
Notes	○ These types of systems may lead to sodium accumulating in the soil. In the long term, this may damage soil structure, and could lead to system malfunction, or reconstruction with a lower soil HLR. ○ ET and moisture deficit data is obtainable from Farmwest, at http://www.farmwest.com/ ○ See the appendix, Section III- 8.4for further information on sodium and soil.

III- 4.1.4.1 Systems in cold climate conditions

Some parts of BC are cold enough freeze components of sewerage systems. The highest risk systems are those that are:

- Installed in the open, particularly in locations where snow will not accumulate;
- Located in areas where very cold conditions occur without snow;
- Where snow is compacted; and
- Used seasonally, or with uses that produce cold sewage.

In very cold conditions, strategies that help systems avoid freezing include the following:

- Install deeper soil cover over the system, usually with vents that are opened in the summer. A lower soil HLR may be advisable.
- Place strips of rigid Styrofoam board insulation on top of the trenches.
- Insulate the top of the tank or tanks, extending the insulation at least 60cm beyond the edges of the tanks.
- Install the sewerage system where snow will be trapped, and preferably under tree cover.

- Use an Alberta at Grade system; this system was developed for use in a cold climate.

III- 4.1.4.1.(a) Pressure distribution system dosing in a cold climates

The Volume II standards provide an option of low frequency dosing. This option may be useful if there is a risk of the system freezing. This is because it is not always practical to have frequent dosing, and drain the laterals in a pressure distribution system, and because larger doses reduce the freezing risk for some systems.

Another option is to slope the laterals back toward the manifold, in order to drain the effluent back into the pump chamber between doses. This will allow for a higher dosing frequency, but leads to shorter laterals. See Section III- 6.10.3.4 for guidance on specifying laterals to drain back.

III- 4.1.5 FLOOD PLAINS

To check for known flooding risks on a property, contact the local government for flood plain maps and elevations. Ask the property owner about observed flooding elevations on the property.

III- 4.1.6 OFF-SITE DISCHARGE

For a severely constrained site consider the potential for locating the dispersal area on a neighbouring property. See Section III- 2.2.5 for guidance on discharge to a neighbouring property.

III- 4.2 Treatment method and treatment system selection

The Sewerage System Regulation defines three treatment methods and so three kinds of effluent, Type 1, 2 and 3.

- Type 1 is treatment by septic tank.
- Type 2 is treatment that produces an effluent consistently containing less than 45 mg/L of total suspended solids and having a five day biochemical oxygen demand (BOD_5) of less than 45 mg/L.
- Type 3 is treatment that produces an effluent consistently containing less than 10 mg/L of total suspended solids and having a five day biochemical oxygen demand (BOD_5) of less than 10 mg/L, and a median fecal coliform density of less than 400 Colony Forming Units (CFU) per 100 mL. Treatment systems which meet the BOD_5 and total suspended solids standards but not the fecal coliform standard are considered Type 2 treatment methods.

See Section III- 5.1.3 for information on residential sewage and Type 1 effluent.

After selecting a dispersal system, the AP should select a treatment method (Type 1, 2 or 3) and treatment system to match the planned dispersal system and the sewage to be treated. The rationale for selecting the treatment system should be documented.

III- 4.2.1 TYPE 1 (SEPTIC TANK AND EFFLUENT FILTER)

See Section III- 6.4 (septic tanks) and the Volume II septic tank standards for septic tank specification. See Section III- 5.1.3.1 for typical Type 1 effluent quality.

III- 4.2.2 TYPE 2 AND 3 TREATMENT SYSTEMS

III- 4.2.2.1 Selection of Type 2 or 3 treatment systems

When selecting a Type 2 or 3 treatment system, consider **all of the following**:

☐ Match the treatment system to the design flow rate (DDF) and the expected strength of the sewage, and to expected water use patterns (see Section III- 4.2.3 below)

☐ Availability of power

☐ Match to the site and climate

☐ Performance certification and auditing by third party (see Section III- 4.2.2.1.(a))

☐ Performance records for other comparable installed and operating systems on similar sites with similar use

☐ Capital and operating costs, including energy costs and component replacement costs

☐ Availability of preventative maintenance in the future (maintenance provider familiar with the system)

☐ Provisions for effluent quality monitoring

III- 4.2.2.1.(a) Treatment system testing and certification

It is recommended that APs specify treatment systems which have been certified by an accredited certification body to meet the selected treatment method standard.

In general, specific equipment should not be selected on its certification alone, but also assessed for suitability to the particular site and operating conditions as outlined above.

Treatment system testing and certification in Canada and the United States is carried out under the Bureau de Normalization du Quebec (BNQ) (accredited by the Standards Council of Canada) standards, and also under the United States National Sanitation Foundation (NSF) standards.

https://www.bnq.qc.ca/english.html

http://www.nsf.org/

If information from the manufacturer or testing agency was used to help select a system, then the AP should keep this information on file.

III- 4.2.2.2 Performance monitoring of effluent quality in sand media or soil

For a combined treatment and dispersal (CTDS) system collecting an effluent sample at the point of application may require installation of a site built lysimeter. In general, options may include:

- Suction lysimeters:
  - Cup lysimeters, that use a porous ceramic or stainless cup, these are not suitable for bacterial sampling since they will sieve out bacteria and give a false reading.
  - Wick lysimeters, these may be suitable for bacterial sampling but testing of performance will be needed.
- Pan (gravity) lysimeters, these may not give adequate samples if the soil or sand moisture content is low.

For information on lysimeters refer to the United States Environmental Protection Agency, Office of Research and Development, May 1993. *Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide. EPA/625/R-93/003a.*

This US EPA manual may be found by searching online at http://nepis.epa.gov/ for “625R93003a”

III- 4.2.2.3 Additional treatment

As a design option, the AP can define additional treatment needs for an onsite system.

III- 4.2.2.3.(a) Type 2 10/10 Effluent

Type 2 effluent is of minimum 45/45 standard. Certain Type 2 treatment systems may produce an effluent consistently containing less than 10 mg/L of total suspended solids, and having a five day biochemical oxygen demand (BOD_5) of less than 10 mg/L.

This is termed “Type 2 10/10” effluent and the filing should report the treatment method as Type 2. Where “Type 2 10/10” effluent is used, the HLR and other standards for application of this effluent is the same as for Type 2 effluent, Type 3 standards cannot be used for these systems.

III- 4.2.3 MATCHING THE TREATMENT SYSTEM TO THE SEWAGE FLOW RATE AND STRENGTH

When matching the design of the sewerage system to the characteristics of the sewage (the flow rate and sewage strength), the AP should consider the following:

- Examine whether there is a benefit to using flow equalization before, or as part of, the treatment system. This may be helpful if the sewage flow varies widely, or has higher peak flows than typical residential sewage, as defined in III- 5.1.3.1. See below and see Section III- 6.4for discussion of surge flows to septic tanks.
- Review the benefits to using a larger septic tank (or larger trash tank); consider the volume needed and available for sludge accumulation.

- Consider the ability of the treatment system to work with unusually cold water. Most sewage treatment systems do not operate well at water temperatures below 10 C.
- If the sewage is expected to have an unusually high BOD, or high oil and grease content, ensure the treatment system is appropriate to treat the non-residential strength sewage.

III- 4.2.3.1 Flow equalization

Flow equalization prior to treatment will usually improve treatment performance.

Table III- 9 (page III-46) provides typical maximum sewage flow rates per minute and per hour for "residential" effluent from single family homes. If peak minute or hour flows are expected to be greater, then the AP should consider flow equalization.

Flow equalization measures may include one or more of the following:

- Larger septic or trash tank.
- Flow restrictions at the tank outlet filter, so that the septic tank equalizes flows; (These restrictions should accessible for cleaning, and should allow overflow to the outlet pipe).
- Timed dosing to the septic tank or treatment facility.
- A treatment system which includes timed dosing, or other internal flow equalization.

Also see Section III- 5.2.2 for flow equalization and dosing. See Section III- 5.1.3.1 for information on surge flows.

III- 4.2.4 DISPOSAL OF SOLID WASTES

Septic tanks and treatment processes produce biosolids (sometimes known as septage or sludge). These biosolids are treated off-site at an authorized receiving facility. The treatment and discharge of biosolids is not covered by the SSR or by this Manual. When selecting a treatment system, the AP should consider the following:

- The expected pump out interval for tanks and treatment plants, and the associated cost. Refer to the appendix, Section III- 8.6 for expected pump out intervals for septic tanks.
- The need to periodically dispose of degraded filter media, and the associated cost.

For example, for a site where pump out is very expensive due to travel time for the pumper truck, a larger septic tank may mean lower long term operating costs.

III- 5 GUIDELINES FOR PLANNING SYSTEMS

III- 5.1 Daily Design Flow

The Daily Design Flow (DDF) is selected for sizing and specification of the sewerage system, based on the estimated peak (maximum) daily flow of the system. It is also the daily domestic sewage flow to be entered in the Filing of Sewerage System Form.

The DDF is used for sizing septic tanks based on the number of days of retention time at DDF, and is used for assessing the treatment plant hydraulic capacity. It is also used for calculating the area of infiltrative surface (AIS) needed for dispersal areas. See Volume IV, Section IV- 5.4 for further information on DDF.

See Sections III- 3.1.4 and III- 3.1.5 for information on characterizing the source.

III- 5.1.1 CONFIRMATION OF SITE USE

For all types of system, the AP should inform the owner about the DDF, the expected average daily flow to the system, and the type of sewage that the system is designed to accept.

III- 5.1.1.1 Owner declaration and acknowledgement

It is considered good practice to obtain a declaration from the owner that clearly states the owner’s proposed use of the system.

See Section III- 3.1.2 and the appendix, Section III- 8.1 for information on the owner declaration. See Section III- 3.7.2.3 for information to be included in the maintenance plan for owner acknowledgement.

III- 5.1.2 RESIDENTIAL DAILY DESIGN FLOW RATES

The standards provide tables for selecting a DDF; these are based on typical residential use. The AP may use either one of the two methods provided in Volume II:

- Selection using the number of bedrooms and floor area.
- Selection using expected occupancy of the house.

The DDF values in the tables include a peaking factor of 2 (so they are twice the expected average flow). The figures are based on normal residential sewage strength; this is to take into consideration mass loading to the dispersal area. For these reasons it is important that:

- The average flow discharged to the dispersal area should be no more than 50% of the selected DDF (from Section II- 5.1.2) on a 30 day average basis.
- The strength (BOD and TSS) of Type 1 effluent which is discharged to the dispersal area should not exceed the values for Type 1 effluent in Table III- 8 (below).

See Section III- 5.1.3.1 (below) for information on typical residential sewage and peaking factors.

The use of flow reduction devices (example low flow fixtures) does not reduce the Daily Design Flow rates. Although low flow fixtures may reduce the volume of flow, the Daily Design Flow rates are not reduced for system sizing, as the mass loading does not change.

III- 5.1.2.1 Calculating the floor area of a house

To calculate total house floor area, for use in the selection of DDF, do not include:

- Wall thickness, and
- non-living areas, including “air space” (e.g. open space above a stairway or vaulted room), breezeways, carport, garage, workshop, decks, verandahs, and other unheated spaces.

If the house has an unfinished basement, or some other unfinished area, this can be considered as potential future living space, or shown as non-living area, in the best judgment of the AP. The AP should discuss this decision with the owner, explaining the cost and system sizing implications, and also the risk of having to upgrade the system if these areas are finished later. Ensure the owner signs off on the living area used to select the DDF.

III- 5.1.2.2 Examples of selecting Daily Design Flow

III- 5.1.2.2.(a) Using bedrooms and floor area

3 bedroom house, 225 m^2 living area.

From Table II- 8 (page II-20) DDF 1300 L/day

(Maximum allowable floor area 280 m^2)

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3 bedroom house, 300 m^2 living area

From Table II- 8 (page II-20) DDF 1300 L/day

Plus 3L/day additional flow for each square metre of floor area over 280 m^2

= (300 – 280) x 3 = 20 x 3 = 60 L/day.

Total DDF = 1300 + 60 = 1360 L/day.

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3 bedroom house, 225 m^2 floor area plus 1 bedroom carriage house, 100 m^2 floor area

From Table II- 8 for 3 bedroom house, < 280 m^2 floor area, DDF 1300 L/day

And for carriage house, I bedroom, < 140 m^2 floor area, DDF 700 L/day

Total DDF = 1300 + 700 = 2000 L/day.

III- 5.1.2.2.(b) Using occupancy

4 bedroom house with 8 occupants.

Per person flow for normal dwelling from Table II- 9 (page II-21) = 350 L/day

DDF = 8 occupants x 350 L/day/person = 2800 L/day

2 bedroom house, 370 m^2 floor area, projected 2 occupants

DDF based on bedrooms and floor area = 1390 L/day

Minimum occupancy from Table II- 9 for a two bedroom house, 3 people.

Per person flow for single family dwelling from Table II- 9 (page II-21) = 350 L/day

DDF = 3 occupants x 350 L/day/person = 1050 L/day

III- 5.1.2.3 Seasonal cottages

For the purpose of this Manual, seasonal cottages are defined as: Small dwellings (less than 100 square metres floor area) which are occupied for no more than 6 months a year, and are not used as a principal residence.

There is a potential risk of high occupancy for these units, as well as the risk of later use as a full time residence.

If there is doubt about the future use of the cottage as a full time residence or on the level of occupancy, the AP should discuss the decision with the owner, explaining the cost and system size implications, and also the risk of having to upgrade the sewerage system if the building is later used full time. Ensure the owner signs off on the approach used to select the DDF.

III- 5.1.2.4 Suites

For one bedroom suites use the one bedroom DDF from Table II- 8. Add the DDF for the one bedroom suite to the DDF selected for the main dwelling to obtain the overall DDF for the house.

For larger suites either use the appropriate DDF based on bedroom and floor area from Table II- 8 (page II-20) or use the occupancy method. If using the occupancy method consider type of use, it may be appropriate to use per capita flows for multi-family occupancy if the suite shares laundry facilities with the main house.

III- 5.1.2.5 Types of residential occupancy

III- 5.1.2.5.(a) Selection of type of residential use

For existing summer cottages, mobile homes and multifamily dwelling units, consider existing and proposed use and occupancy. Use the standard of Table II- 8, or increase the estimated number of occupants if there is doubt.

III- 5.1.2.5.(b) Luxury homes

For a luxury home average sewage flow per occupant is often higher than for an average home. Luxury homes often include the following:

- Larger overall floor area with larger rooms than an average home.
- High quality, high cost materials than average.
- More water use appliances than an average home.
- Domestic service workers.
- Large parties and frequent guest use.

III- 5.1.3 RESIDENTIAL SEWAGE AND TYPE 1 EFFLUENT CHARACTERISTICS

III- 5.1.3.1 Residential sewage and Type 1 effluent

III- 5.1.3.1.(a) Sewage and effluent quality

Where considering if wastewater is “typical residential sewage” or if effluent is equivalent to that from Type 1 treatment, parameters should be at or below the median values shown in Table III- 8.

Table III- 8. Typical and average parameters for residential sewage and Type 1 effluent

PARAMETER	RESIDENTIAL SEWAGE		TYPE 1 EFFLUENT	
	RANGE	MEDIAN	RANGE	MEDIAN
cBOD5 (mg/L)	290 - 560	420	150 - 300	210
TSS (mg/L)	175 - 400	230	50 - 80	60
Oil and Grease (mg/L)	35 - 60	50	15 - 25	18 (see note)

Note: Oil and Grease may cause plugging of soil or sand surfaces and coat soil particles, reducing soil permeability and reducing the capacity of the soil to treat effluent. For dispersal to sand media (such as to a sand mound), take particular care is to restrict Oil and Grease levels. The recommended median Oil and Grease concentration in effluent is 15 mg/L or less for these systems.

Testing of sewage strength and Type 1 effluent quality is sometimes used to diagnose a malfunction, but seldom as routine monitoring.

III- 5.1.3.1.(b) Peak flows and peaking factors

i) Collection and treatment system

Table III- 9 provides guidance for allowable maximum peak flows from the sewer to a septic tank or trash tank. Where peak flows are expected to exceed these values, (e.g. where large bathtubs will be discharged to the system), the AP should use flow equalization prior to or as part of the septic tank.

Table III- 9. Peak flow rates for residential sewage

	MAXIMUM PEAKING FACTOR TO DAILY DESIGN FLOW	MAXIMUM PEAK FLOW
Peak minute flow	50	75 L/min
Peak hour flow	4	370 L/hour

Notes:

- Peak flow rates shown are for systems with DDF of up to 2200 L/day.
- Refer to treatment plant manufacturer guidelines for allowable peak flows to treatment plants.

In order to estimate the peak surge flows to be expected from a residence or small commercial establishment, Table III- 10 can be used.

Table III- 10. Surge Flows for plumbing trap sizes

OUTLET OR TRAP SIZE	**HIGHEST EXPECTED SURGE FLOW RATE**
INCHES	L/MIN
1.25	28
1.5	57
2	83
2.5	114
3	142
4	170

Note: These surge values per trap size assume that the trap is emptying a container such as a bathtub. They do not take into account the volume of water entering the trap. For example, where a 2" trap serves a shower and the shower is flowing at 11 L/min, the flow from the trap will be only 11 L/min and surge flow rate will be lower than the highest expected surge flow rate.

Where a sewage pump is installed, calculate surge flows based on capacity of the basin and design flow rate.

ii) Dispersal system

Typically peak flow from the treatment system to the dispersal system is 2 to 3 times average daily flow for single family residences and typical onsite systems. Standards of this manual are based on a peaking factor of 2 from the 30 day Average Daily Flow to the tables of residential DDF.

III- 5.1.3.2 Garburators

This Manual instructs the AP to increase the DDF if the building has a garburators (garbage grinder). This is so that the system can accommodate the increase in organic mass loading.

This increased DDF is for use in specifying size of septic tanks and or treatment systems, and sizing the area of infiltrative surface for the dispersal area. When entering the DDF on the filing form, or for other calculations, use the estimated DDF before this increase.

Typically, garbage grinders increase BOD mass discharged by 20–65%, suspended solids (TSS) by 40–90%, and Oil and Grease by 70–150%.

For buildings with a garburator, the AP should consider some type of grease interceptor.

III- 5.1.3.3 Source control

Include instructions for sewage source control in the system maintenance plan. In the instructions, define allowable average and peak flows and allowable sewage strength. Identify harmful chemicals and other contaminants that should not be discharged to the system. Include a summary that the owner can understand. Some important notes for source control, beyond the common concerns:

- Hot tubs, swimming pools, water softener back wash water; iron filter flush water, reverse osmosis system flush flows or any chlorinated back-wash should not be discharged to the system. Refer to the appendix, Section III- 8.2 for further information.
- Where chlorine or other persistent chemicals are used as disinfectants in the house or building, the chemicals should be removed before the effluent is discharged to the septic tank. These chemicals can kill the bacteria in the septic tank and soil, reducing soil-based treatment, and potentially causing a health hazard. The design and operation of the sewerage system should consider how to limit the discharge of disinfecting chemicals into the sewerage system. This is equally the case if chlorine is used for disinfection of effluent in a Type 3 system. The recommended maximum residual level is 4.0 mg/L Chlorine in the wastewater discharged to the septic tank and is less than 1.0 mg/L Chlorine in the effluent discharged to the dispersal area. Refer to the appendix, Section III- 8.2for further information.
- Where sodium levels in effluent are raised because chemicals that disinfect are used (e.g., Sodium Hypochlorite), the AP should ensure that Sodium levels will not cause long-term damage to receiving soils.
- Floor drains should not be connected to the onsite system.
- Excess disinfectants and chemicals will affect the biological processes. Examples of disinfectants and chemicals are: RV holding tank chemicals, photographic chemicals, weed killers, motor oils, antibiotics, floor waxes and strippers. These chemicals and similar substances should not be discharged to the onsite system.

III- 5.1.3.3.(a) Sodium and salinity

Over time, effluent with a high concentration of sodium can cause clay soils to swell or disperse and lose structure and permeability. This will reduce the infiltration capacity of the dispersal system and may lead to premature failure of the sewerage system.

The rate of Type 1 effluent infiltration will usually be limited by the permeability of the Biomat, rather than the soil. However, with limited biomat, expanding clays may limit the long term application of Type 2 or 3 effluents.

See the appendix, Section III- 8.4 for further information.

To reduce the risk of sodium damage to soils, control of the sewage source is important. Low sodium detergents are preferred and water softener flush water should not be discharged to the system. See Section III- 5.1.3.3 (source control).

III- 5.1.4 DAILY DESIGN FLOWS FOR NON-RESIDENTIAL BUILDINGS

Frequently, sewerage system filings for small non-residential facilities or non-residential accessory uses are made under the SSR. For these facilities flows may vary widely from literature and table values, and sewage strength may also vary widely.

Estimating non-residential or multi-use flows is more complicated than estimating flows for a single home. Table III- 11 provides typical average flows for non-residential uses, and can be used as a starting point when selecting a DDF for a non-residential building. Use the average flow and BOD values from the table with a peaking factor appropriate to the use and application.

Table III- 11. Non-residential Average Daily Flow Rate guide

DESCRIPTION	UNIT (PER)	AVERAGE FLOW (L/DAY PER UNIT)	AVERAGE DAY BOD (GRAMS/DAY PER UNIT) AND NOTES
Industrial, commercial (domestic and food service waste only)			Risk of wax strippers and cleaning chemicals, risk of cold water and high ammonia
Office/factory without cafeteria	person	50 to 75	30
Office/factory without cafeteria and with showers	person	75 to 125	35
Office/factory with cafeteria	person	100	38
Open site (e.g. quarry) without canteen	person	60	25
Full time day staff (staff figures apply to all applications)	person	50 to 75	38
4 hour shift day staff (staff figures apply to all applications)	person	45	25
Dental or medical office	practitioner	1000	(risk of antibiotics and drugs)
Beauty salon (without staff)	Seat	1000	(risk of chemicals and hair)
Store, washroom flow only	square metre	5	
Shopping center, per toilet room	toilet room	1700	380
Shopping center, per parking space	parking space	10	
Accommodation			Risk of wax strippers and cleaning chemicals
Hotel or motel, bed and breakfast, per guest, except for luxury hotels	person	200	90
	bedroom unit	250 to 400	180
Housekeeping unit, no meals	bedroom unit	450	130
Guest bedrooms only, no meals	person	80	50
Non-residential conference guest or day camp, including meals	person	60	25
Resident staff	person	170	60
Cabin resort	person	225	90 (risk of high strength wastes from food service)
Residential or work camps, flush toilets, no meals	person	140	90
Residential or work camps, flush toilets and meals	person	225	90 (risk of high strength wastes from food service)
Residential camps, no flush toilets	person	60	
Dormitory bunkhouse	person	140	90
Nursing Home or retirement home	person	475	110 (risk of antibiotics and drugs)
Laundromat (e.g. in apartment building)	machine	1200 to 2400	260 to 530

DESCRIPTION	UNIT (PER)	AVERAGE FLOW (L/DAY PER UNIT)	AVERAGE DAY BOD (GRAMS/DAY PER UNIT) AND NOTES
Food service and bars			Risk of wax strippers and cleaning chemicals, risk of cold water and high ammonia, risk of oils and greases
Restaurant	meal	12	15
Restaurant (fast food, paper service)	meal	12	12
	seat	60	
Restaurant (full service)	meal	30	38
	seat	90	120
Open more than 16 hours a day	seat	190	250
Restaurant (pre prepared catering)	meal	25	30
Institutional meals	meal	20	20
Function rooms, buffets	meal	30	20
Snack bar or bar meals	person	15	20
Bar/lounge/pub	person	12	15
	seat	140	180
Coffee shop	patron	20	20
	seat	400	
Amenity sites			Risk of wax strippers and cleaning chemicals, RV holding tank chemicals, risk of cold water and high ammonia
Toilet and shower blocks			
Shower	use	40	6
Toilet urinal	use	5	1.5
Toilet (WC)	use	10	12
Visitor center or Day use site, with flush toilets	person	20	15
Tent or trailer sites (central comfort station, no sani-dump facility)	person	75 to 150	45 at low end of range
	site	180 to 360	108 at low end of range
Camp Trailer site fully serviced (with hook up)	person	70	75 (risk from RV holding tank wastes and high strength)
	site	170	170 (risk from RV holding tank wastes and high strength)
Assembly hall	person	15	12

DESCRIPTION	UNIT (PER)	AVERAGE FLOW (L/DAY PER UNIT)	AVERAGE DAY BOD (GRAMS/DAY PER UNIT) AND NOTES
Schools and day care			Risk of wax strippers and cleaning chemicals, risk of cold water and high ammonia
School, non-residential no cafeteria, no showers	student	15 to 30	20
School, non-residential no cafeteria, with showers	student	50	25
school non-residential with cafeteria, with showers	student	90	38
Boarding school per student	student	200 to 300	75 to 100
Day care center, per child	child	75	30

Notes:

- Use these figures with caution, these are averages and the flow and BOD values may vary widely from one facility to another. For food service uses, consider Oil and Grease level as well as the BOD level.
- Consider the potential impact of high ammonia loading and cold water on treatment processes.
- Consider the expected level of use and installed fixtures when estimating average daily flow if a value is shown as a range.
- Add staff flows as needed.

III- 5.1.4.2 Peaking factors for use with non-residential average flow values

The values provided by Table III- 11 relate to peak day flows in differing ways. For example, the flow per use for a water closet is an actual flow, whereas the flow per person for a bunkhouse is an average flow that will need to be multiplied by a peaking factor to result in a Daily Design Flow.

A typical range of peaking factors for treatment and dispersal system design for non-residential facilities is 1.5 to 5. The AP should select and use a peaking factor appropriate to the facility and projected use

The treatment and dispersal system sizing and specification standards of this Manual are based on flow peaking for normal residential sewage and effluent. In order to use the sizing and specification standards of this Manual the AP should ensure that the selected peaking factor and any flow equalization specified results in a DDF with peaking equivalent to that for residential sewage and effluent.

For example, if expected flow peaking is higher than normal for residential sewage, added flow equalization can be used to reduce flow peaking to the treatment and dispersal systems.

III- 5.1.4.3 Mass loading and non-residential flows

The system selection standards (site capability, treatment system selection) and system sizing (septic tank sizing, hydraulic loading rate and linear loading rate, etc.) standards of this Manual are based on typical residential sewage and effluent (see Section III- 5.1.3.1 for sewage strength and peak flows).

When estimating a DDF for non-residential uses, it is standard practice to consider BOD mass loading, and to check that mass loading does not exceed that for typical residential effluent when applied to the treatment system and the dispersal area. This consideration goes hand in hand with selection of a peaking factor to estimate DDF from the values in Table III- 11.

Table III- 12 indicates particular categories of non-residential uses where sewage strength varies widely from normal residential sewage strength.

Because of this greater strength it is not appropriate to size and specify a dispersal system based on the standards of this manual for these uses.

Table III- 12. Facility categories

TYPE OF FACILITY	SEWAGE STRENGTH SIGNIFICANTLY HIGHER THAN RESIDENTIAL?
Industrial, commercial	At minimum for medical and Personal Care facilities
Accommodation	At minimum for commercial food service flows
Food Service and bars	Yes
Amenities	At minimum for food service flows and for RV holding tank sani-dumps.
Schools	At minimum for food service flows

III- 5.2 Distribution and dosing guidelines

III- 5.2.1 TYPES OF DISTRIBUTION AND DOSING

This Manual provides different vertical separation and soil capability standards depending on the type of distribution and on the type and frequency of dosing.

This is because:

- More uniform distribution has been demonstrated to improve soil treatment by improving aeration and by reducing saturation.
- Small doses have been demonstrated to improve soil treatment by reducing saturation and improving oxygenation.

See Volume IV Section IV- 5.6 for further information on soil treatment and the factors that affect soil treatment.

For very permeable soils, the standards of this Manual specify considerably larger vertical separation for gravity distribution and demand dosed uniform distribution systems. These highly permeable soils are considered to have poor pathogen removal performance unless effluent is applied in small doses; this is because larger doses or trickling application to these soils result in bypass flows and poor pathogen removal.

III- 5.2.1.1 Options

The standards provide a wide range of options. For the majority of sites the simpler options, gravity distribution and demand dosed pressure distribution, will be adequate.

As the site becomes more constrained, the options of timed or micro-dosing will give advantages—particularly in reduced vertical separation or allowance for shallower native soil depth.

If Type 2 HLR is being used, increased vertical separation (VS) is needed for gravity and also for some types of dosing on some soils—in these cases, if soil is shallow the use of uniform distribution and timed or micro-dosing will allow for use of the same VS as for Type 1 HLR.

When deciding on the best **option** for the site, consider a number of factors, including installation and maintenance cost. For example, it may be more economical to choose the option of uniform distribution with timed dosing rather than add extra sand fill to allow use of demand dosing.

III- 5.2.1.2 Flow equalization and treatment

By specifying a simple system that equalizes or buffers the rate of effluent flow into a treatment plant, an AP can improve the performance of the treatment system.

Where the Volume 2 standards refer to timed dosing or equivalent flow equalization, the flow equalization can be made prior to or as part of treatment. This approach may be used to reduce or remove the need for flow equalization at the dispersal system pump tank.

The AP should assess the degree of equalization to determine if it is reliable and is equivalent to timed dosing, and add further equalization at the pump tank, if appropriate.

For micro-dosing, APs will find advantages to using timed dosing from the pump tank to reliably achieve the small, evenly spaced, doses needed for this type of application.

III- 5.2.2 DOSING FOR UNIFORM DISTRIBUTION SYSTEMS

III- 5.2.2.1 Selection of dosing method and dose frequency

III- 5.2.2.1.(a) Hydraulic application rate

Dosing standards for uniform distribution systems are based on the concept of Hydraulic Application Rate (HAR). This is the depth of effluent applied to the infiltrative surface per dose (example mm). HAR may also be expressed in terms of volume per area per dose (example L/m^2) or in volume per orifice or emitter per dose.

HAR = HLR ÷ Dose Frequency

In general it is important to use a low HAR, that is, to dose as frequently as practical, considering uniformity of distribution. This will result in as small a dose as practical, while still achieving proper distribution.

Specify a minimum dose frequency when planning the system, following the standards. If practical, increase the number of doses per day at commissioning. See Section III- 6.12.3.5 for instructions on calculation of dosing at system commissioning.

The standards provide the allowable minimum doses per day, however the intent is to control the dose volume, and so control the HAR.

Dose frequency is different for Type 1 and Type 2 HLR. This is because Type 2 HLR is higher and so higher dose frequency is needed to maintain a low HAR, in order to provide adequate pathogen removal within the soil or sand vertical separation. See Section III- 5.3.2.2.(d) for further information.

III- 5.2.2.1.(b) Low frequency dosing option

The vertical separation (VS) standards of this manual were developed considering HLR and dose volume (dose frequency). Since VS is often a constraint, higher dose frequency is specified to allow the use of shallower VS.

However, where VS is not constrained because of deeper soils, it is often feasible to use lower dose frequency (larger dose volumes). This is provided as the “low frequency” dosing option for demand and timed dose uniform distribution systems.

This option may be useful where freezing conditions make it more difficult to use small dose volumes, or for certain dosing methods. See Section III- 6.10.3.4 for discussion of strategies for pressure distribution systems in freezing conditions.

III- 5.2.2.1.(c) Timed dosing

Timed dosing is an option that can be considered for a uniform distribution system. This method can offer advantages, such as reduced requirements for vertical separation. However, it is seldom required.

Timed dosing results in equal doses, spaced more evenly over 24 hours. This provides several advantages over demand dosing, including:

- Limiting the Hydraulic Application Rate, because the dose is restricted to a certain pump time (and so a certain volume), whereas a demand dose can discharge larger than planned volume if there is inflow to the pump chamber during a dose.
- Improved aeration of the infiltrative surface due to certain resting time between doses, in contrast to a demand dosed system where doses can occur in close sequence if peak flows are high from the house.

- Equalization of peak day flows over the day and, in some cases, over more than one day.
- Control of effluent discharged to the dispersal area. A properly specified timed dose system will not allow discharge of more than the design flow in any day. This reduces the risk of overloading the dispersal area due to leaks, inflow or infiltration or due to over use of the system.
- More reliable calculation of system flows based on pump starts and run times.

Timed dosing standards are provided as doses per day at DDF for simplicity. However, the critical advantage of timed dosing is that it controls the Hydraulic Application Rate (HAR) per dose, and spaces doses apart by a defined length of time. So, whether flows are high or low, the HAR and interval will stay the same.

Where practical for the project, plan to time dose at average flows. This will improve spread of the doses over the whole day during normal operation. This may require a larger pump chamber, see Section III-6.12.2.1.(b) (Timed dosing pump chambers) for further information.

III- 5.2.2.2 Micro-dosing

Micro-dosing is a form of timed dosing also termed "low hydraulic application rate timed dosing". This is a further option that can be considered for a uniform distribution system.

While seldom necessary, this method can offer advantages, such as reduced requirements for vertical separation. Micro-dosing is timed pressure dosing at a high dosing frequency, resulting in a low hydraulic application rate (HAR), as defined in Volume II, Section II- 5.2.2.3.

The standards provide a simplified table (Table II- 12, page II-24) of dose frequency for micro-dosing. The table is based on calculation of hydraulic application rate (HAR) for each soil type, but for simplicity several types of soil are combined. It is also based on use of standard maximum HLR for Type 1 or 2 effluents.

This means that, in some cases, a lower frequency of dosing can be used if hydraulic application rate is calculated instead of using the simplified table. A lower frequency could also be used if a lower HLR is being used.

For some soil conditions (example high coarse fragment content), higher frequency will be needed as identified in the soil constraint summary table (see Section III- 4.1.2.2).

When calculating micro-dosing HAR, the maximum dose per square metre is not to exceed 10% of the water holding capacity of the soil or sand media directly below the bed.

For calculation of micro-dosing HAR, use the depth of the selected vertical separation up to a maximum of:

- 60 cm depth for sands, loamy sands, *Clean Coarse Sand* or Mound Sand, fine sands and loamy fine sands;
- 30 cm depth for loamy very fine sands and sandy loams;
- 15 cm depth for loam, silt loams, silts, clay loams and clays.

III- 5.2.2.2.(a) Example of selecting micro-dosing frequency based on the simplified table:

Consider a site with 60 cm total VS, made up of 50 cm depth of silty clay loam (structure and consistence category "Favorable") plus a 10 cm sand blinding layer. Type 1 effluent, HLR 15 L/day/m^2 and DDF of 1500 L/day:

Do not consider the blinding layer.

The silty clay loam soil is 50 cm deep, but for micro-dosing consider only 15 cm of this depth.

Minimum dose frequency from Table II- 12 (page II-24) = 12 doses per day at DDF

Dose volume = DDF ÷ maximum doses per day = 1500 ÷ 12 = 125 L per dose

III- 5.2.2.2.(b) Micro-dosing frequency calculation based on soil water holding capacity.

For micro-dosing, the frequency of doses is calculated so that each individual dose amounts to less than 10% of the water holding capacity (WHC) of the soil below the infiltrative surface.

For this calculation, the depth of soil to be considered depends on the soil type. See Volume IV Section IV-5.7.1.1 for further information on water holding capacity and hydraulic application rate.

If the soil's water holding capacity is expected to vary over the depth under consideration, give priority to the layer closest to the infiltrative surface. For example; in the case of a sand fill system, use the water holding capacity of the sand media and the depth of the sand media. However, blinding layers should not be considered. For soils with strong structure or macropore conditions lower HAR is preferred. In all cases it is preferable to use as large a number of doses per day as is practical.

As a guideline, Table III- 13 (below) provides typical water holding capacity values for soils. The AP should adjust these values where soil conditions do not meet the stated norms.

If non-standard (for example, lower) HLR is used, then the AP can use this table to calculate the minimum number of doses per day, which, may be less than the number in the simplified standards table.

As noted above, calculated minimum dose frequency may also be lower than the simplified table for some soil types (since soil types are grouped in the simplified table).

Table III- 13. Typical soil water holding capacity (WHC)

SOIL TEXTURE	WHC	10% OF WHC, IN MM DEPTH OF APPLICATION (L/M^2 /DOSE)			
	AS VOLUME PROPORTION	FOR 15 CM SOIL DEPTH	FOR 30 CM SOIL DEPTH	FOR 45 CM SOIL DEPTH	FOR 60 CM SOIL DEPTH
Very Gravelly sand	0.025	0.37	0.75	1.13	1.5
Gravelly Sand	0.042	0.63	1.26	1.9	2.52
Mound sand	0.046	0.7	1.4	2.1	2.75
Sand or *Clean Coarse Sand*	0.05	0.75	1.5	2.25	3.0
Loamy Sand	0.07	1.0	2.0	3.2	4.1
Sandy Loam	0.10	1.5	3.1		
Loam	0.14	2.2	4.3		
Silty Loam	0.20	3.0			
Silt	0.24	3.6			
Sandy Clay Loam	0.11	1.7			
Clay Loam	0.15	2.2			
Silty Clay Loam	0.18	2.7			
Silty Clay	0.14	2.1			
Clay	0.12	1.7			

Note: These values are based on favorable soil structure and consistence and average soil characteristics, including organic matter content (2 to 4% for soils and 0.5% for sand media). They do not include consideration of coarse fragments (except in the case of Very Gravelly or Gravelly Sand.

III- 5.2.2.2.(c) Examples of micro-dose calculation using 10% of water holding capacity

i) Example 1:

For this example consider a Sand mound with 75 cm total VS, made up of 30 cm depth of Mound Sand on top of 45 cm depth of Sandy Clay Loam (favorable structure and consistence, Perc rate 45 min/inch). Type 1 effluent, HLR to the sand surface 40 L/day/m^2:

Water holding capacity varies over the VS but the sand is closest to the infiltrative surface, so the sand water holding capacity and depth is used.

10 % of water holding capacity for 30 cm depth of Mound Sand from Table III- 13 = 1.4 L/ m^2, this is the maximum volume per square metre per dose (maximum HAR).

Minimum dose frequency = HLR ÷ maximum HAR = 40 ÷ 1.4 = 28.5 doses per day at DDF.

This is the same as the frequency in the simplified dosing table in the standards

(Which shows 28 x day).

ii) Example 2:

For this example consider a site with 60 cm total VS, made up of 60 cm depth of Silty Clay Loam (structure and consistence category "Favorable", Perc rate 35 min/inch). Type 2 effluent, HLR 25 L/day/m^2:

The Silty Clay Loam soil is 60 cm deep, but for HAR consider only 15 cm of this depth.

10 % of water holding capacity for 15 cm depth of silty clay loam from Table III- 13 = 2.7 L/ m^2, this is the maximum volume per square metre per dose (maximum HAR).

Minimum dose frequency = HLR ÷ maximum HAR = 25 ÷ 2.7

= 9.2 doses per day at DDF.

Although this calculated dose frequency is less than that in the simplified dosing table

(Which shows 20 x per day) it can safely be used for micro-dosing.

In this case, the Silty Clay Loam soil has a higher water holding capacity than some of the other soils it is grouped with in the simplified table; this means that the calculated micro-dosing frequency will be lower than the minimum frequency in the simplified table.

III- 5.2.2.2.(d) Micro-dosing to soils with high coarse fragment content and denser soils

Soils with a higher coarse fragment content will have a lower capacity to hold water. In general, soils with higher density will also have a lower capacity to hold water. Therefore, when dosing effluent to these soils, use a lower hydraulic application rate.

i) Micro-dosing frequency from the simplified table:

The Volume II standards provide lower HLRs for denser soils. The standards also reduce the HLR for soils with a high content of coarse fragments. This means that the simplified micro-dosing frequency from Table II- 12 (page II-24) has already been adjusted for these soils.

For very gravelly sand, start with the dosing frequency for gravelly sands (from the simplified table) and multiply by a factor of 1.7.

ii) Calculated micro-dosing frequency for soils with high coarse fragment content:

When calculating a hydraulic application rate (HAR), following Table III- 13, adjust the water holding capacity of the soil, for gravel content above 35%.

To do this, reduce the water holding capacity by multiplying the table WHC value by a factor of (1 – coarse fragment content).

For example, for a site with a 60 cm depth of Very Gravelly Loamy Sand, with a total coarse fragment content of 50%, and a selected HLR of 25.5 L/day/m^2 , calculate the dosing frequency as follows (note that this HLR has been adjusted based on gravel content following Section III- 4.1.2.2):

10% of WHC from Table III- 13 is 4.1 L/m^2

This is the recommend maximum volume per square metre per dose, and needs to be adjusted for coarse fragment content;

Design maximum volume per square metre per dose =

4.1 x (1-0.5) = 4.1 x 0.5 = 2.05 L/m^2 per dose

Minimum dose frequency = HLR ÷ maximum HAR = 25.5 ÷ 2.05

= 12.5 doses per day at DDF

iii) Calculated micro-dosing frequency for soils with “poor” structure and consistence category:

For soils with a structure and consistence category of “Poor” (from the standards Table II- 4 (page II-13)), if calculating a hydraulic application rate (HAR) following Table III- 13, then adjust the water holding capacity of the soil by multiplying the table WHC value by a factor of 0.83. This is based on these soils typically having a higher bulk density.

For example, for a site with 60 cm depth of Loamy Sand soil with consistence of firm (structure and consistence category “Poor”) and HLR of 27 L/day/m^2:

10% of WHC from Table III- 13 is 4.1 L/m^2

This is the recommend maximum volume per square metre per dose, and needs to be adjusted for the denser soil;

Design maximum volume per square metre per dose = 4.1 x 0.83 = 3.4 L/m^2 per dose

Minimum dose frequency = HLR ÷ maximum HAR = 27 ÷ 3.4

= 8 doses per day at DDF

III- 5.2.2.3 Timed and micro-dosing with subsurface drip dispersal systems

Since subsurface drip dispersal systems (SDD) use a lower hydraulic loading rate it is acceptable to reduce the dose frequency from the values in the Volume II standard dose frequency tables.

The standards specify that HLR for SDD is reduced from the standard values by multiplying those values by a factor of 0.5 for Type 1 effluent and 0.7 for Type 2 effluent. See Section III- 5.5.2.2for details.

For timed dosing, where the HLR is selected and reduced using the factors for SDD in the standards, Table III- 14 provides minimum dose frequencies for timed dosed SDD systems. Note that SDD systems do not use the reduced dose frequency standards for cold climate conditions.

SDD systems typically use micro-dosing. Micro-dosing frequency can be calculated following Section III- 5.2.2.2. For common situations, where the HLR is selected and reduced using the factors for SDD in the standards, Table III- 14 and Table III- 15 (below) provide recommended minimum dose frequencies. If lower HLR are used, calculate micro-dosing frequencies.

Table III- 14. Minimum dosing frequency for timed dosing, with SPM HLR for SDD

SOIL TYPE OR NOTES	DOSING FREQUENCY AT DDF	
	Type 1 SDD HLR	Type 2 SDD HLR
Gravelly Sands, Coarse Sand, Loamy Coarse Sand, Sand, Loamy Sand, Fine Sands, Loamy Fine Sands, *Clean Coarse Sand*, Mound Sand.	8 x per day	16 x per day
Clean Coarse Sand, Mound Sand in sand mound or sand lined trench/bed.	8 x per day	Micro-dosing
Other soils	5 x per day	10 x per day

Table III- 15. Micro-dosing frequency, with SPM HLR for SDD

EFFLUENT TYPE	DOSES PER DAY, TYPE 1 SDD HLR			DOSES PER DAY, TYPE 2 SDD HLR		
SOIL TYPE / SOIL DEPTH	30 CM	45 CM	60 CM	30 CM	45 CM	60 CM
Gravelly Sands	18	12	9	36	24	18
Mound sand	14	10	8	34	22	16
Sands, Loamy Sands, *Clean Coarse Sand*	10	8	6	24	16	12
Loamy Fine Sand, Sandy Loam, Fine Sandy Loam	8	8	6	20	12	10
Very Fine Sandy Loam, Loam, Silt Loam, Silt	6	6	6	12	12	12
Clay Loams, Clays	6	6	6	12	12	12

Note: Follow soil depth instructions in the standards.

III- 5.3 Vertical separation

III- 5.3.1 MINIMUM REQUIRED VERTICAL SEPARATION

In general, the purpose of vertical separation is to provide unsaturated aerated soil to treat the effluent. The primary objective is to remove pathogens.

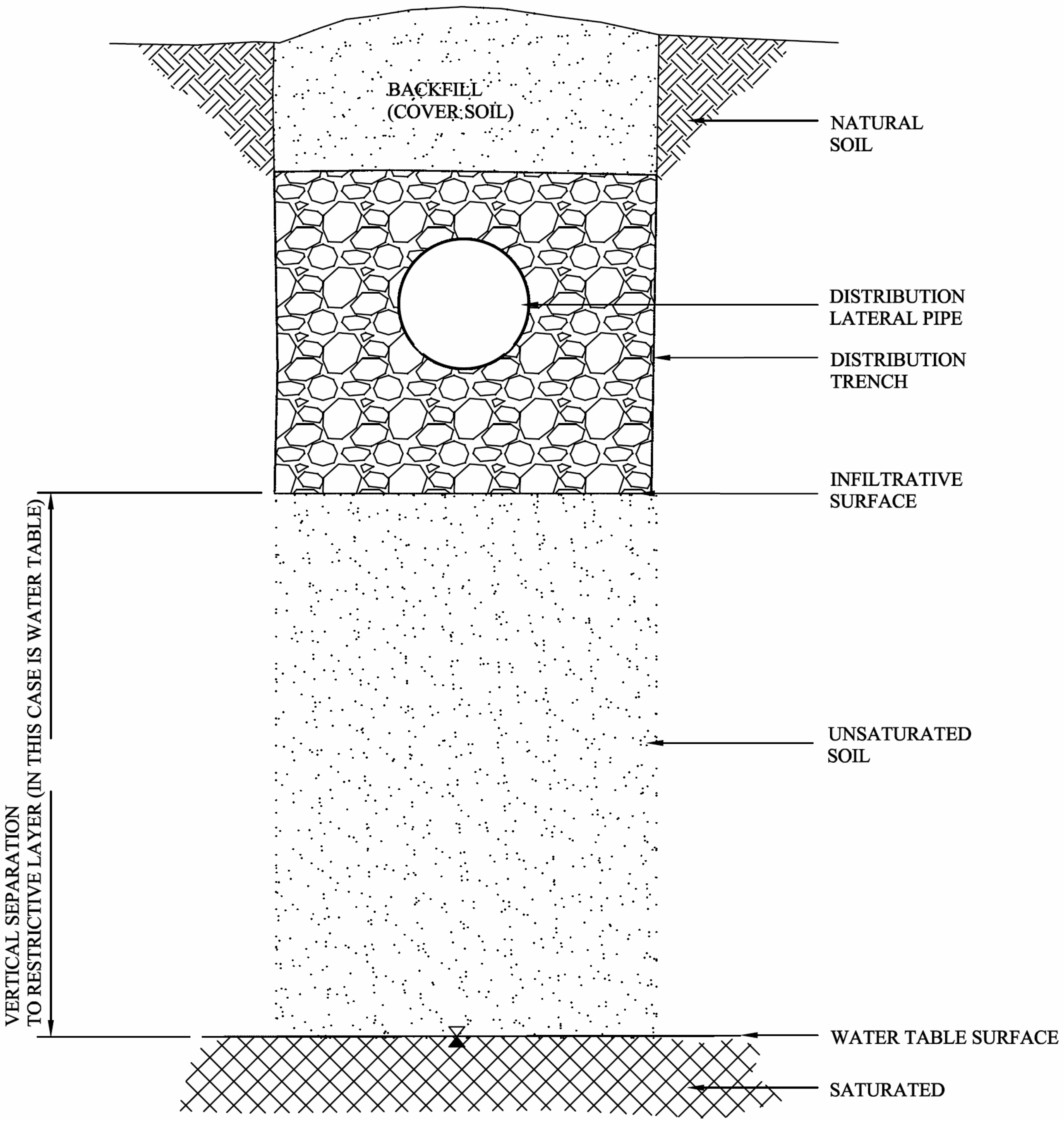
Soil treatment performance is affected by many factors, including characteristics of the effluent, hydraulic loading rate, hydraulic application rate, type of distribution and dosing, type of soil, and the specification and operation of the sewerage system.

This is why there are different tables for different types of distribution, and different rows for type of dosing and type of effluent hydraulic loading rate (HLR) used. For most sites there will be several different vertical separation options available.

Figure III- 1 shows vertical separation (VS) for a conventional system. The vertical separation (VS) is measured in the same way for fill systems and sand mounds.

See Section III- 6.16 for illustration of vertical separation for a Combined Treatment and Dispersal System.

Figure III- 1. Vertical Separation between the Infiltrative Surface and the Restrictive Layer



III- 5.3.2 VERTICAL SEPARATION FOR DISPERSAL SYSTEMS

III- 5.3.2.1 Selecting vertical separation

To select the vertical separation (VS), the AP should use the standard VS tables, starting with the simplest in ground system and noting the available options. See Section III- 4.1.1.1 for information on conceptual design and system selection.

The System Selection Worksheet can be used to record VS options (see Section III- 4.1.1.2).

If soil depth is limited, the infiltrative surface can be placed higher in the soil ("shallow placement"), at the surface ("at grade") or elevated above the surface on a layer of sand media fill ("above grade" or "raised").

Gravity systems can be used below grade, shallow or even at grade. Uniform distribution systems can be used below grade, shallow, at grade or above grade. At-grade beds and Alberta At Grade systems are specialized forms of at grade systems.

If the sand layer used to raise the system above grade is 30 cm or thicker, then the "above grade" or "raised" system becomes a sand mound.

Sand mounds are a type of above grade system. Sand mounds, sand lined trenches and beds have a separate VS table because they are a specific technique.

III- 5.3.2.1.(a) Soil and as constructed vertical separation

Where Volume II tables show a minimum soil VS and a minimum as constructed VS, then meet both standards:

Soil VS + Sand media fill VS = as constructed VS.

For example, Native soil depth is 60 cm and soil texture is Loamy Sand, Using Type 2 effluent, with pressure distribution and standard frequency demand dosing:

Table II- 15 (page II-27) minimum native soil VS is 60 cm, minimum as constructed VS is 85 cm.

A raised system can be used with 25 cm sand fill to meet the standard for as-constructed VS

60 cm of Soil + 25 cm sand = 85 cm as constructed VS.

When looking at the VS tables, look at the type of distribution and dosing that is needed for each option. It is important to also consider the site capability standards (Section II- 4.1.2).

Remember that site drainage may be an option if the shallow soil depth is caused by seasonal high water table. See Section III- 6.19 for information on site drainage.

III- 5.3.2.2 Example of selecting vertical separation options for a site

Consider a site with the following conditions: Land slope is 12%. The soil is a Loamy Sand, with a favorable structure and consistence, Kfs of 3000 mm/day and a 90 cm soil depth to the restrictive layer (low permeability). The climate is not extremely cold. Area for dispersal system is not constrained.

Check site capability, then check distribution and dosing options, simplest first.

Gravity site capability Table II- 5 (page II-14) specifies gravity distribution not allowed as soil depth (maximum available VS) is less than 150 cm

System constraints Table II- 6 (page II-16) allows for any type of dispersal system other than lagoons and ETA beds

Soil constraint Table II- 7 (page II-17) does not require any specific distribution or dosing method.

Working down through the VS tables (page II-26 onward), simplest first:

Table II- 14 (gravity distribution), no option due to soil depth

VS options, using Type 1 HLR as area is not constrained

Table II- 15 (uniform distribution with demand dosing to systems with < 30 cm sand media fill):

1. Type 1, demand dose, minimum 60 cm native soil, 60 cm total. Option is usable.
2. Type 1, low frequency demand dose, minimum 75 cm native soil, 75 cm total. Option is usable with shallow placement system.

Table II- 16 (uniform distribution with timed or micro-dosing to systems with < 30 cm sand media fill):

1. Type 1, timed dose, with 45 cm minimum native soil, minimum 60 cm total. Option is usable.
2. Type 1, low frequency timed dosing, with 60 cm minimum native soil, minimum 75 cm total Option is usable with shallow placement system.
3. Type 1, timed dose, with 45 cm minimum native soil, minimum 55 cm total. Option is usable but is not necessary as does not provide VS advantage for this site.

Choice of option is open, as all types of dosing are usable on this site. As freezing is not an issue, normal dose frequency may be preferred to allow normal system placement. Timed dosing may be selected for reasons other than VS—for example, to prevent over use of the system, but is not required.

Table II- 17 (sand mounds, sand lined trenches/beds), options are available but not needed as simpler option using native soil is available.

Table II- 18 (subsurface drip dispersal (SDD) systems with micro-dosing), options are available:

Type 1 or 2 SDD with micro dosing, minimum 45 cm native soil, fill option not needed.

For this site, the simplest and lowest cost option, considering only VS, is likely to be Type 1 pressure distribution with normal demand dosing.

Note that options may be chosen for reasons other than VS—for example, timed dosing may be chosen for other advantages, or subsurface drip dispersal may be chosen to allow retention of trees or landscaping.

III- 5.3.2.2.(a) Example of selecting vertical separation options for a site, shallow soil

Consider a site with the following conditions: Land slope is 12%. The soil is a Sandy Clay Loam, with a favorable structure and consistence, and a 30 cm soil depth to the restrictive layer (low permeability). The climate is not extremely cold.

Gravity site capability Table II- 5 (page II-14) specifies gravity distribution not allowed for soil type

System constraints Table II- 6 (page II-16) shows sand mounds are allowed

Soil constraint Table II- 7 (page II-17) specifies uniform distribution and timed or micro dosing.

Working down through the VS tables (page II-26 onward) , simplest first:

Table II- 14 (gravity distribution), no option due to soil type

Table II- 15 and Table II- 16 (uniform distribution to systems with < 30 cm sand media fill), no options due to soil depth.

Table II- 17 (sand mounds, sand lined trenches/beds), three options are available since minimum soil depth is met (25 cm minimum):

1. Type 1, demand dose, with 60 cm minimum sand depth, minimum 85 cm total
   60 cm sand plus the 30 cm soil = 90 cm total, meets the 85 cm total standard
2. Type 1, timed dose, with 45 cm minimum sand depth, minimum 75 cm total
   45 cm sand plus the 30 cm soil = 75 cm total, meets the 75 cm total standard
3. Type 1, low frequency timed dosing, with 60 cm minimum sand depth, minimum 85 cm total
   60 cm sand plus the 30 cm soil = 90 cm total, meets the 85 cm total standard
4. Type 1 with micro-dosing 30 cm minimum sand depth, minimum 60 cm total
   30 cm sand plus the 30 cm soil = 60 cm total, meets the 60 cm total standard
5. Type 2 with micro-dosing 45 cm minimum sand depth, minimum 75 cm total
   45 cm sand plus the 30 cm soil = 75 cm total, meets the 75 cm total standard

Table II- 18 (subsurface drip dispersal (SDD) systems with micro-dosing), options are available if sand media fill is added, since the 30 cm minimum native soil depth is met:

Type 1 or 2 SDD with micro dosing, minimum 60 cm total
30 cm sand plus the 30 cm soil = 60 cm, meets the standard

The choice of dispersal system will now depend on other factors, such as the available land area. Again, start with the simplest option first. For this example, if area is not a constraint, a Type 1 sand mound with demand or timed dosing could be a suitable option for this example.

The choice in this case would include consideration of how high a sand mound is acceptable to the owner, and consideration of the cost of added sand for the demand dose option given the relatively steep slope. Timed dosing or micro-dosing options may be less costly if sand is expensive, despite the need for larger pump tanks and a more sophisticated pump control panel. These options would also give other advantages, such as more reliable control over flows to the dispersal system.

Check back to Table II- 6 (page II-16) (key system constraints): The table indicates that a sand mound is OK for the site.

Document the selected VS option(s) and the rationale in the System Selection Worksheet (see Section III-4.1.1.2) or by recording in another format.

III- 5.3.2.2.(b) Blinding layer and vertical separation standards

See Section III- 6.5.2.1.(e)for description of a sand blinding layer and information on where a blinding layer should be used.

When selecting a vertical separation for a system with a blinding layer, consider the following:

- For gravity and uniform distribution systems, the blinding layer can be considered part of the native soil VS, if the infiltrative surface is at or below grade, and **provided** that the layer is less than 10 cm thick.
- If the sand layer is thicker than 10 cm, then it is not a blinding layer, and the full sand depth should be considered as part of the sand media depth, **not** the native soil depth.
- If the infiltrative surface is raised, all the sand media (regardless of thickness of the layer) should be considered as part of the sand media depth, **not** the native soil depth.

This allows for installation of the blinding layer by over excavating a trench by 10 cm, and then adding the blinding layer, and dis-allows using a blinding layer to raise a system above grade or to allow use of shallower native soil depth than indicated by the standards tables with a fill system.

III- 5.3.2.2.(c) Boundary conditions

Depending on the type of boundary at the base of the VS, special care may be needed.

Boundaries that need special care include:

- Fractured rock above a fractured rock aquifer.
- Very high permeability soil, particularly when above an unconfined aquifer.
- A permanent water table, when nearby water wells draw water from the same shallow aquifer.

For these higher risk situations, consider increasing the vertical separation, reducing the soil hydraulic loading rate, and using micro-dosing.

In general, increasing the VS by 15 to 30 cm, or moving from demand to micro-dosing, will improve pathogen removal in the soil system. Reducing HLR will also improve pathogen removal. If Type 2 effluent is being used, consider reducing the HLR so that the HLR is closer to that for Type 1 effluent; this will improve pathogen removal.

Online mapping of aquifers and wells can be viewed at iMapBC (http://maps.gov.bc.ca/ess/sv/imapbc/) and the BC Water Resources Atlas (http://www.env.gov.bc.ca/wsd/data_searches/wrbc/index.html), respectively. Note that provincial aquifer mapping exists only where sufficient information is available—not all aquifers in BC have been mapped and assessed.

III- 5.3.2.2.(d) Type 2 effluent hydraulic loading rate and vertical separation

i) Vertical separation for Type 2 hydraulic loading rates

The use of a Type 2 treatment method is a viable option on many projects and sites (particularly if available area is limited), although this will seldom be the only viable option. The Volume II standards indicate a larger vertical separation for Type 2 effluent hydraulic loading rates (HLR) in some cases, particularly for gravity distribution and for demand dosing.

A larger soil depth is specified to provide for adequate soil based treatment (particularly pathogen removal) in these cases because:

- Type 2 effluent may have pathogen levels nearly as high as in Type 1 effluent.
- Type 2 effluent hydraulic loading rates are higher than for Type 1, and so:
    - risk of bypass or saturated flow from the infiltrative surface is higher,
    - there is a higher risk of soil saturation if multiple doses are applied in a short time, and
    - total number of pathogens applied will be correspondingly higher at the higher HLR.
- Type 2 systems typically have less or no biomat, resulting in:
    - less effective distribution with gravity dispersal,
    - less moderation of effluent flow to the soil from the infiltrative surface, and
    - less removal of pathogens by the biomat.

Since Type 2 treatment systems are often used as a solution for a small site, the standards of this manual allow for high HLR with Type 2 effluent. It is considered that vertical separation can be adjusted, but site area is generally fixed. So, the standards prioritize higher HLR for Type 2 rather than smaller VS.

However, if Type 2 effluent is applied using Type 1 hydraulic loading rates (HLR) then the standards allow for use of Type 1 vertical separation standards and Type 1 dosing and distribution standards. This is because at the lower HLR the shallower VS will be adequate for treatment.

For example, for gravity distribution to Fine Sand Table II- 14 (page II-26) specifies 120 cm VS for Type 2 effluent HLR, but if the effluent was applied at Type 1 HLR, then 90 cm VS could be used.

ii) Type 2 effluent with uniform distribution

The Volume II standards allow smaller vertical separation when timed or micro-dosing options are used with Type 2 HLR. This is because these options lead to lower hydraulic application rates (HAR), more similar to those for Type 1 HLR. They also lead to lower risk of soil saturation by spacing doses apart.

Timed and micro-dosing therefore reduce the risk of bypass flows and poor pathogen removal posed by high Type 2 HLR. See Section III- 5.2.2.1.(a) for discussion of hydraulic application rate (HAR).

Timed dosing standards for Type 2 HLR result in higher HAR than for Type 1 HLR. For this reason, on some soils, the standards specify slightly larger VS for Type 2 HLR with timed dosing.

Since micro-dosing ensures the same HAR regardless of hydraulic loading rate, the VS standards are the same for Type 1 and Type 2 HLR on all soil types if micro-dosing is used.

Standards for sand mound and sand lined trench or bed systems allow very high HLR to the sand media with Type 2 effluent, for that reason micro-dosing is required where these high HLR are used.

III- 5.3.2.3 Monitoring vertical separation

Vertical separation may be monitored or confirmed using an observation standpipe or standpipes (see Section III- 6.5.2.5). For guidelines on monitoring of vertical separation to SHWT see Section III- 3.3.2.2.(a).

The observation standpipe(s) may be installed at the time of system installation, or may be installed at a later date to observe the vertical separation available below an existing system.

III- 5.4 Horizontal separation

This Manual provides horizontal separation standards as a safety factor to protect water wells, water bodies, and other potential receptors (boundaries). The setback distances also provide for some further nutrient removal and dilution. See Volume IV, Section IV- 5.9 for further information.

In some cases local government bylaws may specify minimum setbacks for system components to features such as water bodies. This may include setbacks established as part of a Development Permit Area. The AP should check for potential issues as part of site evaluation.

III- 5.4.1 SEPARATION TO FRESH WATER

Separation distances to fresh water are shown in the standards; these are the minimum allowable distances. The AP should be aware that the Riparian Area Regulation and local bylaws may affect placement of system components and work near streams, and that work in watercourses is also subject to regulation. Land use bylaws and development permit areas may also restrict the location of sewerage systems in other cases.

The AP should assess a ditch in the same way as any other water body, and separation should be based on whether the ditch is ephemeral, intermittent or permanent fresh water.

III- 5.4.2 SEPARATION TO WATER WELLS AND AQUIFER CONSIDERATIONS

Separation distances to water wells are shown in the standards. The AP should be aware that Well Head protection plans for water supply systems, or restrictive covenants, may lead to larger setback distances. Where adjacent wells are known to be situated in an unconfined aquifer, placement of the sewerage system should be as far away as the site allows.

III- 5.4.3 SEPARATION TO SLEEVED WATER LINES

If the standard separation to a drinking water suction or pressure water line is not achievable, it is acceptable to sleeve the line with a suitable continuous pipe, extending to the minimum standard setback distance and sealed to the suction line pipe at each end. No joints for the sleeving pipe (other than fusion welded joints) are to be used within the setback distance. The sleeving pipe is to be of the same or greater pressure rating as the water line.

This will allow reduction of the setback to the standard for sleeved line.

III- 5.4.4 UPSLOPE AND SIDE SLOPE DRAINS OR BREAKOUTS

The AP determines the location of potential breakouts.

The horizontal separation standards give a minimum distance to downslope drains and breakouts.

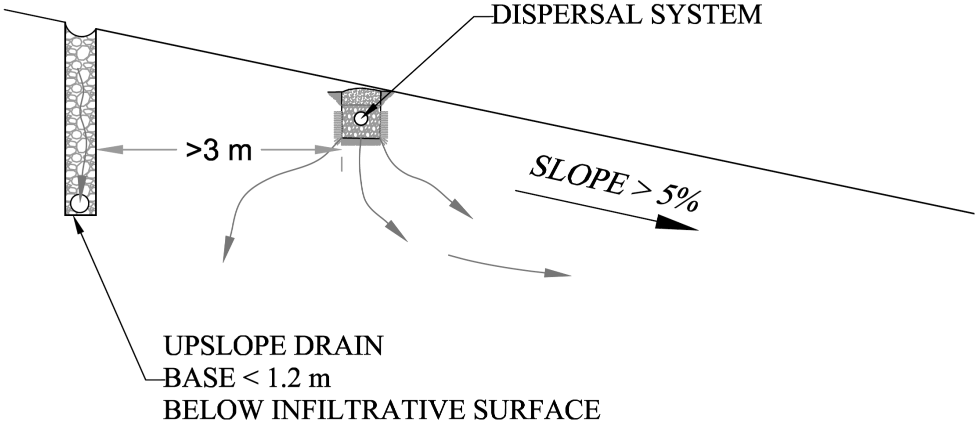
In some situations, there may also be a risk that effluent will seep into drains located upslope or side-slope from the dispersal.

For upslope or side slope drains, and potential breakout points (see Figure III- 2), use the following guidelines:

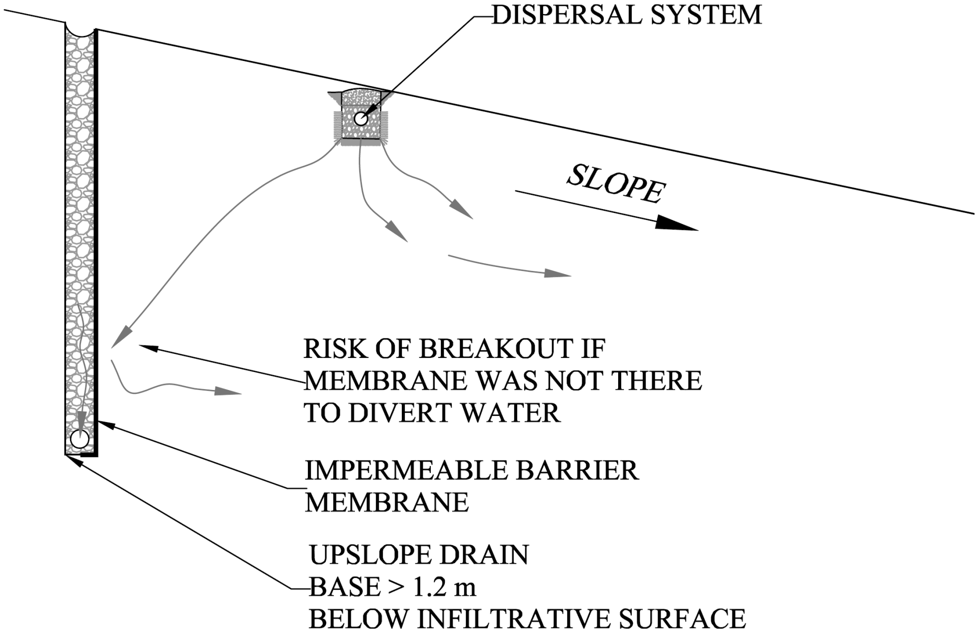
- Separation to the dispersal area should be a minimum of 3m for slopes of 5% or greater except where a subsurface dam (impermeable barrier) is used.
- Where the slope is lower (less than 5%) or the drain or breakout point is over 1.2 m below grade use a subsurface dam (impermeable barrier) or increase the horizontal separation to meet the downslope breakout or drain standard.

Figure III- 2. Schematic cross sections showing upslope drain and subsurface dam

SAFE HORIZONTAL SEPARATION TO UPSLOPE DRAIN



IMPERMEABLE MEMBRANE PREVENTING
BREAKOUT TO DEEP UPSLOPE DRAIN



III- 5.4.5 SEPARATION DISTANCES FOR BC ZERO DISCHARGE LAGOONS

The setback distances for lagoons consider the particular conditions of lagoons, especially the presence of open water containing untreated sewage. Lagoons raise extra concerns regarding vectors (insects, animals) transferring pathogens to humans, and concerns about odours.

In addition, measurement is taken from the maximum water level, so for practical consideration some separations are greater because of the lagoon berm top width and berm toe area.

III- 5.4.6 HORIZONTAL SEPARATIONS TO REDUCE RISK OF DAMAGE OR ENCROACHMENT

Horizontal separation is useful to reduce the risk of accidental system damage or encroachment on a neighboring property, and Table III- 16 provides guidance for these situations.

Table III- 16. Guidelines for minimum horizontal separation distances

DISTANCE TO	FROM DISPERSAL SYSTEM (METRES)	FROM LAGOON (METRES)	FROM WATERTIGHT SUBSURFACE TREATMENT TANK (METRES)
Property lines	3	*	1
Building or structure (where there is not a perimeter drain)	1	*	1
Dispersal system (including other dispersal system)	6	6	3
Buried utility services	1	1	1
Drinking water supply cistern, at or above ground	1	*	1

Notes:

- * For lagoon separations in these cases see Volume II, Table II- 20 (Page II-33)
- For swimming pools or lined ponds with no external subsurface drainage, use the horizontal setbacks for a building or structure for all systems except for BC zero discharge lagoons. Always provide access for maintenance work.
- If these guidelines are departed from, the AP should include in their rationale steps taken to mitigate risk of system damage or encroachment.
- Buried utility services include sewer, stormwater, electricity, gas, cable and telephone. For any work near buried services follow guidelines published by the utility.

In freezing conditions it is important to consider setback to roads, driveways and other similar areas where:

- Soil may be compacted.
- Snow cover may be disturbed, compacted or removed.

A separation of 3 m to these areas from system components may reduce risk of system freezing.

III- 5.5 Hydraulic Loading Rate

Hydraulic Loading Rates (HLR) include consideration of volume of effluent applied, but also mass loading of organic material. See Volume IV, Section IV- 5.10 for further information.

III- 5.5.1 SOIL CHARACTERISTICS FOR THE HLR TABLES

The HLR and LLR tables group soils with the same loading rate together, these groups are termed "soil texture groups". See Section III- 3.3.2.3.(a) for further information on soil groups and categories, and for Table III- 1 (page III-12) which indicates which group the USDA soil texture classes and sub classes fall into.

III- 5.5.2 HYDRAULIC LOADING RATE TABLES

III- 5.5.2.1 Example of selecting HLR and calculating Area of Infiltrative Surface

For this example, the soil at infiltrative surface, and at least 30 cm below that, is a Sandy Clay Loam, with strong angular blocky structure, friable consistence, and coarse fragment content of 10%. Kfs is 350 mm/day. System DDF 1300 L/day:

Determine soil structure and consistence category, using Table II- 21 (page II-35) *(same table as* Table II- 4*)*. Category is "Favorable".

Select HLR from Table II- 22 (page II-36), based on soil type group and category:

Type 1 HLR = 15 L/day/m^2, Type 2 HLR = 25 L/day/m^2

Select HLR from Table II- 23 (page II-36), based on Kfs:

Kfs is in range of 300 to 550 mm/day.

Type 1 HLR = 23 L/day/m^2, Type 2 HLR = 40 L/day/m^2

Choose most conservative (lowest) HLR for design:

Type 1 HLR = 20 L/day/m^2, Type 2 HLR = 25 L/day/m^2

Coarse fragment content is <35%, HLR adjustment is not needed.

(See Section III- 4.1.2.2 for example calculation)

Then the Area of Infiltrative Surface (AIS) is calculated:

With Type 1 effluent, AIS = 1300 L/day ÷ 15 L/day/m^2 = 86.7 m^2.

With Type 2 effluent, AIS = 1300 L/day ÷ 25 L/day/m^2 = 52 m^2.

Record this selection and calculation in the System Selection Worksheet (see Section III- 4.1.1.2).

III- 5.5.2.2 Subsurface Drip Dispersal (SDD) hydraulic loading rates

The sizing of subsurface drip systems is based on an area loading rate; see Section III- 6.11. Because of the small contact surface between the emitter and the soil, the SPM reduces the standard HLR for use with these systems.

The SPM standards have a simple factor for reducing the HLR for SDD. The factors reduce the standard table values to roughly coincide with manufacturer's recommendations. See Section III- 6.11 for an example.

For more specific guidance, refer to the manufacturer standards. However, be aware that that some outdated guidelines may still be in circulation. These older guidelines may recommend high HLR values, but these may be only suitable for hot, dry climates, where evapotranspiration is significant even in the winter.

III- 5.5.3 HYDRAULIC LOADING RATES FOR SAND MOUNDS, SAND LINED TRENCHES OR BEDS

III- 5.5.3.1 Selection of HLR for a sand mound, sand lined trenches or beds

In a sand-lined system, the sizing procedure considers two separate hydraulic loading rates, one for the native soil at the base of the sand, and one for the sand:

- The basal (native soil) HLR is selected in the same way as for a native soil systems (see examples above). Use the Type 2 HLR for the native soil.
- The sand HLR is selected based on the type of effluent and specifications of the sand.

See Section III- 6.15 for an example.

III- 5.5.3.2 Sand media and HLR

Volume II provides a range of sand media specifications, recognizing that some sands may be difficult or expensive to locate in some regions of BC.

HLR to sand media takes into consideration the amount of fines in the sand. This is because fines are a key factor in establishing the permeability of the sand, and its suitability for effluent infiltration.

The ASTM C33 specification allows for up to 10% passing the 150 µm sieve and does not specify particles passing the 75 µm sieve. C33 may also have an effective diameter smaller than the size preferred for sand mounds. For these reasons, Table II- 25 (page II-37) modifies the C33 specification for the use in sand mounds, in order to ensure the sand does not have excessive fines. To differentiate this specification, the table identifies the sand as either "*Clean Coarse Sand*" or as "Mound Sand", these sands can be considered as "modified C33 sand.

It is preferable to sieve test sand following a wet sieving test protocol (example ASTM C117) to ensure fines (less than 75µm) in the aggregate are characterized. If sand is merely dry sieved there is a risk of underestimating the amount of fines, as the fines may be stuck to sand particles.

III- 5.5.4 HYDRAULIC LOADING RATE AND THE INFLUENCE OF SODIUM AND SALINITY

Over time, sodium can accumulate in the soil and reduce the permeability of clay-rich soils. See the appendix, Section III- 8.4 for further information.

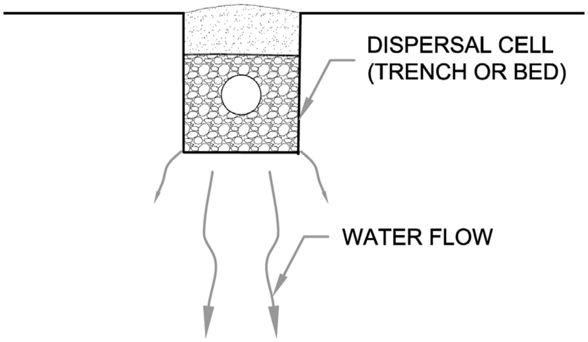
III- 5.6 Minimum system contour length and Linear Loading Rate (LLR)

Dispersal systems are installed along the contour ("on contour") so that the system follows a contour line on the ground. The length of the system on the contour is important to maintain vertical separation.

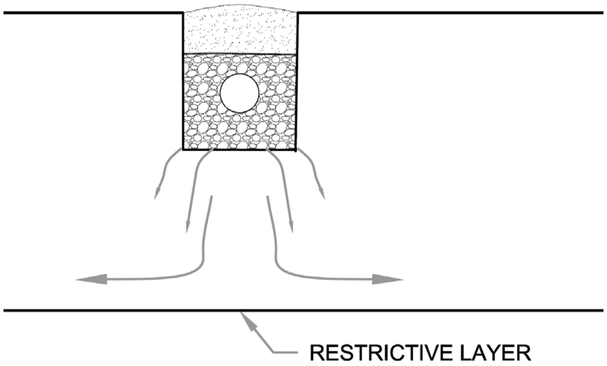
III- 5.6.1 SYSTEM CONTOUR LENGTH

III- 5.6.1.1 Horizontal flow and groundwater mounding

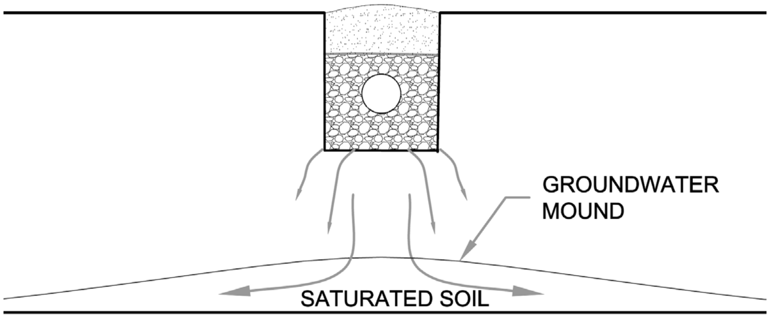
When effluent is dispersed into the ground by a dispersal system, the effluent should drain away from the site; otherwise the soil will become saturated below the dispersal area. If the dispersal cell (trench or bed) is underlain by deep, permeable soils, then much of the water will flow vertically down through the upper soils, and the water table rise will be very small.



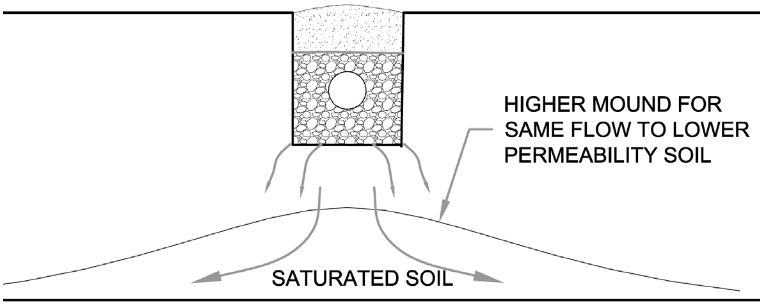
If the dispersal cell is located above a very low permeability layer, the water has to move horizontally (sideways) to get out from underneath the dispersal area.



To move horizontally, the water needs some head pressure to overcome the resistance to movement in the soil. On a flat site, this head can only come from the build-up of a "mound" of water under the dispersal area.

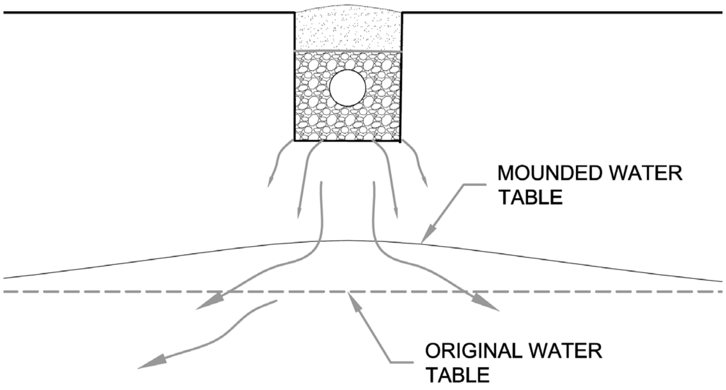


The finer the soil (with smaller pores) the more head is needed to drive the water through the soil, and so the higher the mound will become.

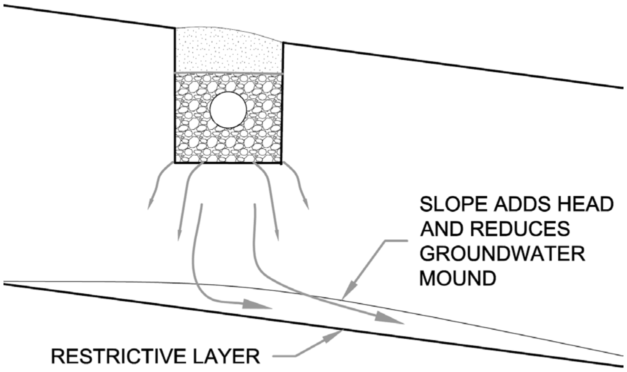


This is much the same with a water table below the dispersal area, the applied water will mound up to overcome the resistance of the saturated soil below the water table to sideways movement of the water.

This is similar to the mound that builds up if you pour thick syrup onto a plate.



On a sloping site, the head pressure comes from a combination of the slope and the mound, and so the mound will be smaller as the slope gets steeper.



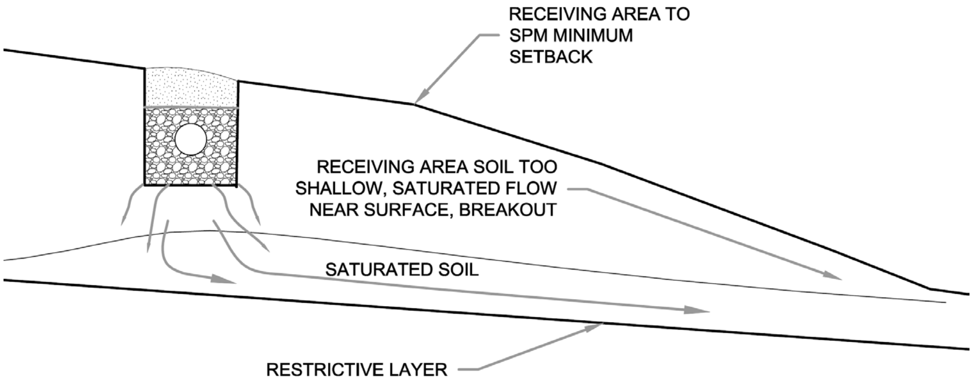
This groundwater mound continues to grow with time, and can reduce the vertical separation to such an extent that it no longer meets the standards.

III- 5.6.1.2 Breakout risk

On a sloping site the water will move down gradient, usually that means downhill (as long as the restrictive layer follows the shape of the ground).

The **receiving area** is the area of soils downslope of the system and located within the required horizontal separation to a breakout (7.5 m). The soil depth in this area is important, because the water flowing downhill needs a certain depth of soil—just as a larger pipe can carry a larger flow, a thicker soil layer can carry a larger flow.

If the soils in the receiving area are too shallow, the water flowing downhill may reach the surface and break out.



Capillary rise can be an issue too—even if the water is near the surface contaminated water may wick up to the surface.

So when considering flow away from the dispersal area it is important to think of the receiving area soils as well as those below the dispersal cells.

III- 5.6.1.3 Linear Loading Rate (LLR)

By applying less water per metre along the contour, less water builds up under the system.

The example below in Figure III- 3 and Figure III- 4 shows a plan and section of a system that is the same size, but in one case is stacked on the slope, and in the other is spread out along the contour. In each case the DDF is 1500 L/day.

The site has a flow restrictive horizon at relatively shallow depth below the trench base (infiltrative surface).

Figure III- 3. Example of "stacking" a system, plan

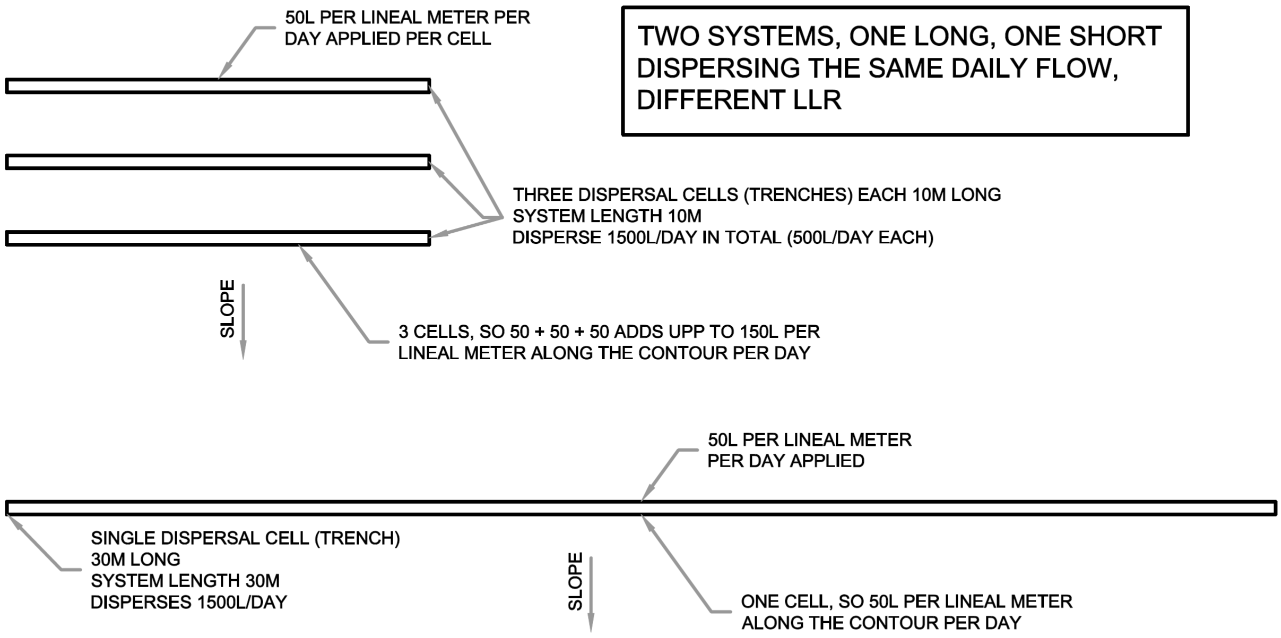
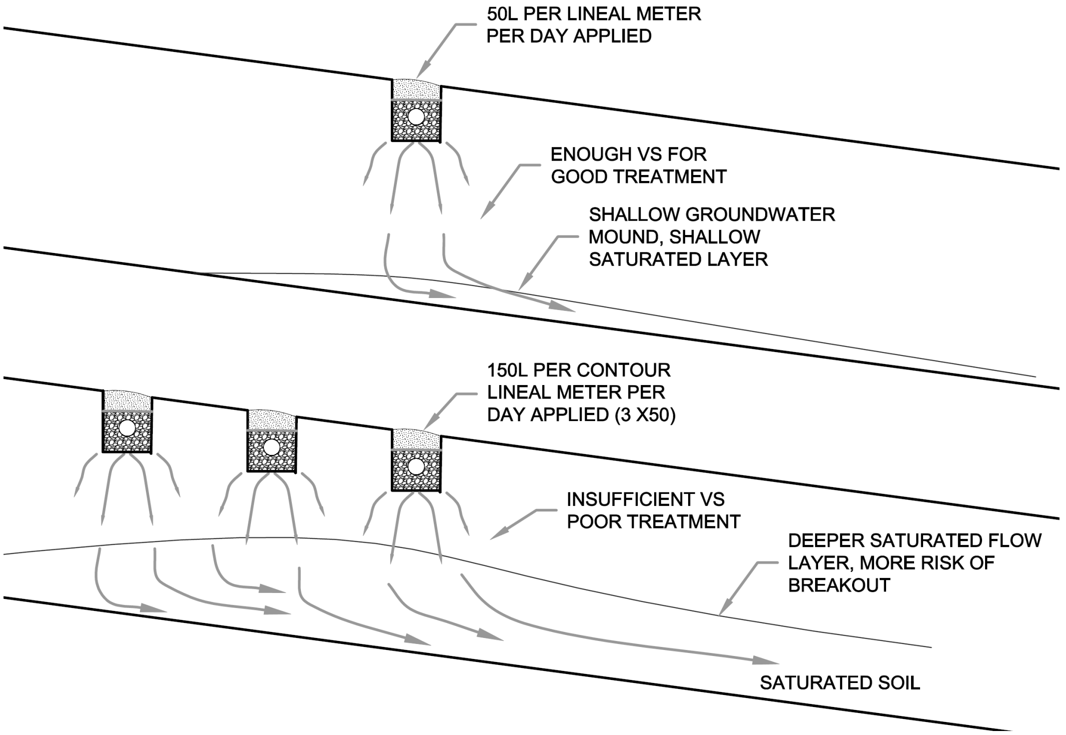


Figure III- 4. Example of "stacking" a system on a site with flow restrictive layer, section



The longer, narrower, system (in this case one long trench instead of three short ones) maintains deeper vertical separation because less water is applied per metre along the contour.

The amount of water applied per metre along the contour is the **Linear Loading Rate**.

LLR = DDF ÷ SYSTEM CONTOUR LENGTH

Linear Loading Rate table values are used to size systems so that they are long enough to maintain VS. LLR values are:

- Greater for deeper soil, because there is more depth for flow.
- Greater for more permeable soils, because the water will flow faster.
- Greater for steeper slopes, because the water will flow faster.

III- 5.6.2 MINIMUM SYSTEM CONTOUR LENGTH

The standard provides a simplified table (Table II- 26, page II-38) to determine minimum system contour length.

For smaller systems on deep, permeable, soils a the standards of this Manual specify that a minimum length of 7.5 m, measured along the contour, can be used as an alternative to using LLR values.

III- 5.6.2.1 Applying the specified minimum system contour length standard

The final selected length of the dispersal system may need to be increased to more than the prescribed minimum system contour length, in order to meet the bed width standards for Seepage Beds or for sand lined bed systems, particularly when only one bed is installed.

For example, consider the following situation:

The design flow rate (the DDF) is 1600 L/day, the Type 1 soil HLR selected is 27 L/day/m^2 and the soil depth is over 180 cm with no evidence of flow restrictive horizon or water table. Soil Kfs is 1200 mm/day. The planned system is a Seepage Bed.

AIS = DDF ÷ HLR = 1600 L/day ÷ 27 L/day/m^2 = 59.26 m^2

Minimum system contour length from Table II- 26 (page II-38), specified minimum of 7.5 m

Maximum Seepage Bed width from Table II- 38 (page II-49), 3 m

System contour length to achieve bed width = AIS ÷ 3 m = 59.26 m^2 ÷ 3 m = 19.75 m (approximately 20 m)

Based only on the DDF and the soil depth, the system contour length could be 7.5 m. However, the maximum allowable bed width, combined with the standard allowable HLR, leads to a minimum system length on contour of 19.75 m for a single seepage bed.

Alternately, two beds at 3m wide x 10 m long each could be installed, the beds would need to be spaced apart to meet the standards for seepage bed spacing (see Section II- 6.7).

III- 5.6.2.1.(a) Soil depth below the infiltrative surface for minimum system contour length

For the purpose of selecting the minimum system contour length, or a linear loading rate, the "soil depth below the infiltrative surface" is measured from the infiltrative surface down to the flow restrictive horizon or to the seasonal high water table or water table, whichever is the smallest distance.

A high permeability layer (e.g. gravel or fractured rock) may be a limiting layer for VS but is not a flow restrictive horizon and so can be considered as part of this “soil depth” for selection of minimum system contour length or LLR.

Note that this is different than the definition of vertical separation, which is defined to the limiting layer, which may be extremely permeable material (e.g., fractured rock or gravel) (see Section III- 5.3).

III- 5.6.3 SELECTING AND USING LLR VALUES

LLR values are selected in the same way as HLR values, using soil characteristics and permeability. They are then used to calculate minimum system contour length on contour.

Minimum system contour length = DDF ÷ LLR

In all cases, the system should be long and narrow on contour, so even if a very short system would meet the minimum length calculated. If there is more length available it is preferable to use a longer system.

III- 5.6.3.1 Example

Consider the following site and soils:

- Daily Design Flow 1500 L/day.
- Loamy Fine Sand, single grain, loose. Kfs 1750 mm/day. Site slope 12%.
- 50 cm soil depth below proposed infiltrative surface to restrictive layer. Applies for over 7.5m downslope (soil depth is the worst case for receiving area within 7.5m of dispersal area).

Refer to Table II- 26 (page II-38), soil depth < 150 cm, use LLR table values.

Determine soil structure and consistence category, using Table II- 21 (page II-35). Category is “Favorable”.

Select LLR from Table II- 27 (page II-39), based on soil type group and category:

Soil depth range “45 to 60 cm”, slope range “>10%”; LLR 75 L/day/m

Select LLR from Table II- 28 (page II-40), based on Kfs:

Kfs is in 1000 to 2000 mm/day range

Soil depth range “45 to 60 cm”, slope range “>10%”; LLR 90 L/day/m

Choose most conservative (lowest) LLR for design; LLR = 75 L/day/m

Calculate minimum system contour length:

Minimum system contour length = 1500 L/day ÷ 75 L/day/m = 20 m

Record the selected LLR and the calculation of minimum system contour length in the System Selection Worksheet (see Section III- 4.1).

III- 5.6.3.2 Soil layer for LLR considerations

For assessing LLR and selecting LLR values, the soil layer of interest is the soil layer at and just above the depth of the seasonal high water table (SHWT).

In the absence of a SHWT, the soil layer of interest is the soil layer immediately above the flow-restrictive horizon.

If both the SHWT and the flow-restrictive horizon are deeper than the deepest test pit, then the soil layer of interest is the lowest soil layer in the deepest test pit.

Consider the soil depth below the infiltrative surface in the receiving area as well as the dispersal area.

III- 5.6.4 MINIMUM SYSTEM LENGTH FOR AT GRADE AND RAISED SYSTEMS

The standards specify that, for LLR or minimum system length considerations, there is no allowance for lateral spread of effluent at the ends of beds or trenches, or at the end of a Combined Treatment and Dispersal System (CTDS).

Note that if the CTDS is placed on a coarse aggregate or gravelless (e.g. chamber) Seepage Bed, then minimum system length is determined as for Seepage Beds.

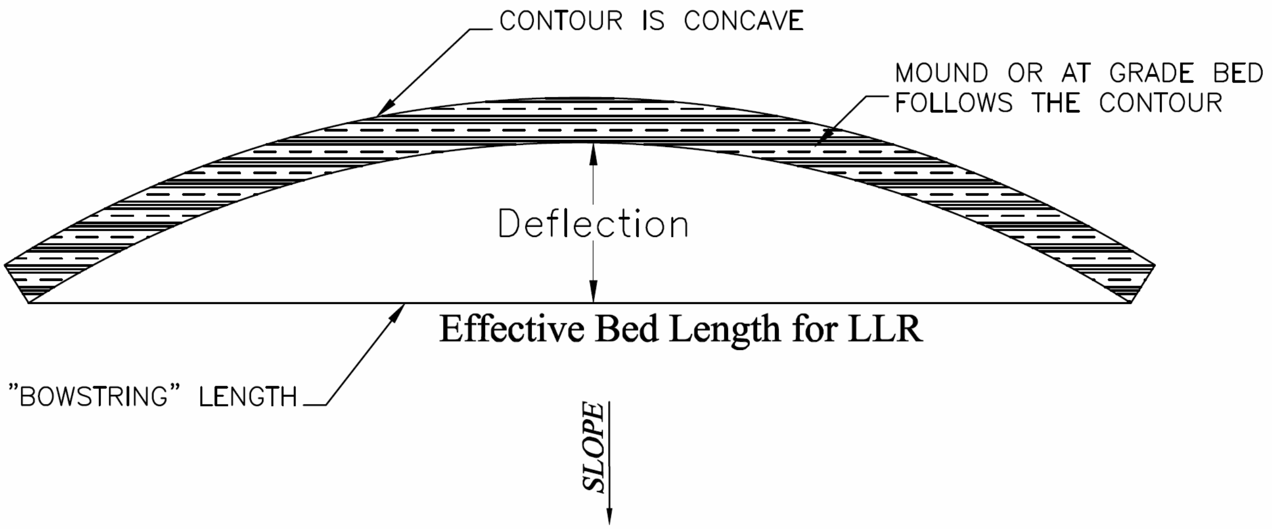
III- 5.6.5 MINIMUM CONTOUR LENGTH FOR BELOW GRADE SYSTEMS USING SAND MEDIA

The standards establish that there is no allowance for spreading in sand media below the infiltrative surface (or, for CTDS, below the point of application). This approach is the same as for at grade and raised systems, as described above.

III- 5.6.6 SLOPES WITH CONCAVE CONTOUR

Dispersal systems are placed along the contour of the land, to keep the system level along its length. If the land surface is concave, then there is a risk of flow concentrating.

Figure III- 5. Contour bed effective length (plan view)



If the contour is curved to give a concave (from side to side) slope, the effective bed (cell) length is given by the distance between the furthest points along the contour line of the downslope edge of the concave distribution cell.

However, if subsurface water flow is primarily vertical or soil depth below the infiltrative surface is over 150 cm, it is not necessary to apply this consideration.

A highly concave slope (similar to a broad gully or swale) may have a deflection of more than 10% of the bowstring length. This situation could result in surfacing in the receiving area, if the soils are shallow (the "funnel" effect). Sites with a highly concave slope may not be suitable for systems such as Alberta at Grade systems, at-grade beds and sand mounds, and need extra care.

III- 5.6.7 SITES WHERE LENGTH IS CONSTRAINED

If the minimum allowable system contour length will not fit on the site, the AP may consider the following approaches.

III- 5.6.7.1 Toe blankets

A toe blanket (see Section III- 6.8.4) can be used to increase effective depth in the receiving area. The toe Blanket is a blanket or mantle of sand or permeable soil that is placed at the toe of raised dispersal system or in the receiving area. The purpose is to aid seepage from the raised system into the native soil, or to provide additional depth for effluent to move away from the dispersal area and to provide a cover above soil that may be saturated.

- Ensure the toe blanket is at least 25 cm deep or at least 15 cm above the maximum expected water table level in the receiving area.
- Toe blankets should not be used with Alberta at Grade systems.
- The toe blanket may cover the entire receiving area or only a part—for example where there is a small area of shallow soils due to a dip.

III- 5.6.7.2 Sand mantle sand mound

See Section III- 6.15.1.2 for a special case of the use of toe blankets for sand mantle sand mounds.

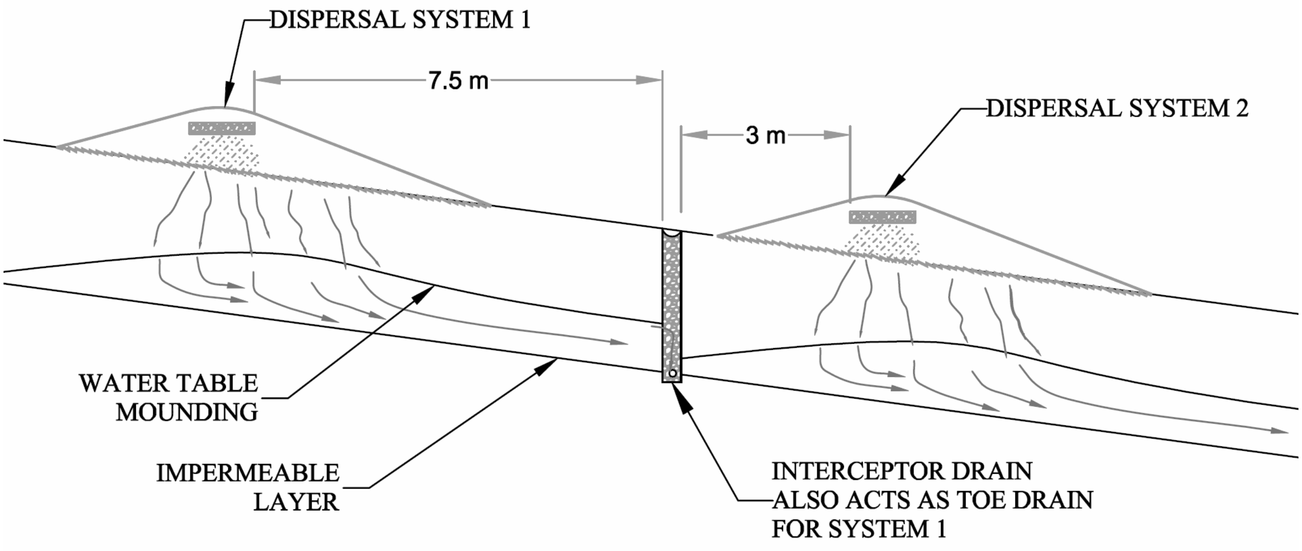
For systems with a DDF of 2400 L/day or less, and slope of up to 25%, this specified technique allows the AP to use a linear loading rate of up to 50 L/day/m.

III- 5.6.7.3 Relief drainage

As another option for sites with limited contour length, the dispersal system may be installed in a series of stacked cells on the slope, with interception drains above each cell or group of cells. Horizontal separation from the dispersal systems to the interception drains should meet the standards of Section II- 5.4. See Figure III- 6 for an example.

Drain performance should be monitored by checking the depth of the water table in the dispersal area. See II- 6.19.

Figure III- 6. Example of interception and relief drainage between two systems on a slope (section)



III- 5.6.8 OXYGEN TRANSPORT

For all sites and dispersal methods, it is important to have oxygen available at the infiltrative surface, to promote aerobic bacteria that consume sewage.

The standards for bed width, trench and bed spacing, and soil type restrictions for systems in this Manual are based on consideration of oxygen transport. See Volume IV, Section IV- 5.11.3 for further information.

III- 6 SPECIFICATION AND INSTALLATION GUIDELINES

III- 6.1 Flow monitoring

Monitoring of sewage flows is recommended for all onsite systems. Records of actual flow to the system will assist with diagnosis of system malfunction, and will allow the maintenance provider to confirm that system use matches the capacity of the system.

Options for monitoring flow to the dispersal area include:

For all types of systems:

- Flow meter on the interior plumbing for the house.
- Primary flow meter on the house water supply, plus a secondary flow meter on the house exterior plumbing, to allow calculation of indoor water use by subtraction.
- Calculate indoor water use using a primary flow meter on the house water supply, but limiting the analysis to times of the year when outdoor water use is very limited.

For trickling gravity systems:

- Tipping D-box with switch and counter.

For dosed systems:

- Float switch and counter for floating outlet device or siphon system.
- Float and mechanical counter for dosing system.
- Pump start and run time counter for pump dosed system.
- Pump control panel which records pump start and run time for dosed system.
- Pump control panel with data logging for pump dosed system.
- Flow meter between the pump and the dispersal system.

III- 6.2 Access provisions and provisions for maintenance and monitoring

Access points for system maintenance and monitoring should be extended up to grade. Routine maintenance should not involve entering a confined space.

Without maintenance, onsite systems will not perform properly and may become a risk to health. Therefore, making maintenance and monitoring simple, safe and economical is critically important.

When specifying system components it is important to consider long term maintenance of the system, and one key aspect is the ongoing availability of parts from a local supplier.

Provide appropriate access to all serviceable points including the following:

- Dispersal system observation ports, monitoring wells, lysimeters and any similar in-ground monitoring provision.
- Lids of all tanks, dosing chambers, and treatment plants.
- Filters, including effluent filters and pressure filters.
- Control panels, alarms, and electrical junctions.
- D-boxes.

- Valves including lateral isolation valves, check valves, indexing valves, back flow prevention valves, air/vacuum valves, etc.
- Cleanouts (including cleanouts for sewer lines, force mains, pressure laterals, interceptor drains, etc.).

Suitable access provisions will include risers or access boxes with lids exposed flush or above finished grade, and with adjacent ground sloped to direct surface water away.

If a component will need to be removed for service, true unions or other method should be used to allow easy, reliable removal.

Pump control panels should be located in external locations or in a service building that will be accessible to the maintenance provider, and preferably within a line of sight of the pump chamber.

III- 6.2.1 SAFETY

When specifying all aspects of the sewerage system, consider the safety of the maintenance workers. Refer to WorkSafeBC for information on confined spaces.

http://www2.worksafebc.com/Topics/ConfinedSpaces/Home.asp

Any components that need to be accessed or removed from tanks will need to have handles or disconnect fittings located within 15 cm of the riser or access lid.

Access points to tanks or to other system components may be a safety risk for owners or the public, and should be labelled with cautions (example "sewer" or "poison gas") as well as secured. See Section III-6.4.2.1.(b).

III- 6.2.2 CLEANOUTS AND SAFETY

Sewerage systems should include access pipes (cleanouts) for access to flush the system. Additional considerations regarding cleanouts include:

- Manage safe effluent disposal during flushing (i.e. rather than contaminating the lawn). For a pressure system, clear hoses connected to the cleanout will allow visual assessment of residual head ("squirt height") while containing effluent and allowing it to be captured in containers for disposal to the septic tank during maintenance. Permanent piping systems may also be incorporated in the design as a means of directing flushed effluent to the septic tank or other suitable containment.
- Pressure distribution system squirt testing through temporary threaded caps with the equivalent size orifice (as per orifices in the laterals) may be acceptable if surface contamination is not a concern. Test caps should be left on site, stored in the cleanout access boxes.

Manage how effluent will drain from the cleanout access box after system flushing. A direct pathway through pea gravel or similar means should allow effluent to drain into the dispersal system trenches or bed.

III- 6.3 Connections, piping and collection systems

Connection and collection systems take sewage from the building or buildings served to the treatment system.

For small systems connection is typically by a short gravity sewer and sometimes by a sewage ejector pump and force main. In other cases several buildings are connected using gravity sewers or other alternative collection systems.

The house to tank sewer is a common cause of system malfunction, due to pipe settling or breakage. Water can also leak into defective collection sewers, overloading the system.

The BC plumbing code applies to sanitary drainage piping in buildings. The code also applies to the building (or sanitary) sewer between the building drain (which ends 1 m from the building) and a "private sewage disposal system". This means that the piping connecting the building drain to the septic tank falls under the plumbing code, and should be inspected as part of the plumbing inspection.

III- 6.3.1 SEWERS

III- 6.3.1.1 Gravity sewers

The BC plumbing code contains standards for gravity sewers.

The plumbing code requires that every pipe in a "sanitary drainage system" be capable of withstanding a water test. A water test consists of applying a water column of at least 3 m to all joints for a minimum of 15 minutes. The code also requires that a 3" or 4" sewer have cleanouts at minimum 15 m spacing, in the direction of flow.

III- 6.3.1.2 Pumped discharge of sewage to the septic tank (Table II- 31, page II-43)

See Section III- 5.1.3.1 for information on allowable surge flows.

III- 6.3.1.3 Alternative collection systems

Alternative collection systems, which include a septic tank, fall outside the BC plumbing code and are a part of the sewerage system. These systems include:

- S.T.E.P. (Septic Tank Effluent Pumping).
- S.T.E.G (Septic Tank Effluent Gravity).
- Combinations of S.T.E.P. and S.T.E.G.

For design guidance, one useful resource for these alternative collection systems is the Iowa DNR, "Alternative Collection Systems Technology Assessment and Design Guidance."

http://www.iowadnr.gov/portals/idnr/uploads/water/wastewater/files/dg_alt_collect_manual.pdf

III- 6.3.2 SPECIFICATIONS AND INSTALLATION

The BC plumbing code and the Iowa DNR guide include information on specification and installation of sewers and collection systems. Key factors for small systems include the following:

- All pipes should be properly bedded with clean granular material, a minimum of 15 cm on all sides.
- All piping should be watertight.
- Sewer inlet to the septic tank (and other tank connections) should be properly supported on compacted material or in other reliable fashion. This could include use of heavier wall pipe.
- For pumped systems, ensure the standards for surge flows to the tank system are not exceeded, and that an effluent filter alarm is used.
- If grinder pumps are used, ensure septic tank (and treatment system) sizing is increased following the standards.
- For force mains, provide for expansion and contraction if the pipe is very much warmer or colder than normal soil temperature when it is installed, allowing for 2.5 cm per 30 m per 6 C temperature change.
- Protect pipes under driveways etc. from breakage; consider use of a pipe sleeve under a driveway.
- Protect pipes from frost, either with adequate soil cover or with suitable insulation.

III- 6.3.2.1 Piping specifications and installation

The piping used for a building sewer, effluent sewer, or gravity or pressure distribution piping, should be certified to one the following standards:

- CAN/CSA 8181.1 Standard for ABS Drain Waste and Vent Pipe and Pipe Fittings.
- CAN/CSA 8181.2 Standard for PVC Drain Waste and Vent Pipe and Pipe Fittings.
- CAN/CSA 8182.1 Standard for Plastic Drain and Sewer Pipe and Pipe Fittings.
- CAN/CSA 8182.2 Standard for PVC Sewer Pipe and Fittings (PSM Type).

Or to equivalent U.S. or European standards.

Where there is no existing standard for the intended use of a piping material, follow the manufacturer’s recommendations for that pipe.

Piping sizing, layout, specification and installation (including pipe joints) should follow manufacturer guidelines. For plastic pipes, refer to publications available from the Plastic Pipe and Fittings Association:

http://www.ppfahome.org/

III- 6.4 Tanks, septic tanks and effluent filters, treatment systems

Section II- 6.4 provides standards for septic tanks and also general standards for other tanks and enclosures, including pump tanks, treatment plant tanks and treatment plant enclosures.

III- 6.4.1 SEPTIC TANKS AND EFFLUENT FILTERS (TABLE II- 32, PAGE II-44)

The septic tank (Figure III- 7) provides settlement and flotation, together with some anaerobic treatment and digestion of sludge. Settlement is improved in tanks that have a shallow and long flow path, and settlement is a function of surface area in relation to flow. This Manual specifies using inlet and outlet baffles.

Septic tanks are available in single chamber and two compartment configurations. For tanks of equal volume and surface area, a single chamber tank will have improved settlement over a two compartment tank. Conversely, a two compartment septic tank will commonly have less scum accumulation at the outlet filter than a single compartment tank.

The tank provides some equalization of short term peak flows; this can be improved by the use of an effluent filter with a modulating port or weir installed in the outlet of the filter.

Treatment and digestion of the accumulated sludge and scum is improved with long sludge retention times. Flow rates through the tank should be kept low to improve sedimentation efficiency and to prevent scouring of previously accumulated sludge.

The working volume of a septic tank is measured from the inside bottom of the tank to the invert of the outlet pipe. An effluent filter is provided at the outlet of the tank, drawing from the clear zone, this filter protects the dispersal system as well as improving BOD, TSS and Oil and Grease removal.

In general septic tank performance is improved by:

- Larger surface area (higher surface area: volume ratio).
- Longer distance between inlet and outlet pipes (higher length: width ratio).
- For two compartment tanks, letterbox openings in the compartment divider.

III- 6.4.1.1 Sizing of the septic tank

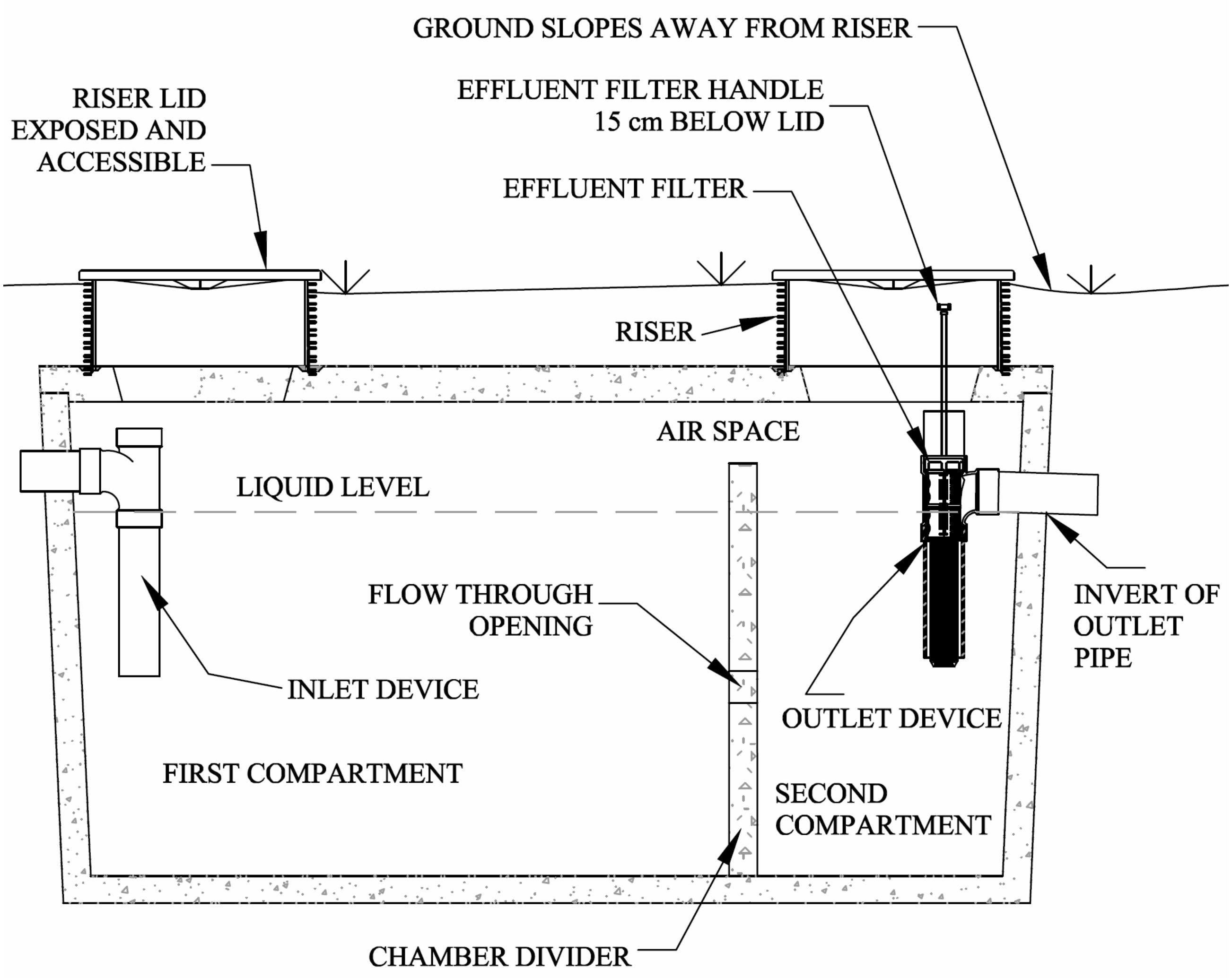
This Manual specifies minimum tank sizes. Larger tanks can improve treatment performance, and may be preferred in some cases—for example:

- To improve Oil and Grease removal.
- To improve suspended solids removal.
- To increase interval between pump outs,
- To improve flow equalization where large surge flows are expected.

To gain the best advantage from an increased tank volume, specify a tank with larger surface area and greater length between inlet and outlet as well as larger volume.

See the appendix, Section III- 8.7 for expected pump out intervals for residential septic tanks. Pump out intervals of 5 years or more are preferred.

Figure III- 7. Typical two compartment septic tank

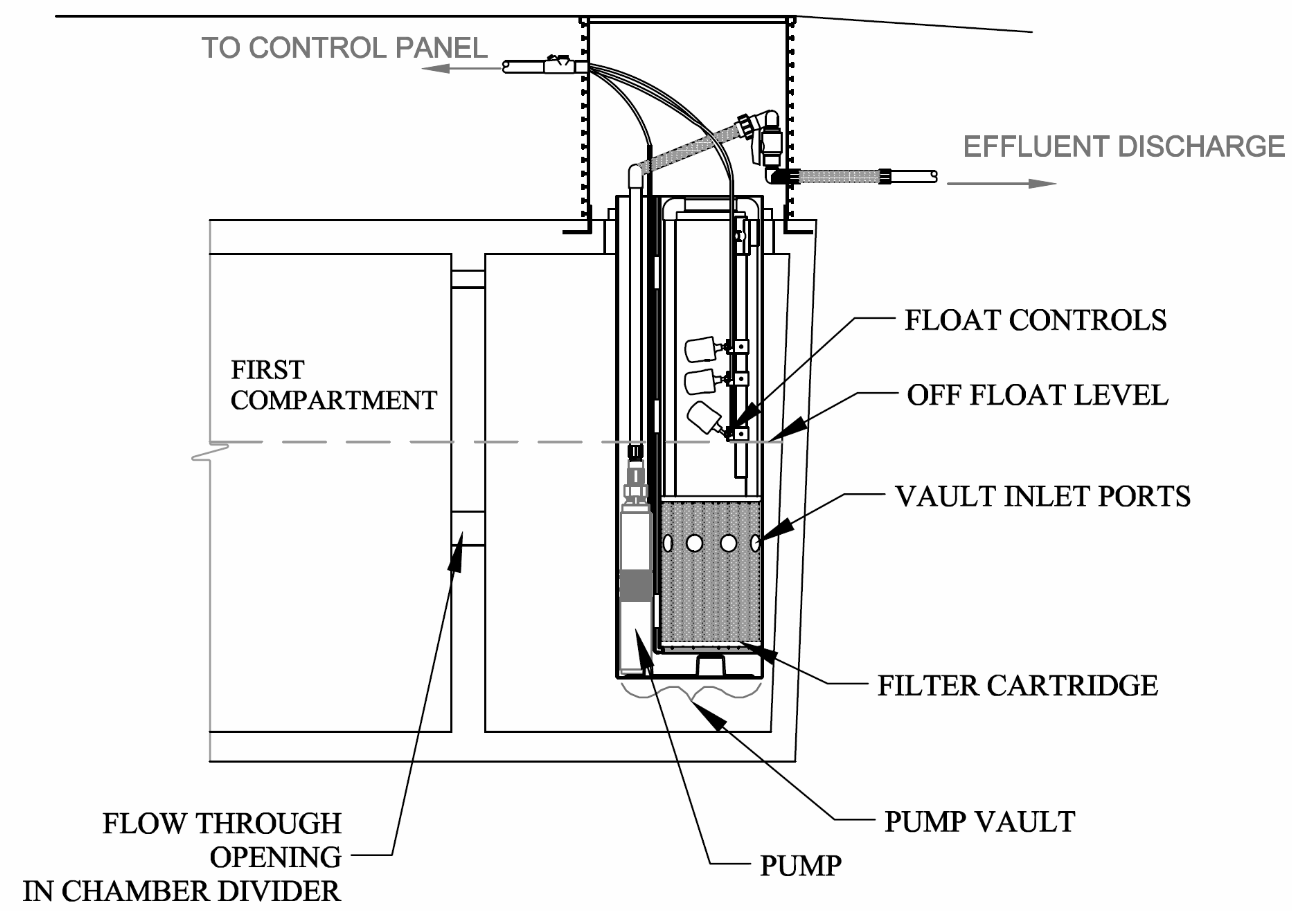


III- 6.4.1.2 Dosing from the septic tank with screened pump vault

For screened pump vaults in septic tanks the working volume of the tank is measured from the inside bottom of tank to the pump OFF float level (or pump timer OFF float level).

Where the pump is used in a two-compartment combined septic pump tank with the liquid level equalized between the two compartments, the working volume is calculated as the combined liquid capacity of both compartments. This minimum working volume should meet the standards of Volume II.

Figure III- 8. Typical pumped discharge from second compartment of a septic tank



III- 6.4.1.3 Septic tanks before treatment systems (trash tanks)

A septic tank used before a treatment system is typically termed a “trash tank”. When sizing the trash tank follow manufacturer recommendations, and provide adequate volume for sludge accumulation and projected pump out interval, see the appendix Section III- 8.6.

III- 6.4.1.4 Effluent filters

An effluent filter should be provided at the outlet of the last compartment of the septic tank. The filter should pass a minimum flow rate 50% greater than the Daily Design Flow, and when 85% clogged, be able to pass a flow rate equivalent to the Daily Design Flow.

NSF has established a test protocol and certification for effluent filters, NSF/ANSI Standard 46.

When specifying an effluent filter, the AP should ensure that the projected cleaning interval for the selected filter is longer than the time between maintenance visits that will be specified in the maintenance plan. Refer to the manufacturer for estimated cleaning intervals. The maintenance plan should include an estimate of expected effluent filter cleaning intervals.

If a flow modulating port or weir is used, after the filter or in the outlet of the filter, this needs to be readily accessible for cleaning, and should provide for overflow to the outlet pipe if the orifice or weir is clogged.

It is recommended that filters have a valve, example a knife valve (sliding gate valve), or a built-in mechanism, to stop effluent flowing out of the tank when the filter is removed for cleaning. This is particularly important for single compartment tanks.

If an effluent filter alarm is used, and if the effluent filter is of a type which would allow bypass of solids if water level was above the top of the filter housing, the alarm should be set to activate before water level rises above the filter housing.

III- 6.4.1.4.(a) Effluent filters and treatment plants

Effluent filters should be used in septic (trash) tanks before treatment plants, unless the manufacturer specifically recommends they not be used.

Effluent filters may be used after treatment plants prior to dosing to pressure distribution systems to provide protection from treatment plant upsets or if no filter is used on the trash tank. This is not necessary if:

- The treatment plant is designed to avoid discharge of particles larger than 2 mm and accidental discharge of sludge, or
- a secondary filter is used on the pump discharge.

However, installing an effluent filter after a treatment plant may not be advisable if the treatment plant manufacturer indicates that the filter will rapidly plug with biological growth.

III- 6.4.2 TANKS AND TANK ACCESS (TABLE II- 33, PAGE II-45)

III- 6.4.2.1 Tank access

The installed sewerage system should allow maintenance workers to safely and easily access the tanks and components (pumps, floats, filters etc.).

Any components that need to be accessed or removed need to have handles or disconnect fittings located within 15 cm of the riser or access lid.

Access lids should be exposed and readily accessible. They should be flush with finished grade or above (2.5 cm above is preferred). To improve safety, installation of safety screens inside tank risers is recommended.

For tanks that are installed deeper than normal (over 90 cm of fill over the tank lid), larger access risers may be needed to facilitate pump out of a tank. For example, for a riser height of more than 90 cm, a 76 cm diameter riser is preferable. Another option is to provide additional accesses.

III- 6.4.2.1.(a) Access for pump chambers

Consider the need to clean pump chambers when specifying pump chamber access risers. For example, provide two risers if one will be largely filled with the pump, connections and float switches.

The inlet pipe to the pump chamber should be accessible for visual inspection by the maintenance provider, or for collecting effluent samples for laboratory testing.

III- 6.4.2.1.(b) Security and Tank Access

Septic tanks and treatment systems need to be safe and secure. Access lids should be secure, either requiring special tools for removal, or provided with a lock.

Removable access lids (including any job built access components) should be capable of supporting at least 150 kg without collapse.

III- 6.4.2.1.(c) Sampling access

Provide suitable means to collect effluent samples. Options include:

- A sampling port after a treatment plant.
- A pressure sampling port as part of a pump connection or at the dispersal area.
- Lysimeters for sampling of effluent from the unsaturated zone below a CTDS.

III- 6.4.2.2 Sealing of enclosures

The standards specify, in the footnote to Table II- 33 (page II-45), that treatment system enclosures are to protect health and safety. This includes reliable sealing of the system to avoid human or animal (e.g. flies, rodents) contact with effluent as well as proper screened venting. If the treatment process involves sprayed effluent, ensure humans cannot accidentally come into contact with effluent aerosols.

III- 6.4.3 TANK INSTALLATION (TABLE II- 34, PAGE II-45)

Tank installation should follow manufacturer recommendations and guidelines.

The Occupational Health and Safety Regulation include specific requirements when a worker enters an excavation over 1.2 m deep. Refer to the Regulation and WorkSafeBC for full information on excavation safety. http://www.worksafebc.com/

III- 6.4.3.1 Tank bedding and backfilling

In all cases, tanks need to be placed on a uniform surface or bed that will not allow uneven settling, and which does not have large rocks or roots that could create point loading on the tank. If bedding is needed, common bedding options include compacted bedding sand, 19 mm drain rock and pea gravel.

Backfill the tank evenly, compacting in accordance with manufacturer recommendations.

III- 6.4.3.2 Watertight testing

Tanks should be watertight tested to meet the standard in Table II- 34 (page II-45).

III- 6.4.3.2.(a) Testing with water

Plug inlet and outlet pipes. Fill the tank to 5 cm above the top of the tank lid (observe in the riser) with clean water (avoid overfilling to reduce risk of lifting the lid off the tank).

For concrete tanks, fill the tank and let it pre-soak for 24 hours before testing.

To measure leakage, measure water level in a riser (which will move faster than in the tank due to the smaller size of the riser). See Table III- 17 for calibration of round risers.

Table III- 17. Depth change equivalent to ten litres in round risers of various interior diameters.

RISER DIAMETER (CM/IN)	DEPTH (CM) EQUAL TO 10 LITRES
46/18	6
61/24	3.5
76/30	2.25
91/36	1.5

When performing hydrostatic testing in cold climates consider that:

- Water is its densest at about 4°C (just above freezing), so water put into a tank at 10 to 20°C (typical of groundwater) and left in the tank overnight at freezing temperatures will drop the level in the tank a substantial amount (about 0.2% or 11 litres in a 5,600 litre tank). A 'loss' of 11 litres in the risers will look like a leak.
- Water used in the test will freeze and expand by approximately 9%. Avoid the water freezing during and after testing.

For testing plastic or fiberglass tanks, follow manufacturer recommendations. Some manufacturers recommend backfilling around the tank before or during filling the tank with water.

III- 6.4.3.2.(b) Vacuum testing

As an alternative to water testing, vacuum testing may be used.

The 2003 National Precast Concrete Association (US) standard states: "The recommended (vacuum test) procedure is to introduce a vacuum of 4 inches of mercury. Hold this pressure for 5 minutes. During this initial 5 minutes, there is an allowable pressure equalization loss of up to one half inch of mercury. If the pressure drops, it should be brought back to 4 inches and held for a further five minutes with no pressure drop."

III- 6.4.3.3 Risk of floating and tank distortion

Ideally, drain the tank area if there is a risk of high water table conditions.

If this is not practical, and if groundwater conditions may lead to tank flotation, prevent flotation by anchoring or other method, and/or install water table observation standpipes to monitor water level at tank (to prevent pumping out when water levels are high).

If plastic or fiberglass tanks are used, follow the manufacturer's recommendations to prevent tanks floating and to reduce risks of distortion during pump out when water table levels are high. This could cause tank collapse in some cases. Detail the procedures for pump out in the maintenance plan. For example, specify that the tank can only be pumped when the water table is below a certain level.

To calculate whether a tank will float consider the weight of water displaced by the tank (or the part of the tank that is below water) balanced by the weight of the tank and cover soil. The weight of water normally in the tank may also be considered, although there is always the risk of the tank being emptied.

For example, if a pump tank is installed with the lid at grade and water table is expected to be at grade during part of the year, tank is 2.4 m long x 1.5 m wide x 1.5 m high. Tank weight 3400 kg

Volume of tank = 2.4 m x 1.5 m x 1.5 m = 5.4 cubic metres

Weight of water displaced by tank = volume x 1000 kg/m^3 = 5.4 x 1000 = 5400 kg

Upward force on tank = weight of water displaced – weight of tank

= 5400 kg – 3400 kg = 2000 kg

In this case the tank will float unless either weighted down with at least 2000 kg of soil or other material, or restrained in some manner. It is recommended to use a safety factor of at least 1.5 when weighing down a tank with soil or other material, so in this case 1.5 x 2000 = 3000 kg.

III- 6.4.3.3.(a) Water table observation standpipes for tanks

Observation standpipes can be made by installing a 50 mm (2″) or larger pipe vertically at the edge of the tank, with the base of the pipe side slotted and installed in drain rock or pea gravel. A tee on the base of the pipe will assist in stabilizing the pipe.

A large diameter pipe (6″ larger) is preferable, because this may allow a maintenance provider to pump the water table down prior to pumping out the tank. If the standpipe is to be used for pumping, provide a larger volume of drain rock or pea gravel around the slotted portion of the pipe, this will work better if the tanks are placed on a bed of drain rock which is continuous with the drain rock around the standpipe.

Where standpipes have been installed at the tanks to monitor the depth of the water table, this should be clearly stated in the maintenance plan. The water table monitoring standpipes should be accessible and clearly labelled.

III- 6.4.3.4 Venting

All tanks need to be vented. If the tank cannot vent back to the building sewer, then provide a vent that meets Volume II standards.

This includes situations where a tank may fill to above the inlet pipe, for example, a pump chamber which is installed lower than the septic tank. In these cases, venting from the risers will be needed.

If an effluent filter does not allow venting through the filter, provide external or bypass venting of downstream tanks.

III- 6.4.3.4.(a) Subsurface vents

If a subsurface vent system is used, it is important that cover soil and backfill remains air permeable after settling. For the cover soil, use dispersal trench or bed system standards. If venting a treatment plant, follow the manufacturer's guidelines for sizing the subsurface vent.

In general, subsurface vent systems provide more successful odor control if the soil or sand covering the vent system is kept damp. Venting to the dispersal system is an acceptable option as long as back pressure is not excessive.

As with all vent systems, subsurface vent pipe outlets need to be accessible for observation and need to be screened. Ensure groundwater cannot get into the vent system.

III- 6.4.4 TANK ABANDONMENT

When a septic tank or other subsurface treatment tank is abandoned one of the following procedures should be taken in order to prevent future health and safety hazards:

- The contents of the tank should be pumped out and the tank, if structurally sound, should be filled with inorganic material such as soil or rock; or,
- the tank should be removed or broken up, and the resulting excavation should be filled with soil or rock.

Filling the tank will prevent caving in, collapse and floatation. Organic materials should not to be used for this purpose as they can decay; possibly leading to caving in or collapse and can produce toxic and possibly explosive gases.

III- 6.5 Dispersal systems, general

III- 6.5.1 SIZING AND LAYOUT

See individual technologies for sizing guidelines.

III- 6.5.1.1 Alternating dispersal areas

An alternating dispersal area system consists of zones (separate dispersal areas or separate parts of a dispersal area) that are used alternately with long rest periods (for example, 3 months on and 3 months off).

These systems allow time for biomat to be broken down during the resting periods, which may increase system life. Each zone is sized to meet standard HLR for the full DDF.

In the case of a gravity distribution system, zones are alternated by using either a full flow valve, splitter tee with diversion valve or a d-box with diverter plates. For pressure systems ball valves can be used.

See Section III- 6.9.2.2 for special precautions when using alternating dispersal areas with gravity distribution.

III- 6.5.2 SPECIFICATION AND INSTALLATION

III- 6.5.2.1 Aggregate and other materials

III- 6.5.2.1.(a) Coarse aggregate

Excessive fines in coarse aggregate can wash down and contaminate the infiltrative surface of a trench or bed, reducing permeability.

It is preferable to sieve test coarse aggregate following a wet sieving test protocol (example ASTM C117) to ensure fines (less than 75µm) in the aggregate are characterized. If aggregate is merely dry sieved there is a risk of underestimating the amount of fines, as the fines may be stuck to gravel particles. If the pit is using a dust suppressant this could increase the risk of fines sticking to gravel particles.

III- 6.5.2.1.(b) Separation layer

When aggregate is used in a bed or trench systems, cover the aggregate with a barrier material to prevent infiltration and migration of fines to the aggregate.

A graded filter can be used. For example, a drain rock bed can be covered by 5 cm of pea gravel, 5 cm of Mound Sand and then cover soil.

Whatever method is used, air exchange should not be reduced, and the risk of root mat forming on the layer should be considered.

III- 6.5.2.1.(c) Geotextile Sample Specification

If geotextile is used to prevent soil cover mixing with aggregate, then it should be lightweight and of “non-woven” type. The textile should be hydrophilic (not repel water). Table III- 18 (below) is a geotextile specification from the Wisconsin Private Onsite Wastewater Treatment Systems code and is provided as a guideline.

Table III- 18. Geotextile Specification for separation layer

PROPERTY	TEST METHOD	AVERAGE ROLL VALUE
Grab Tensile, lbs.	ASTM D4632	35 minimum
Grab Elongation, %	ASTM D4632	50 minimum
Puncture, lbs.	ASTM D4833	10 minimum
Trapezoidal tear, lbs.	ASTM D4533	11 minimum
AOS, US Sieve #	ASTM D4751	20 minimum
AOS, US Sieve #	ASTM D4751	70 maximum
Flow Rate (gal/min/ft^2)	ASTM D4491	100 minimum
Or equivalent Canadian standard		

Notes:

- AOS = Apparent Opening Size.
- Washington State recommends for Soil with 50% or less particles by weight passing U.S. No. 200 sieve, AOS maximum #30 Sieve; and for Soil with more than 50% particles by weight passing U.S. No. 200 Sieve, AOS maximum #50 Sieve.

III- 6.5.2.1.(d) Cover and separation layer

i) Cover grading and water diversion

It is important to divert surface water which would otherwise run onto or pond on the system. This is achieved by crowning the system cover. Diversion swales or interception drains may help.

ii) Cover soil type and depth

Aeration of the dispersal system is critically important. For that reason, avoid excessive cover depth and use permeable soil. If native soil is used for cover soil, it should be as permeable as the most favorable layers of the native soil.

For Seepage Beds, native soil can be used for cover soil as long as it is Loamy Sand, Loamy Fine Sand, Sandy Loam or more permeable. This will be the case for all Type 1 Seepage Beds due to the soil type limitations for these systems. For Type 2 Seepage Beds on lower permeability soils, it is preferable to use imported Loamy Sand, Loamy Fine Sand or Sandy Loam.

Do not increase the cover depth except for frost protection in very cold climate conditions. Limit the depth of cover to 60 cm or less even in very cold climate conditions.

The Volume II standards specify using sand to increase the depth of cover to more than 30 cm rather than deeper cover soil. This is to improve aeration.

The standards specify use of specific soil types for certain types of system. This is to improve aeration, to encourage growth of cover vegetation and to shed water during heavy rainfall.

III- 6.5.2.1.(e) Blinding layer

A blinding layer is a layer of sand, 10 cm or less in thickness that is placed on the infiltrative surface. The layer is installed on the scarified trench or bed base and is settled (not compacted). The blinding layer may also be scarified into the base of the trench or bed.

Use of a blinding layer is recommended when soils have large macro pores (very strong structure and/or coarse fragment content > 35%) to reduce the opportunity for flow concentration and avoid bypass flow-which would lead to poor treatment in the soil.

A blinding layer is also recommended for systems using aggregate when the native soil is fine textured and, as a result, may be prone to crusting or "capping". Crusts are caused in several ways, but of particular concern in this case is the impact of effluent falling onto the soil, which can cause sorting of fine particles resulting in excessive accumulation of fine particles on the infiltrative surface. Crust formation is common with soils containing larger amounts of silt and certain clay minerals, and is not common with sand textured soils.

A blinding layer may also be useful where soils vary widely along the length of a trench or bed, or where the infiltrative surface is in soil that is particularly sensitive to damage during installation.

III- 6.5.2.1.(f) Permeable fill

Where fill is needed between trenches, around chambers, or in a toe blanket, it is acceptable to use clean permeable fill.

The fill material should have permeability equal to or higher than that of the native soil, and it is recommended that the installed Kfs be at least 550 mm/day (perc rate maximum 15 min/inch) after settling. It is preferable to test the Kfs after installation and settling of the fill, alternatively the permeability may be tested at the source, in the bank or on a test pile of settled soil fill. See Section III- 6.8.4for information on toe blankets.

Note that sand blanket sand mounds use a special specification for the toe blanket fill, so the general rules above do not apply.

III- 6.5.2.2 Site, Soil and Ecosystem Considerations

The soil infiltration and treatment of effluent works best under unsaturated conditions. A shallow infiltrative surface, with minimal cover, will encourage oxygen transfer, improve soil treatment, and improve evapotranspiration. Soils close to the surface are more biologically active. One published study found that more than 98 % of the soil biota population is in the upper 40 cm of the soil profile.

The dispersal system acts to disperse effluent through unsaturated soils, achieving hydraulic dispersal and treatment, including pathogen removal. For this process to be effective, the soil should be in as close to an undisturbed state as practical. Site impact on the dispersal and receiving area should be minimized, and it is recommended that as much natural vegetation and root structure be maintained as is practical.

III- 6.5.2.2.(a) Soil moisture and damage to soils

In all cases, systems should not be constructed when the soil moisture is too high, as this will damage soil structure and may lead to system failure.

Check the soil moisture at the surface, and at 20 cm depth. Postpone the installation if a soil grab sample can be rolled into a wire (i.e. will form a wire ≤ 7 mm diameter without adding additional water). Also, postpone work if squeezing a grab sample of soil causes water to escape. Both of these tests indicate that the soil is too wet.

During construction it is important to protect the dispersal and receiving area. This may mean using temporary fencing or taping the area off.

Vehicles or heavy animal traffic should not be permitted on the finished system. This consideration could also apply to the receiving area for some sites. Heavy traffic can compact the soil. This limits oxygen transfer, increases the risk of frost damage, and risks direct physical damage to system components.

III- 6.5.2.2.(b) Vegetation and onsite systems

In many cases the natural ecosystem of a site is important for maintaining the soil characteristics that made the site usable for a dispersal system.

Tree and shrub cover in the dispersal and receiving area can improve system performance by:

- Reducing effective rainfall (the amount of rain that actually soaks into the soil).
- Maintaining soil structure and organic matter content in the long term.
- Reducing temperature extremes, and particularly reducing risk of freezing.
- Improving removal of contaminants.

However, depending on the system type, tree roots may harm the dispersal system.

In general, the recommended procedure is to leave trees and stumps in place. However, for trees with highly invasive roots (examples include willow, aspen, bamboo, and maple), it may be best to remove the tree and stump or to kill the stump if it is left in place.

Reestablishment of natural vegetation cover should be encouraged after system installation, in as far as is practical. Choose trees and shrubs to suit the area and which are known to not have invasive roots.

For BC zero discharge lagoons it is important to prevent tree growth on or near lagoon berms.

III- 6.5.2.2.(c) Completion of vegetation re establishment

After installing a dispersal system, it is advisable to re-establish vegetation, either by seeding or planting in the cover soil. Sod may also be used, but ensure the sod is based on a permeable soil or sand.

Vegetation takes time to establish on the dispersal area. For this reason, the maintenance plan may include instructions for the owner to complete the seeding and establishment of vegetation. The owner will sign off on this with acknowledgement of the maintenance plan.

III- 6.5.2.3 Gravelless systems

Gravelless systems, including artificial aggregate systems, offer alternatives to traditional pipe and gravel distribution. They may consist of chambers, pipe or pipe bundles with artificial aggregate such as Styrofoam, geo-composite bundles or sheets of geotextile material.

For single and multiple pipe gravelless systems, the effective trench width is taken to be the outside diameter of the pipe (including any attached artificial aggregate), pipe and aggregate bundle, or pipe bundle.

For gravelless chamber systems, the effective trench width is taken to be, at a maximum, the outside dimensional width of the chamber in contact with the bottom of the trench or bed. A more conservative approach could be taken by using the actual exposed interior dimensional width of the chamber at the trench or bed bottom.

For geo-composite systems, the effective trench width is taken to be the outside dimension(s) of the bundle(s) in contact with the trench or bed base (or sand layer, where used).

III- 6.5.2.4 Observation Ports

Trench and bed dispersal systems use observation ports to allow checking of the infiltrative surface for ponding. Typically these are 4" or 6" diameter pipes, with side or lengthwise slots near the base of the pipe. These pipes should be capped and should be anchored to prevent pull out; this can be accomplished by use of a toilet flange or tee at the pipe bottom, or other method.

For chambers, install monitoring port pipes as per manufacturer instructions.

Sand mounds, sand lined trenches and beds also use observation ports to allow checking of ponding at the basal area. These are installed in a similar way.

If it is important to check the water table level below the dispersal area or in the receiving area, a similar observation pipe (standpipe) can be installed. The pipe should be installed deep enough to allow confirmation of the design vertical separation, and can be slotted or perforated over the lower 30 cm. When installing these observation standpipes, reduce risk of effluent short circuiting by placing the pipe away from the infiltrative surface, or by using bentonite plugs around the pipe.

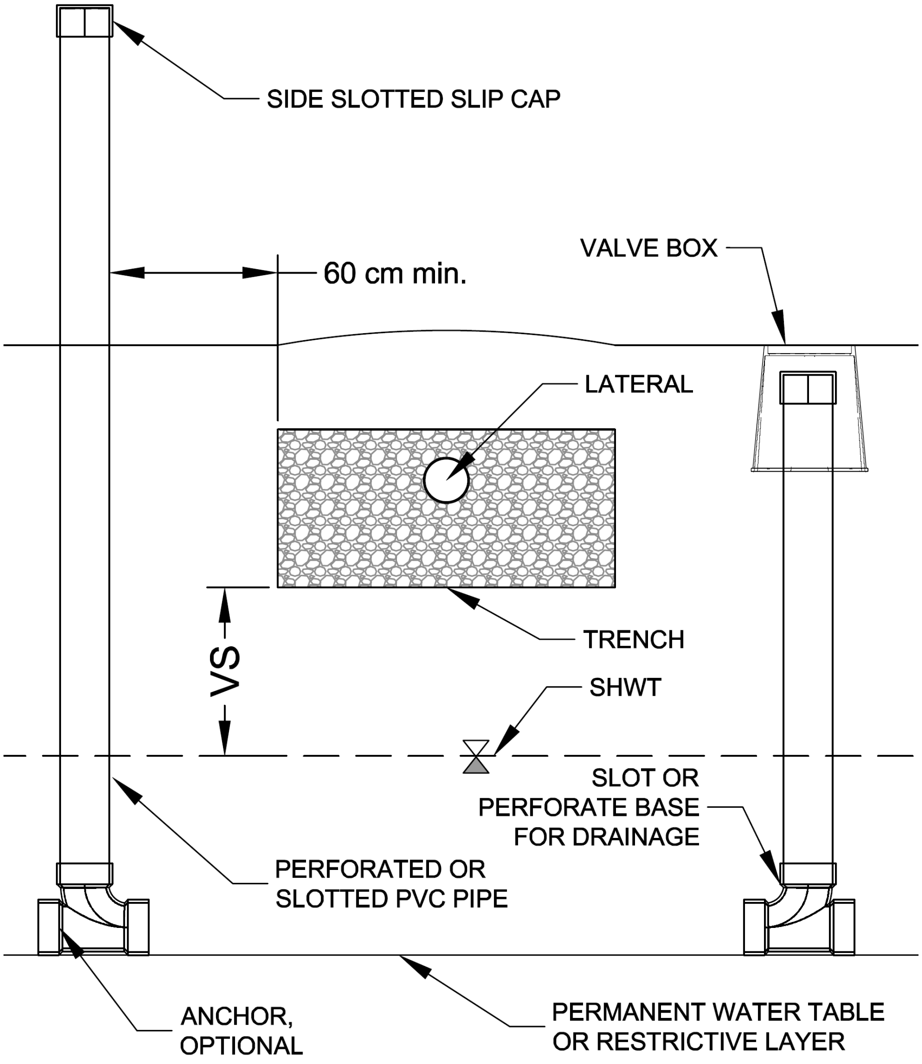
Observation port access can be exposed or can be in a valve box to allow mowing of the dispersal area etc.

III- 6.5.2.5 Observation standpipes

This guideline is intended for standpipes installed to a maximum depth of 180 cm for observation of water table level and confirmation of vertical separation.

Install standpipes using one of the examples show in Figure III- 9.

Figure III- 9. Above grade and at grade standpipes



Construct standpipes using 1″ to 6″ perforated or slotted PVC pipe; 3″ perforated PVC sewer pipe is a common choice. Cap the top and bottom with PVC slip caps, side slot the top cap to facilitate removal. If the slotted or perforated pipe does not extend to the surface, drill a hole near the top of the standpipe to vent air. Ensure the pipe can drain out by slotting or perforating the base. Optionally, to resist heaving forces, anchor the bottom of the pipe with a section of rebar, PVC tee, toilet flange or other anchor.

For at-grade completion, use an irrigation valve cover or other suitable protective cover.

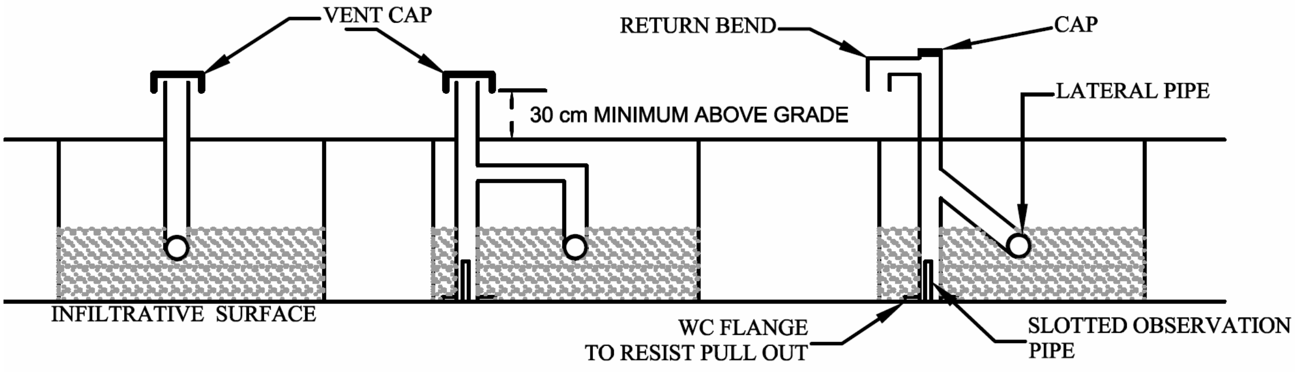
Standpipe depth will be at least as deep as the required system vertical separation, but no deeper than the seasonal low water table. The standpipe should be a minimum of 60 cm from the nearest dispersal trench, bed or dripline. Excavate or auger a hole to the target depth, and install the standpipe in the open hole. Backfill around the standpipe, holding the pipe vertical. Mound the soil above surrounding grade, to divert surface water away from the pipe and to allow for settling of the backfill soil.

III- 6.5.2.6 Vent pipes

In some cases gravity distribution systems and ET beds or ETA beds will use vent pipes to assist with air exchange.

These may be separate pipes or connect to the top of gravity distribution laterals. In chamber systems, these can be directly combined with the observation ports. With standard laterals, this combination will mean use of a tee or wye connecting to the vent pipe above the level of the aggregate in the trench. See Figure III- 10.

Figure III- 10. Vent and Combination Vent and Observation Port Examples



III- 6.5.2.7 Flow concentration and piping systems

Within trenches used for piping, there is a risk that the loose trench backfill might concentrate groundwater flow, or provide a path for unintended effluent flow. These preferred flow paths may develop in trenches used for sewers, manifolds, feed lines, and force mains.

For this reason, when backfilling trenches, it is often good practice to place subsurface dams to prevent liquid flow along the trench. These dams may be constructed from local clay, imported bentonite chips, or a similar material of low permeability. Bentonite may be mixed (at 10% bentonite to 90 % sand) with bedding sand to block the flow around a pipe.

Alternatively, the configuration of the piping can be designed to prevent flow concentration - for example:

- By having the force main enter a dispersal field on the upslope side.
- By stepping the bottom of a trench to provide separation of lateral trenches from the manifold or force main by a section of higher undisturbed soil.
- By shallower excavation of the manifold or feeder line trench.

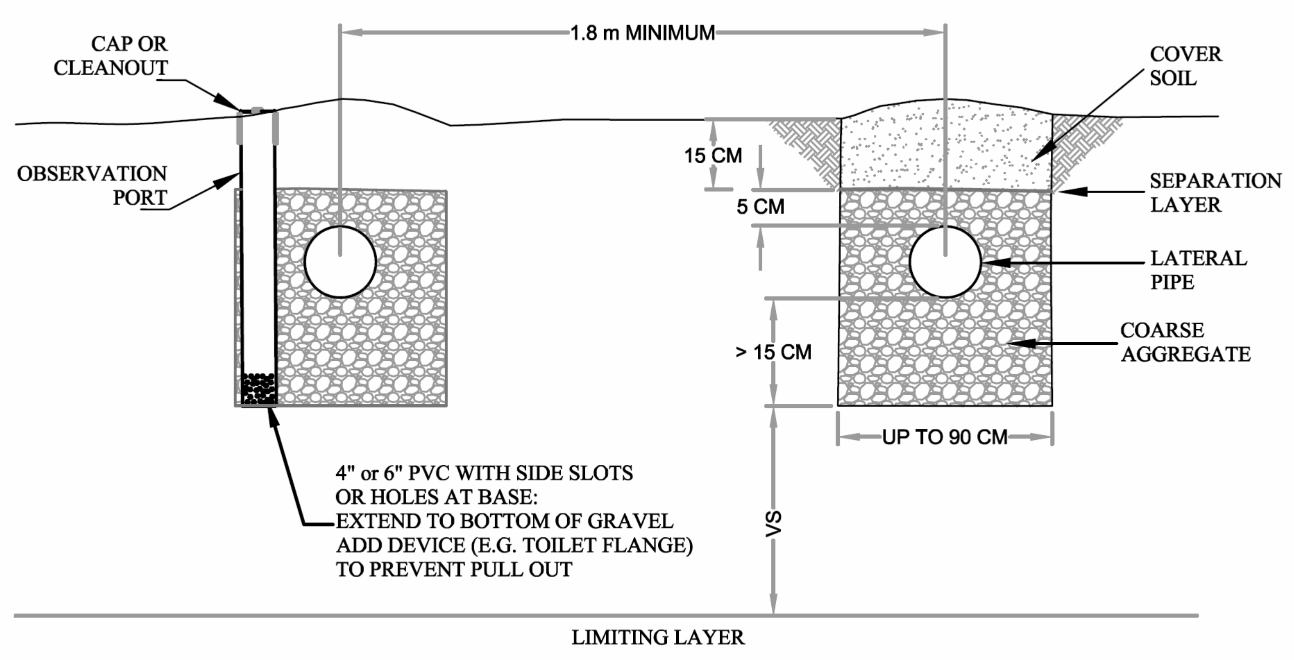
III- 6.6 Trench systems

III- 6.6.1 DESCRIPTION

Trenches (also known as infiltration trenches) can be installed as shown in Figure III- 11, below the ground surface. Trenches can also be installed at shallow depth — in which case trenches are partially below ground and partially covered, or at grade—in which case fill is placed between and over the trenches or the trenches are excavated into fill after it is placed.

The standards specify a minimum aggregate depth of 15 cm below the distribution lateral, greater depth is recommended if more surge storage is needed or if root intrusion is a concern.

Figure III- 11. Trench Dispersal schematic cross section



III- 6.6.2 SIZING AND LAYOUT

Example of trench sizing:

Daily Design Flow of 1300 L/day, HLR of 15 L/day/m^2 and 0.6 m wide trenches

Minimum AIS needed = DDF ÷ HLR = 1300 ÷ 15 = 86.7 m^2

This is the trench bottom area needed

Total length of trenches = 86.7 m^2 ÷ 0.6 m = 144.4 m

The standards indicate minimum spacing between trenches. This spacing is not necessary between the ends of trenches (for example, for a center fed trench system).

III- 6.6.3 SPECIFICATION AND INSTALLATION

To improve infiltration of effluent into the soil, scarify the infiltrative surface to a depth of 5 to 15 cm, depending on the type of soil and soil depth. Scarify the sides of the trench if the soil is smeared or compacted. Scarify with a picking action using the teeth of an excavator bucket, or using hand tools.

Normally, lateral piping is centered in the trench.

III- 6.7 Seepage Bed systems

III- 6.7.1 DESCRIPTION

A Seepage Bed system is simply a wider infiltration trench, typically with more than one distribution lateral.

III- 6.7.2 SIZING AND LAYOUT

Seepage Bed systems are sized in the same way as trench systems.

Volume II standards limit the width of a bed to 3m and also limit the use of Type 1 Seepage Beds to more permeable soil types (see Table II- 6, page II-16). These restrictions provide for oxygen transport to the area under the bed and to the center of the bed.

For the same reason, Type 1 below grade beds are limited to more permeable soil types.

The standards indicate minimum spacing between beds. This spacing is not necessary between the ends of beds (for example, if the bed steps up or down).

If more than one bed is installed, the overall system contour length is determined in the same way as for trench systems.

III- 6.7.3 SPECIFICATION AND INSTALLATION

In a Seepage Bed, the distribution laterals should be evenly spaced across the width of the bed. On seepage beds with pressure distribution, it is better to stagger the orifices on adjacent laterals. The number of pressure distribution laterals is determined based on the minimum infiltrative surface per orifice.

For gravity distribution pipe laterals are typically spaced at no more than 90 cm on center.

For Seepage Beds, native soil can be used for cover soil as long as it is Loamy Sand, Loamy Fine Sand, Sandy Loam or more permeable. This will be the case for all Type 1 Seepage Beds due to the soil type limitations for these systems.

For Type 2 Seepage Beds on lower permeability soils, it is preferable to use imported Loamy Sand, Loamy Fine Sand or Sandy Loam. Ensure the cover is crowned or graded to divert surface water.

III- 6.8 Shallow, at grade and raised systems

III- 6.8.1 DESCRIPTION

Trenches or Seepage Beds can be installed at or above grade. Above grade systems are installed on sand media fill.

The standards specify use of uniform distribution if the infiltrative surface is above grade. If the sand media fill is more than 30 cm, then the system becomes a sand mound or bottomless sand filter, and should conform to standards for those systems; see Section III- 6.15.

The standards also provide two specific technologies for at grade systems which are placed directly on native soil and which follow the slope of the land: The At-grade bed and the Alberta At Grade system. These should conform to the standards for those systems, see Sections III- 6.13 and III- 6.14.

III- 6.8.2 SIZING AND LAYOUT

These systems should be sized using the same approach as used for a conventional below grade system.

Follow Volume II standards and use the HLR for the native soil or the sand media, whichever is lower.

Example 1:

Using Type 1 effluent, the native soil HLR is 35 L/day/m^2;

Fill is Mound Sand (HLR 40 L/day/m^2).

Size system based on HLR of 35 L/day/m^2

Example 2:

Using Type 2 effluent, the native soil HLR is 70 L/day/m^2,

Fill is *Clean Coarse Sand* (HLR 50 L/day/m^2).

Size system based on HLR of 50 L/day/m^2

III- 6.8.3 SPECIFICATION AND INSTALLATION

With at grade and raised systems, a swale or interception drain is often useful to divert water away from the dispersal area.

A swale is a shallow depression installed at the upslope edge of the cover soil, and shaped to divert surface water away from the system. The swale may be lined with low permeability soil or a liner to help divert water.

For interception drains, see Section III- 6.19.

III- 6.8.4 TOE BLANKETS

In some circumstances, it may be appropriate to install a toe blanket around, or downslope from, the discharge system (see Section III- 5.6.7.1). A Toe Blanket is a blanket or mantle of sand or permeable soil that is placed at the toe of raised dispersal system or in the receiving area. The purpose is to aid seepage from the raised system into the native soil, or to provide additional depth for effluent to move away from the dispersal area and to provide a cover above soil that may be saturated.

When specifying and installing a toe blanket, consider the following:

- The toe blanket should be installed as for sand Mound Sand, according to Section III- 6.15.
- For flat and low slope (≤ 2%) sites, the toe blanket should be installed all around the system rather than just down slope.
- Ensure the toe blanket is at least 25 cm deep or at least 15 cm above the maximum expected water table level in the receiving area.
- Cover the toe blanket with cover soil and vegetate, as for sand mounds. The toe blanket should slope to encourage surface water to run off.
- The toe blanket should be installed following the procedure for installing sand Mound Sand (See Section III- 6.15.). Test the permeability of the sand fill after settling.

It is acceptable to use clean permeable fill; see Section III- 6.5.2.1.(f) for a specification.

See Section Figure III- 24 (sand mantle sand mound) for a schematic cross section of a toe blanket. Note that sand mantle sand mounds use a special specification for sand fill and depth, see Section III- 6.15.2.2.

III- 6.9 Gravity distribution

III- 6.9.1 DESCRIPTION

Gravity distribution is an effluent distribution method in which the distribution laterals are not under sustained pressure during the dose event. This includes dosing systems where the effluent is dosed to large diameter laterals by pump or other method.

Gravity distribution systems result in wide variations in application rates through the dispersal area. Effluent may pond in some areas, and may not reach other parts of the dispersal system.

It is this variability in distribution which can result in less effective soil treatment below gravity systems.

Dosing may, in some cases, improve performance of a gravity distribution system, due to improved uniformity of distribution, and also due to improved soil and infiltrative surface aeration resulting from intermittent doses. Distribution is somewhat improved when dosing is used, and dosing has been demonstrated to considerably improve equality of distribution to individual laterals.

III- 6.9.1.1 Flow splitting

Some form of flow splitting is used to divide effluent between laterals. Devices used to split flows include:

- Distribution Boxes (D-boxes) and splitter tees which can both be used with trickling or dosed gravity systems, for these splitters laterals need to be similar lengths.
- Drop boxes (sequential distribution)
- Pressure manifolds, which allow use of laterals of different lengths.

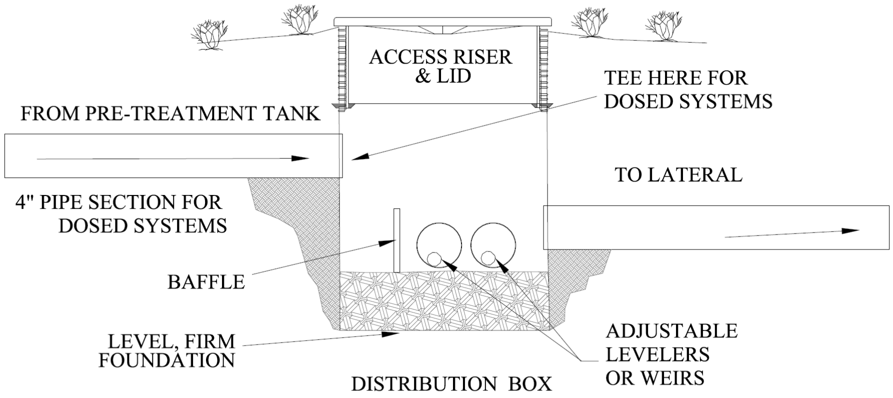
III- 6.9.1.1.(a) Distribution box

The D-box (see Figure III- 12) includes adjustable levelling devices or weirs at the outlets to allow adjustment of flow splitting. Individual feeder lines run from the D-box outlet to each lateral.

On sloping sites there is a risk that a ponded lateral will flow back to the box and drain to lower laterals. D-boxes are not recommended for use on steeply sloping sites.

D-boxes may be built with a tipping mechanism that fills and then releases a small volume of effluent; this improves flow splitting (but is not considered to be a dosing system).

Figure III- 12. Distribution Box



III- 6.9.1.1.(b) Sequential distribution

In sequential distribution, one trench or trench pair is loaded to a predetermined level before passing through a relief line or device to the beginning of the succeeding trench or trench pair; the effluent does not pass through the distribution media before it enters succeeding trenches. This is usually achieved through the use of drop boxes. See Figure III- 13 and Figure III- 14 for explanation of this system.

The connections between distribution lines are made with non-perforated pipe placed in undisturbed soil, and a dam is built up at the trench to prevent draining to the lower trenches.

Sequential distribution used with trickling gravity systems means that the first trench pair will need to pond to considerable depth before effluent can flow to other trenches. For this reason, Volume II specifies dosing for sequential systems, except for trickling gravity distribution to ETA beds (where ponding is needed).

Drop boxes can be used on low slope sites by setting the downstream boxes 5 cm below the upslope unit.

Figure III- 13. Sequential (Drop Box) System (schematic top view)

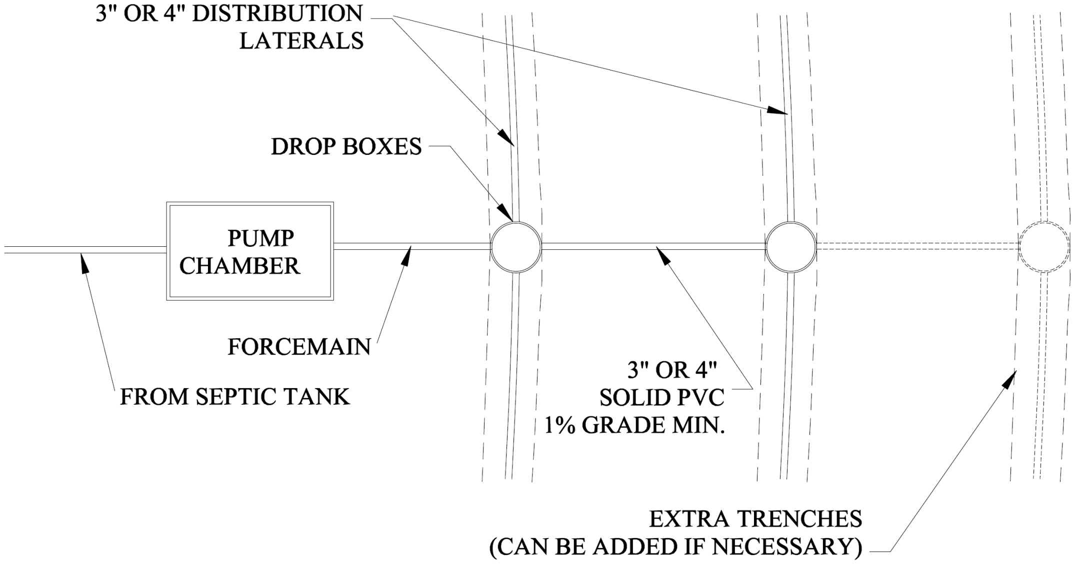
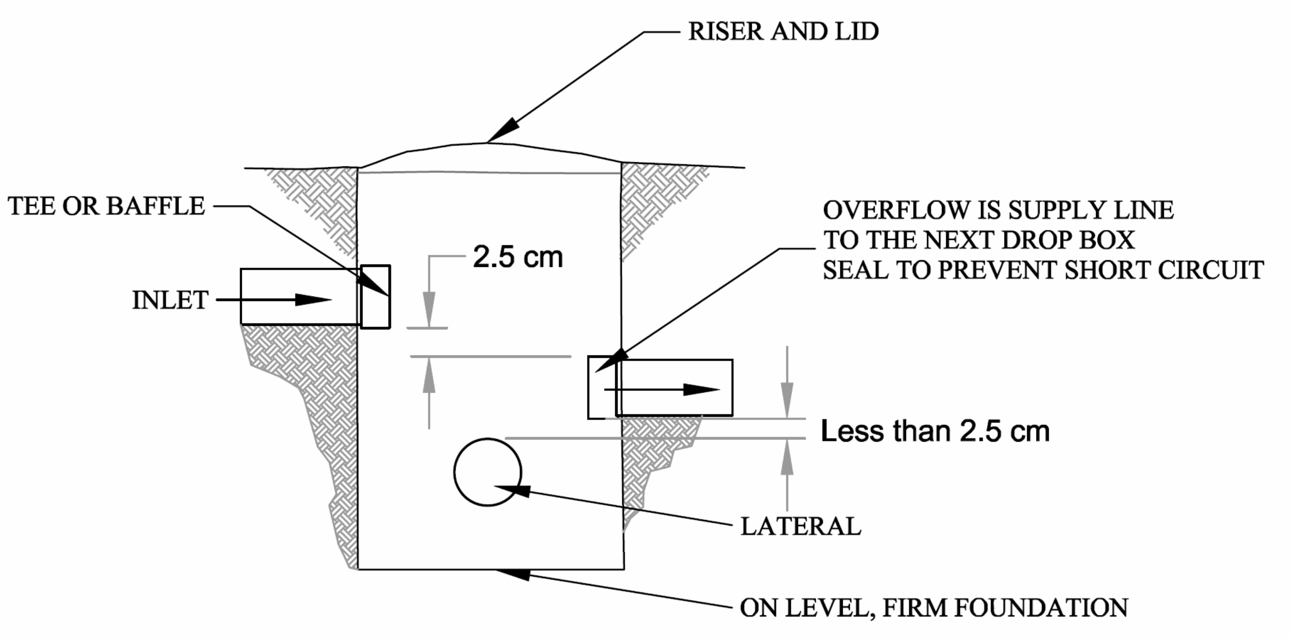


Figure III- 14. Sequential (Drop Box) system (schematic section of box)



III- 6.9.1.1.(c) Pressure Manifold

A pressure manifold is a pressurized flow splitting device, using a short manifold with a series of orifices sized to ensure equal distribution to a network of gravity pipes and trenches.

The manifold can be arranged along the ends of lateral trenches, or the effluent can be taken from the manifold to each lateral by an individual small diameter feeder line. The manifold operates under pressure, while the distribution laterals flow by gravity. This system is considered a simple and effective alternative to pumping effluent to a D-box.

Trenches can be of different lengths and the system can be used on a flat or sloping site.

III- 6.9.2 SIZING AND LAYOUT

III- 6.9.2.1 Dose volume

To calculate dose volume for a dosed gravity distribution systems, add up the total volume of feeder lines and lateral pipes and use a dose between 67 % and 100 % of this volume.

For ASTM D2729 sewer pipe the following internal volumes may be used:

- 3″ pipe, 0.394 USgal/ft. (4.89 L/m)
- 4″ pipe, 0.674 USgal/ft. (8.37 L/m)

For CSA B182.2 sewer pipe the following internal volumes may be used:

- 3″ pipe, 0.378 USgal/ft. (4.70 L/m)
- 4″ pipe, 0.640 USgal/ft. (7.95 L/m)

III- 6.9.2.2 Gravity distribution system design with alternating dispersal areas

Alternating dispersal areas (see Section III- 6.5.1.1) are intended to reduce biomat accumulation. With gravity distribution systems in more permeable soils the biomat forms an important part of the distribution and soil treatment system. Therefore, in these cases, increased vertical separation should be used.

As a guideline, increase vertical separation by at least 30 cm when using an alternating system with gravity distribution to sand textured soils.

III- 6.9.3 SPECIFICATIONS AND INSTALLATION

III- 6.9.3.1 Flow concentration

On sloping sites, there is a risk of effluent concentrating in the feeder line trenches. Care should be taken to prevent this during installation. Techniques include the following: shallower excavation for the feeder pipe trench, clay or Bentonite plugs in the trenches, and separation of the lateral trenches from the feeder trench.

III- 6.9.3.2 Reduction of water flow velocity for dosing systems

Where effluent is pumped or siphoned to the D-box or drop box, a baffle or tee should be provided to improve distribution, and the box should be sized to ensure flow can be accommodated.

A preferred method to moderate flow velocities to the box is to have the pressure line enter a 4” pipe for at least 1 m before the box to slow the incoming flow.

III- 6.10 Pressure distribution

III- 6.10.1 DESCRIPTION

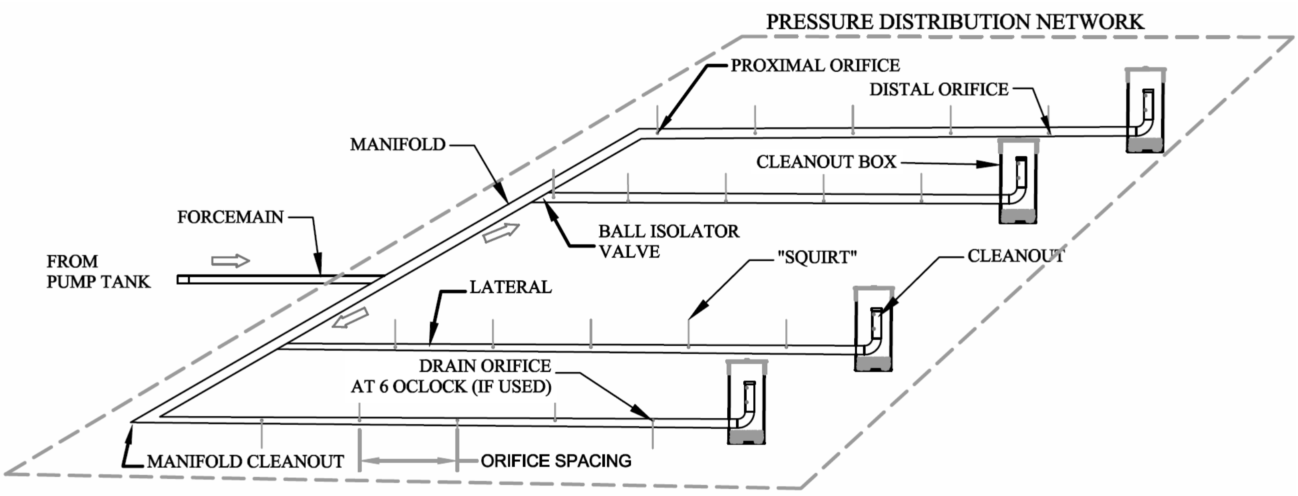
The pressure distribution system relies upon a pump, a floating outlet device or a siphon, to pressurize the dispersal system laterals. These small diameter laterals have orifices drilled in them in an even pattern to discharge the effluent to the infiltration surface.

The pump or dosing device will be housed within a pump tank (pump chamber).

Pressure distribution results in more uniform application rate through the dispersal area, typically variation in flow rate from any two orifices in a dispersal area will not vary by more than 15% if the system is properly specified and installed.

This improved uniformity of application, together with intermittent dosing, improves soil treatment below a pressure distribution system. Figure III- 15 shows the technical terms used in a pressure distribution network.

Figure III- 15. Pressure Distribution system terminology



III- 6.10.2 SIZING AND LAYOUT

III- 6.10.2.1 Hydraulic design

For guidance on hydraulic design of pressure distribution systems, refer to: J. C. Converse, *"Pressure distribution network design,"* Small Scale Waste Management Project, vol. 345, 2000. Available online at:

http://www.soils.wisc.edu/sswmp/SSWMP_9.14.pdf

Techniques for pressure system design planning, following the approach described in Converse's paper are available from the State of Wisconsin, http://dsps.wi.gov/sb/docs/sb-ppalopp/20120165A.pdf and from Washington State, http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-009.pdf

When referring to these manuals, follow SPM standards and guidelines where they differ from those in the manuals.

III- 6.10.2.2 Dose volume

For even distribution, plan the system so that distribution is uniform.

Typically, planning so that at least 67% of each dose discharges at full pressure is considered to provide uniform distribution. Another option is to measure the volume discharged from several orifices within the distribution network at commissioning to confirm that the distribution meets standards for uniformity (see Section II- 5.2.1.1).

See Section III- 6.12.3.5 for adjustment of dose volume or dose time at commissioning.

For high dose frequencies, including for micro-dosing, a small dose volume is needed, strategies to decrease dose volume needed for even distribution include:

- Keep the laterals full, by drilling all orifices facing up, and installing laterals completely level.
- Avoid the manifold and force main draining to the field.
- When planning a system with draining laterals, use short, small diameter, lateral pipes. Small orifice size will allow use of smaller lateral lines.
- Drain the laterals back into the pump chamber (see Section III- 6.10.3.4).

Increased distal pressure (squirt height) will improve distribution by reducing pressurization time, and will also assist in keeping orifices cleared and in scouring laterals.

III- 6.10.3 SPECIFICATION AND INSTALLATION

III- 6.10.3.1 Orifice number

Calculate minimum the number of orifices and orifice spacing based on the maximum infiltrative surface area per orifice.

As a guideline, it is preferred to reduce the area per orifice for sand media systems to a maximum of 0.37 m^2 (4 ft^2) of infiltration surface area per orifice.

III- 6.10.3.2 Flushing and cleanouts

Each lateral, and the manifold, should be fitted with a clean out at the distal (far) end that is:

- Preferably brought to vertical orientation;
- fitted with a short radius bend, or a riser fashioned by two 45^o bends;
- located in a valve box, or similar access provision, allowing easy access for maintenance; and
- provided with a removable threaded cap, or threaded plug located at an elevation close to the underside of the access box lid, to facilitate easy access and removal by tools. A valve (at the distal end of the lateral) may also be used.

III- 6.10.3.2.(a) Small diameter laterals

Small diameter laterals (1″ or smaller) are more difficult to clean with jetting apparatus or to defrost with a steam lance.

For small diameter laterals a long radius bend is preferred at the cleanout, since many cleaning tools will not pass through the small 45 deg. elbows.

III- 6.10.3.3 Sloping sites

On sloping sites, prevent drain back of higher to lower laterals and ensure that all laterals operate at equal flow per basal area. For layout options for sloping sites, refer to the appendix, Section III- 8.8.1.

An alternative is to adjust the flow to the lowest lateral to compensate for drain down to that lateral. This can be set up at commissioning, based on the measured drain down (collect water discharged from upper lateral test orifice and lower lateral test orifice to calculate difference, adjust to equalize).

III- 6.10.3.3.(a) Flow control

Where flow control is needed to balance laterals on a sloping site, or where laterals are of differing lengths, effluent flow can be controlled using orifice plates, diaphragm valves or globe valves. Where orifice plates are used, the plates should be removable for service, and the orifice size should be clearly recorded.

III- 6.10.3.4 Freezing conditions and lateral draining

In climates and sites where there is a risk of the laterals freezing, to avoid freezing, laterals should be emptied at the end of each dose. The manifold and force main may also need to be emptied (either the whole lines or parts that are above the frost line).

This can be achieved by:

- Draining to the field.

- Draining back to the pump chamber, with either:
    - Only the force main and manifold drained back (with laterals draining to the field); or
    - draining laterals back to the pump chamber as well as the manifold and force main.

At the pump tank, the effluent typically is drained back through an orifice or through the pump. A further option on larger systems is to drain using a motorized valve.

Drainback through an orifice will mean that the orifice needs to be adequately sized (see below) and either the orifice needs to be drilled in a location where it will not discharge significantly during pumping (e.g. on the cleanout cap of a y-ball check valve) or the flow from that orifice will need to be accounted for during hydraulic design.

Where the drainback orifice is at the bottom of a pipe there is a higher risk of plugging, consider siting the orifice on a vertical pipe run.

Drainback through the pump should only be used on timed dosed systems to avoid risk of pump start up when the pump is spinning backwards, check with the pump manufacturer if unsure whether this approach is safe with a particular pump.

III- 6.10.3.4.(a) Laterals draining to the field

By drilling every other orifice facing down, or by drilling all orifices facing down with only the first and last facing up (for air clearing) the lateral pipes will drain reliably after a dose, and distribution during draining will be even.

Section III- 6.10.2.2 identifies that this approach will be facilitated by short, small diameter laterals with small orifices and increased distal pressure (squirt height), particularly if frequent dosing is needed.

In some cases an orifice is drilled at the base of the riser pipe (from the manifold to lateral connection) to drain the riser pipe. This is intended to prevent freezing. The orifice should be bedded in a minimum of 15cm depth of drain rock, and vertical separation should be maintained, and care should be taken to avoid flow concentration around the manifold.

III- 6.10.3.4.(b) Laterals draining back to the pump chamber

If the laterals are to be drained back to the pump chamber, all orifices are drilled facing up. The lateral pipe is then sloped back to the manifold at a minimum of 0.5% grade (maximum of 2%) and the manifold and force main graded to drain back to the pump chamber.

Note that the bed or trench infiltrative surface (base) still needs to be installed level; the pipe grade is achieved using additional aggregate. It is also important to ensure that the thickness of cover soil does not exceed the maximum allowed. The cover depth may be increased by using sand media or by using deeper aggregate cover over the proximal part of the lateral pipe (the part closer to the manifold).

Consider using an air vacuum valve at the dispersal area. This device can reduce the risk of drawing debris into orifices when draining and allows for more rapid draining. In very cold climates, air valves need to be installed in insulated valve boxes with sealed lids and with a drain rock sump extending below the frost line.

It is important to make sure that the water drains back in less than 30 minutes or it is likely to freeze in the pipe in cold northern climates. The drainback time can be approximated using the orifice equation and the head of the pipe network above the drainback orifice at the pump chamber.

During the field testing of the pressure laterals for squirt height and even distribution time the drainback and measure the drainback volume in the pump tank (by measuring the rise in fluid level). If the drainback is too slow make the drainback orifice larger and if the dose volume is not as per the calculated design value the pump run time is adjusted. During commissioning, also confirm that lower laterals are not receiving additional flow during drainback.

When using a full drain back system, larger diameter laterals can be used since the lateral volume will not affect the uniformity of distribution. This is because with all orifices facing up the lateral will fill prior to discharging effluent to the field. The use of large diameter laterals can allow longer laterals, because of reduced friction loss.

If long laterals are used, however, deeper aggregate is needed and the elevation of the proximal (near) and distal (far) ends of the lateral will be different enough to affect distribution uniformity. If this is the case, orifice diameters may need to be varied along the individual laterals so that the difference in discharge between any two orifices can be maintained within the 10% recommended tolerance for any one lateral.

III- 6.10.3.5 Commissioning of a pressure distribution system

At commissioning:

☐ Flush the entire system.

☐ Test and record the distal pressure (squirt height) for all laterals, with the flow to laterals adjusted if necessary to equalize distribution.

☐ Check the time to fully pressurize the system (and either check that at least 67% of the dose is delivered at full pressurization or check distribution uniformity by another method). Adjust dose volume or dose time (for timed dose systems) if needed (see Section III- 6.12.3.5).

☐ Test and record the draw down in the fluid level at the pump chamber (distance per minute).

☐ Check that the upper laterals do not overload the lower laterals during drain down of the system. Adjust the lower laterals' distal pressure to compensate if necessary.

III- 6.11 Subsurface Drip Dispersal

III- 6.11.1 DESCRIPTION

Subsurface Drip Dispersal (SDD) systems use timed dosing of filtered effluent to specially-designed small diameter drip tubing, installed in soil close to the ground surface. A fine pressure filter, sized for the system flow and emitter size requirements, is used after the dosing pump. Emitters in the tubing dose the effluent at a low hydraulic application rate to the soil.

These systems provide good distribution, and can improve soil treatment performance, provided the AP takes extra care during planning and installation.

Figure III- 16 shows a schematic flow diagram for a simple SDD system using intermittent flushing and a single zone.

Some SDD systems do not use intermittent flushing, but flush continuously. With these systems, flush return flows are typically returned to the pump tank and a flush control valve is not used.

In some cases filters are manually cleaned and so do not have a filter flush system.

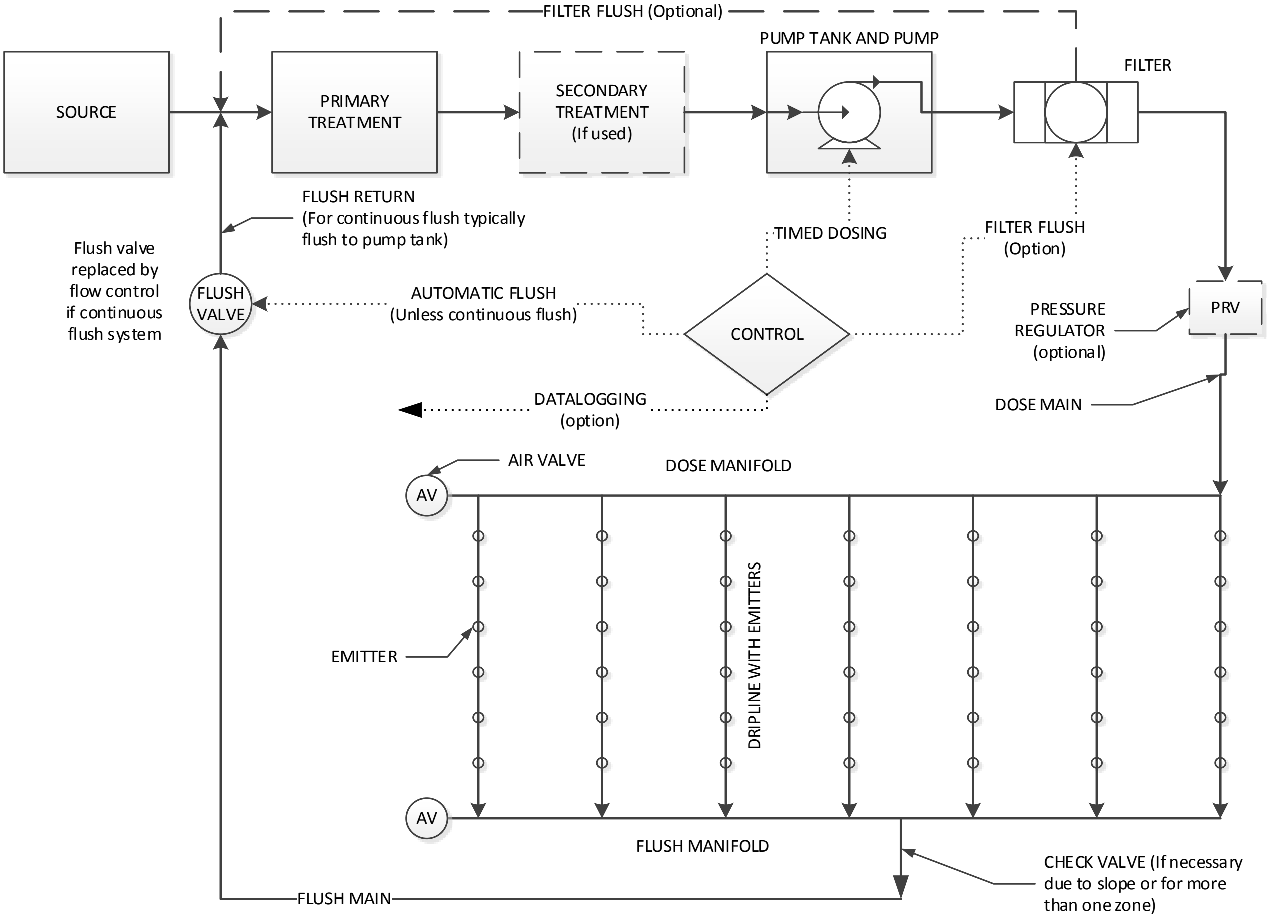
At several points in the system pressure testing ports or gages are installed, these include:

- At dose and flush manifolds (typically at air valves).

- At filter outlet.
- At flush valve inlet (if used).

These pressure test points are important for system maintenance.

Figure III- 16. Typical Subsurface Drip System



III- 6.11.2 SIZING AND LAYOUT

The following manual is recommended for planning, specification, installation and maintenance guidance:

> *"Wastewater Subsurface Drip Distribution Peer Reviewed Guidelines for Design, Operation, and Maintenance"*, March 2004 (Revised May 2004), Tennessee Valley Authority, prepared by EPRI.
>
> Available online at: http://onsite.tennessee.edu/Drip_Guidelines.pdf

When referring to this guideline, follow SPM standards where they differ from those in the guideline.

Refer to manufacturer guidelines for further specific design information. Note that the SPM standards allow for use of manufacturer recommendations for HLR selection, in all other cases follow SPM minimum standards (for example for DDF, VS, minimum system contour length, emitter number for Type 1 systems). If following manufacturer guidelines for HLR, ensure that the guideline is appropriate for use with SPM DDF (particularly, ensure that the guideline design flows use a similar peaking factor)

For very low permeability soils (with Kfs < 150 mm/day or percolation rate > 60 min /inch) the use of Type 2 effluent meeting a 10/10 mg/L (BOD/TSS) standard, or Type 3 effluent is recommended.

III- 6.11.2.1 Examples of system sizing

The standards specify a reduced HLR for SDD, see Section II- 5.5.2.1. The following examples are based on SPM HLR values, reduced by the factors provided in the standards. The examples follow the process for establishing AIS, line length and emitter number in the standards.

As an alternative, manufacturer recommended HLR may be used.

Example 1:

Loamy Fine Sand, loose consistency, Kfs 1000mm/dy.

Daily Design Flow of 1300 L/day Type 2 effluent

Table II- 22 (page II-36) HLR based on soil type is 50 L/day/m^2

Table II- 23 (page II-36) HLR based on Kfs is 60 L/day/m^2

SPM HLR selected 50 L/day/m^2

Adjusted for use with SDD, Adjusted HLR = 50 L/day/m^2 x 0.7 = 35 L/day/m^2

Minimum Area of Infiltrative Surface (AIS) = 1300 ÷ 35 = 37.15 m^2

Minimum line length = 37.15 m^2 ÷ 0.6 m = 61.9 m

Minimum emitter number = 61.9 m ÷ 0.6 m = 103 emitters

Example 2:

Sand, loose. Kfs 5500 mm/day.

Daily Design Flow of 1700 L/day Type 1 effluent

Table II- 22 (page II-36) HLR based on soil type is 30 L/day/m^2

Table II- 23 (page II-36) HLR based on Kfs is 45 L/day/m^2

SPM HLR selected 30 L/day/m^2

Adjusted for use with SDD, Adjusted HLR = 30 L/day/m^2 x 0.5 = 15 L/day/m^2

Minimum Area of Infiltrative Surface (AIS) = 1700 ÷ 15 = 113.3 m^2

Minimum line length = 113.3 m^2 ÷ 0.6 m = 188.9 m

Minimum emitter number = 188.9 m ÷ 0.6 m = 315 emitters

For Type 1 increase minimum emitter number x 4

Adjusted minimum emitter number = 315 x 4 = 1260 emitters

Emitter number may be increased by using 0.3 m line spacing and 0.3m emitter spacing within the minimum AIS.

Alternatively a larger area may be used with 0.6 m line spacing and 0.3 m emitter spacing

III- 6.11.2.2 Hydraulic design

Plan the subsurface drip hydraulic system according to the manufacturer's recommendations. Document the calculations and selections for the four or five main phases of system operation:

- Pressurize,
- dose,
- depressurize,
- flush; and
- optional drain back (necessary in cold climate conditions).

To reduce risk of emitter plugging, it is recommended that minimum pressure during dosing is maintained at or above 15 psi (100 kPa).

III- 6.11.3 SPECIFICATION AND INSTALLATION

Low site impact is important to the functioning of the system, and care in installation is critical to avoid impacting natural vegetation and soil structure (for example, by polishing and compacting soils with installation equipment).

III- 6.11.3.1 Dosing and emitter discharge rate

All SDD systems need to use timed dosing. To improve treatment in the soil, micro-dosing (low HAR timed dosing) is preferred. Volume II standards allow reduced VS when using a micro-dosing option.

In all cases, plan the system to avoid saturated flow in the soil, in order to improve treatment, reduce the risk of biomat formation, and reduce risk of soil damage.

The hydraulic application rate is influenced by the emitter discharge rate as well as by the dose time.

In general, an emitter discharge rate of less than 2.5 L/hour (0.66 USgal/hour) is preferred. Emitters with a higher rate should not be used on low permeability soils or with Type 1 effluent.

Increasing the number of emitters by using closer spacing (without reducing AIS) will reduce the application rate per emitter. This is a standard for Type 1 systems, and may also be used to improve performance of systems on highly permeable soils or sand. If the dispersal area is large enough, the number of emitters can also be increased by simply using a larger area with more dripline.

III- 6.11.3.2 Distribution uniformity

To provide a measure of uniformity of distribution it is recommended that a minimum of 80% of the dose time should be at full system pressurization.

III- 6.11.3.3 Flushing

Proper flushing of the SDD system is considered standard practice.

Adequate flow velocity in the dose main(s) during dosing is important to avoid intermittent high flows (during flush events) moving debris and slime into the driplines. A target velocity for dose mains is minimum 2 ft./sec (0.61 m/sec) during dosing.

Manual flushing of mains should be facilitated by providing accessible cleanouts to allow sequential flushing from the pump outward.

Manual intermittent flushing of the dripline laterals is not an acceptable option.

III- 6.11.3.3.(a) Automatic flushing

Consider the following points when planning an automatic flushing system:

- Provide the minimum recommended flushing velocity for all dripline laterals.
- Meet manufacturer recommended flush return volume.
- The flush return should be in a visible location. One option is to position the return over the septic tank inlet tee.
- Take care that the flush return flows will not adversely affect the treatment system.
- Use a flow inducer to minimize disturbance in the receiving tank from return flows.

III- 6.11.3.3.(b) Continuous flush systems

Consider the following points when designing a continuous flushing system:

- Provide the minimum recommended flushing velocity for all lines.
- The flush return should be in a visible location.
- Take care that the flush return flows will not adversely affect the treatment system.
    - Type 1 systems using continuous flush should flush back to the pump chamber unless the septic tank has been sized appropriately to receive the additional recirculation flow.
- Use a flow inducer to minimize disturbance in the receiving tank from return flows.
- In cold climates, continuous flush may increase risk of freezing due to cooling of effluent as it passes through the field area.
- Ensure distribution performance meets standards, including consideration of time needed for re-pressurization of the flush main at the start of the dose.

III- 6.11.3.4 System layout

The SDD dispersal area needs to be laid out to suit the site. Key points to consider include:

- Ensure air valves are placed at high points in the network to protect the dripline from vacuum conditions when de pressurizing and to allow air to be purged from the dripline laterals as rapidly as possible during pressurization (to improve distribution uniformity).
- Dripline should, wherever practical or workable, be installed on contour.
- If the dripline uses pressure compensating emitters, these may be installed with a slight slope from dose (supply) to flush manifolds. If the dripline is not level, dose from high elevation to low elevation—that is, place the dose manifold at the higher end.
- A severely off contour layout should include provisions to mitigate drain down (such as drain back of the dripline).
    - This off contour installation may be needed to ensure drain back of dripline in freezing conditions.

- Drain down from dripline is usually minimal. However, on steep slopes, care should be taken to prevent drain down to lower areas. This may include the use of check valves, smaller zones, greater spacing for dripline lower on the slope, and short top down manifolds among other techniques.
- Ensure the dose main, flush main and/or filter head works do not drain down to the dispersal system after a dose.
- On steep slopes increase the dripline spacing (measured horizontally):
  - Increase the minimum spacing to 90 cm, on slopes of 25% to 45% where the VS is at least 90 cm, and for slopes of 15% to 25% with VS shallower than 90 cm.
  - Increase the dripline spacing further with steeper slopes or shallower soils, following manufacturer recommendations.
  - Do not reduce the total amount of dripline.

Dripline laterals within one zone should be of approximately the same length. If lines are of significantly different lengths, additional attention will be needed to ensure all lines will flush adequately and that the entire network is pressurized to provide a balanced dose.

All zones should have approximately the same total dripline length, unless the control panel allows for adjustment of dose and flush times per zone.

III- 6.11.3.5 Freezing conditions

In severe freezing conditions, extra measures may include the following:

- The full system, including the dripline, should drain back to the pump chamber:
  - Air valve placement and dripline alignment needs to consider positive drainage.
  - All mains need to be laid to drain, unless below frost level.
  - The electrical control system needs to adequately control drain back.
  - It may be necessary to use motorized valves for drain valves or flush valves rather than using solenoid valves. Ensure that these valves have anti-condensation heaters.
  - Drain back (if used) should be complete in less than 10 minutes.
- Air valves need to be installed in insulated valve boxes with sealed lids and a drain rock sump extending below frost line (following manufacturer guidelines). Ensure groundwater cannot flood the air valve.
- Layout to minimize the number of air valves and consider the risk of circulation of air between air valves.
- Provide adequate soil depth, or other insulation, over all mains and manifolds.
- Install dripline with a minimum 20 cm of insulating soil cover.
- Maintain forest or shrub vegetation in the dispersal area, if practical.
- Maintain organic soil cover, where occurring.
- Use organic material to assist in insulating the dispersal area during the first winter.
- Trap snow over system, but do not allow packing of snow.
- Avoid installing dripline near roads or driveways.
- Keep the effluent as warm as possible, using one or more of the following strategies:
  - Install all tanks in an insulated "heat island" at the house or other location.
  - Use an intermittent flush system.

  - Consider effluent heaters where seasonal use or cold water use is problematic.
- It is critical to plan the system to prevent soil saturation, and encourage drainage. Consider using a lower HLR and lower HAR per emitter.
- Insulate or heat all valves and head works.
- Ensure all valves and access points can be located for service under snow.

III- 6.11.3.6 Commissioning

Record system flows, pressures and other parameters during system commissioning. This will allow for proper maintenance and troubleshooting. The following checklist shows the minimum information to record in the maintenance plan:

☐ Pressure, after the filter when dosing and when flushing

☐ Filter differential pressure

☐ Dosing and flushing pressure before flush valve (or before flush control for continuous flush systems)

☐ Dosing and flushing pressures at the dose and flush manifolds (typically at air valve ports)

☐ Dosing and flushing flows

☐ Flushing return flow

☐ Pressurization time

☐ Drain down time

☐ System control panel settings and baseline data records

☐ Float settings for the pump chamber

☐ Pump run amperage

Prior to commissioning, flush system.

Where a system has more than one zone, parameters need to be recorded for each zone.

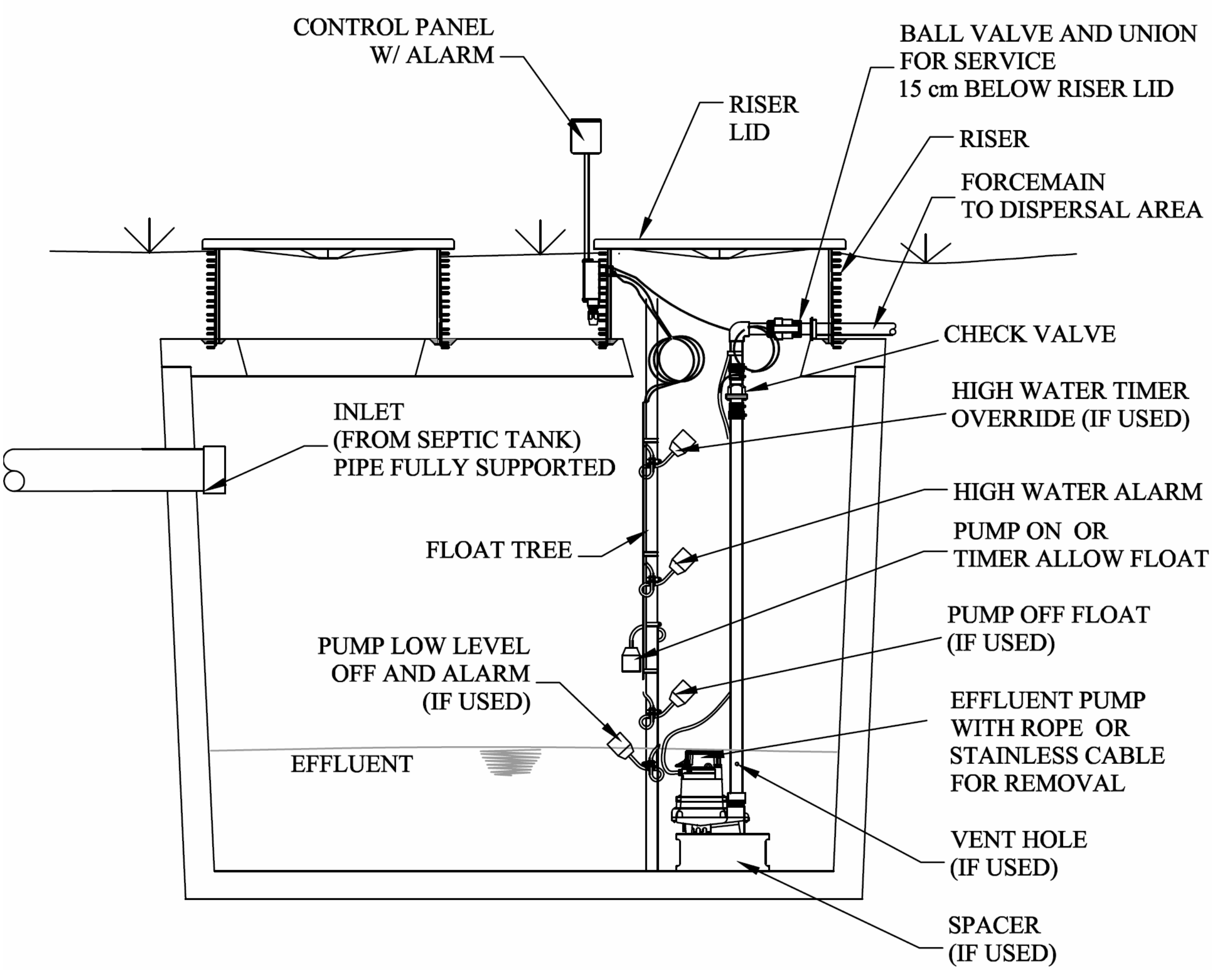
III- 6.12 Dosing and pump chambers

III- 6.12.1 DESCRIPTION

III- 6.12.1.1 Pump chamber

Figure III- 17 shows a typical pump chamber with pump. In cases where a supply line exiting as shown will freeze insulation is used or the supply line is looped back down to exit at greater depth. If the force main is drained back to the pump chamber, the check valve will be installed close to the pump and a ball valve will not be needed.

Figure III- 17. Pump chamber terms, with layout suitable for areas with low risk of freezing



III- 6.12.1.2 Zones

In some cases the dispersal area will be split to two or more zones—where the dispersal system is split into separate areas of the same size.

Zoning a dosed dispersal area has advantages. For an equal total dispersal area size a zoned system will use a smaller pump size and smaller force main size. Zoning also may be used to increase reliability by using alternating pumps to different zones. Zoning is frequently used on larger dispersal systems.

III- 6.12.2 SIZING AND LAYOUT

III- 6.12.2.1 Pump chamber Sizing

The working volume of a pump tank is the volume from the inside bottom of the tank to the invert of the inlet pipe.

III- 6.12.2.1.(a) Surcharge to upstream tanks

Where the pump tank inlet is lower than the outlet of the preceding tank, then the alarm reserve volume could include the depth from the invert of the inlet to the underside of the tank lid, as long as the valve and union is accessible above that level and the tanks are properly vented.

III- 6.12.2.1.(b) Demand dosing pump chamber

Guideline working volume = 1 day Daily Design Flow.

With systems that drain back to the pump chamber (normally only to prevent freezing), then the drain back volume should be added to the dose volume when sizing the pump chamber. As a result, the pump chamber will need to be larger.

Figure III- 18 describes the terms used when specifying a demand dosing system. In some cases the pump on and off float switches may be separate.

The depth of water for pump submergence is determined by the AP. The diagram shows the effluent covering the pump, but this is not required by this Manual. Considerations include:

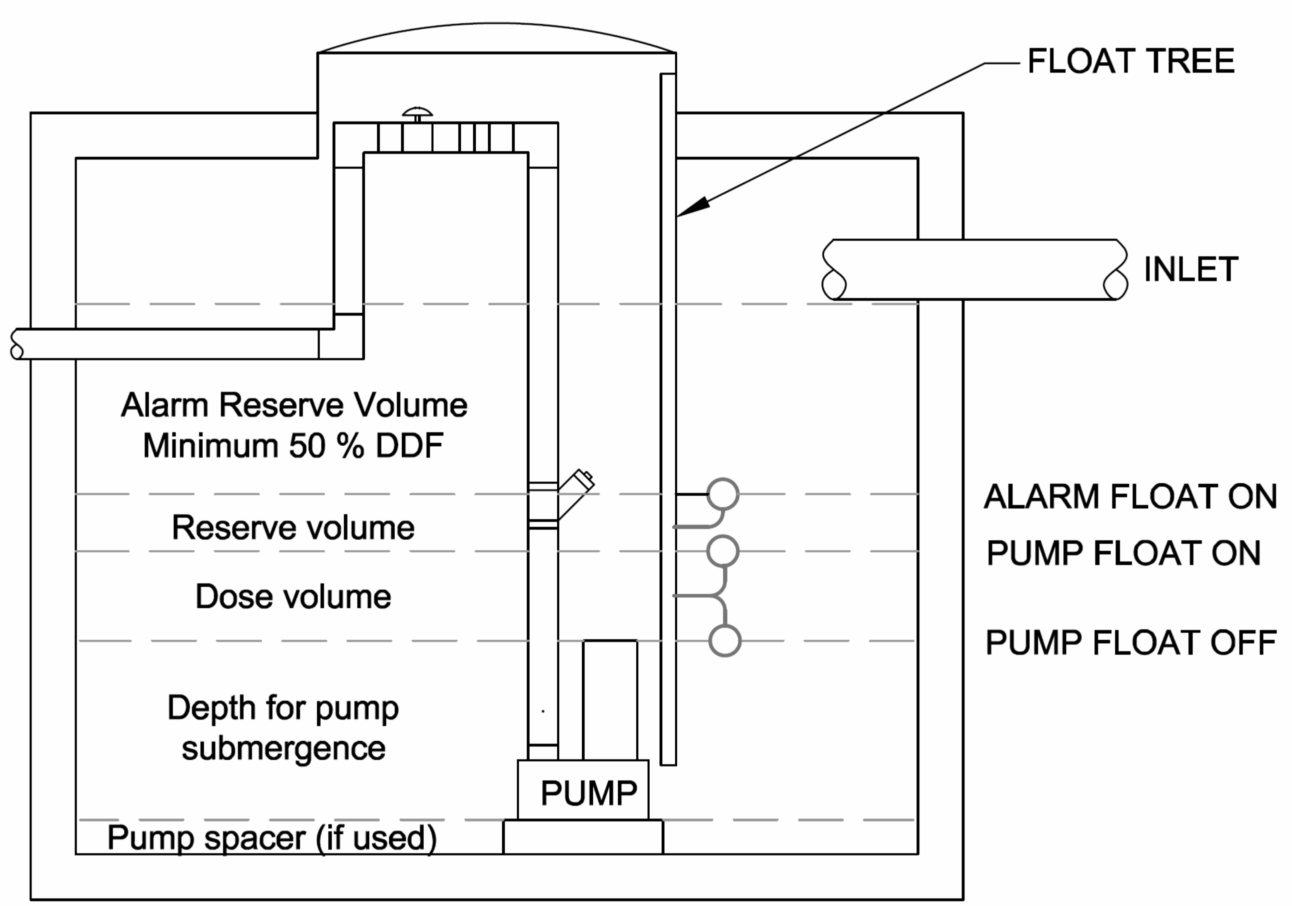
- Depth to prevent air entering the pump inlet during pumping.
- Depth for pump cooling (refer to the manufacturer).
- Reduced corrosion of the pump if submerged in anaerobic effluent.

If the alarm reserve volume is increased to more than 50% of the DDF (e.g. to make allowance for longer power outages), then check that the dispersal area has the capacity to accept the maximum volume that could be dosed in one dose. Calculate the storage volume of the dispersal area based on dispersal trench void volume:

- For aggregate systems, use a volume of 0.35 times the trench or bed coarse aggregate volume. This calculation is based on an effective porosity of 0.35, or 35%.
- For gravelless systems, including chambers, refer to the manufacturer’s specifications for internal volume or void volume (porosity).

In the maintenance plan, include measures for responding to an extended power outage. For example, the AP could specify in the plan that when the power resumes, the pump should ideally be manually cycled with short on times (< 2 minutes), followed by 30 minute off times, so that the dispersal system is not overloaded.

Figure III- 18. Schematic of Demand Dosing Terms



III- 6.12.2.1.(c) Timed dosing pump chamber

Timed dosing systems are intended to equalize flow peaks and ensure relatively even distribution throughout the day (24 hrs.). This is achieved by use of a timer, and pre-set pump on and off periods. In some cases, the dosing regimen can include a “lag” event. This increases the dose frequency to reduce peak flows.

The guideline working volume for the pump chamber is 2 times the Daily Design Flow.

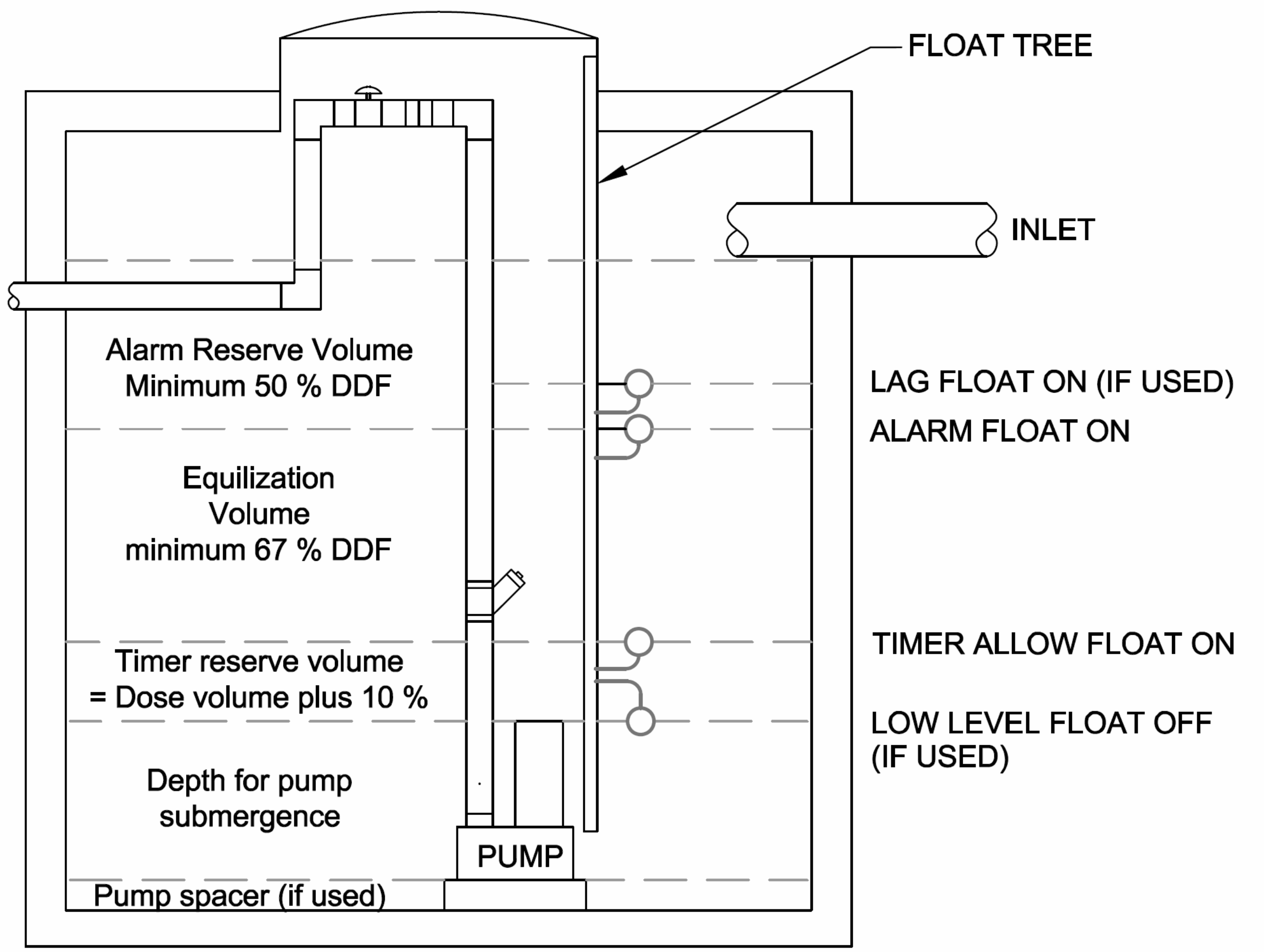
Figure III- 19 describes the terms used when specifying a timed dosing system. See Section III- 6.12.2.1.(b) for discussion of pump submergence.

To equalize flows, a larger reserve volume (equalization volume) is needed above the timer allow float. For small flow systems (DDF < 9100 L/day) a minimum volume of 0.67 × the Daily Design Flow is used. For larger systems flow equalization should be specified on a project specific basis.

The lag float is typically set to trigger dosing at a higher frequency than the standard timer (lag or override timer). The Volume II standards specify that the lag float should not activate a demand dose. This is to prevent overloading of the dispersal area.

The lag float can be placed above the alarm, as shown. Alternately, the standard timer can be set to dose at average flows and the lag timer set to dose at DDF, in which case the lag float is **below** the alarm float and a second reserve volume is needed above the lag float before the alarm activates. This approach may require a larger pump chamber, but will result in improved spread of timed doses over the whole day.

Figure III- 19. Schematic of timed dosing terms: showing example of tank with lag float



For systems where the flow is pre-equalized (for example, from a timed dosed pre-treatment system) the pump chamber may not need to be as large because this equalization volume will not need to be as large.

The standards indicate that the lag (override float switch) should not cause demand dosing, and that the override event should not dose at a rate greater than DDF. The lag float can be installed above the alarm, or combined with the alarm float. In some cases the lag float is below the alarm, with the standard timer set at average daily flow and the lag timer at DDF. In this case, two equalization volumes are needed—one for the standard timer and one for the lag (override) timer.

The alarm reserve volume should be at least 50% of the DDF. If larger alarm volumes are used, then there is no risk of overloading the dispersal area with large doses because the alarm reserve storage will be time dosed as for normal dosing.

III- 6.12.2.2 Siphon Systems and Floating Outlet Devices

Siphons and floating outlet devices are only suitable for demand dose systems.

The correct tank size should be used to match the siphon or floating outlet device range and provide the design dose volume. Follow manufacturer guidelines.

After the high level alarm activates, siphon or floating outlet device vaults should include an alarm reserve volume of 25% of DDF for systems with overflows, or 50% of DDF for systems without overflows.

Where siphons are used to dose pressure distribution systems or pressure manifolds, design should ensure that the distribution system or pressure manifold is properly pressurized to achieve uniform distribution.

Follow manufacturer recommendations for design, unless these are inconsistent with the standards of the SPM.

III- 6.12.3 SPECIFICATION AND INSTALLATION

III- 6.12.3.1 Pumps,

Any pump should be easily removable without having to remove other components.

Lifting ropes or corrosion resistant cable or chain are acceptable for pumps weighing less than 40 kg. Heavier pumps should be installed with a lift assembly rail system and a pit-less adaptor.

Provide adequate free length of the electrical service cord to allow removal of the pump, without disconnection, to an external position near the access opening.

See Section III- 6.4.2 and III- 6.2.

III- 6.12.3.2 Pump chambers

See Section III- 6.4 for guidance on tank installation.

III- 6.12.3.3 Siphons and floating outlet devices

For siphons and floating outlet devices, follow manufacturer recommendations for specification and installation, unless these are inconsistent with the standards of the SPM.

Transport line installation may need venting to avoid air binding in the line.

For a pressure system or pressure manifold, ensure at commissioning that uniform distribution and adequate distal pressure (squirt height) is achieved, and if not, adjust transport line to provide proper pressurization of the distribution network.

Siphon systems need to have a reliable method for detecting trickling failure. Typically a float switch or mechanical float is used to trigger a cycle counter, which is used to monitor flows and also serves to detect trickling failure.

III- 6.12.3.4 Float switches and level sensors

Install float switches or transducers to provide for easy removal and replacement.

Removable float trees or float hangers, with weighted floats, can be used for float control systems. Similar methods can be used for other types of level sensors.

Float wires or transducer wires and vent tubes that are in the pump tank should be removable without having to excavate. This can be provided for by using conduit to a junction box.

Control float switches, transducers, associated wires or vent tubes should not be attached to the force main (pump riser pipe). There needs be adequate free length of float wires or level sensor wires and tubing to allow removal for servicing without disconnection.

III- 6.12.3.5 Calculating dose volume or dose time and frequency at commissioning

When a pressure distribution or subsurface drip dispersal (SDD) system is commissioned the time to pressurize the system is measured, and the dose time is either measured (demand dose system) or is set (timed dose system).

For pressure distribution systems that remain full, or which drain back to the pump chamber, the pressurization time is measured from the first evidence of effluent flow from an orifice to full squirt height from all orifices.

The time to refill the force main and other portions that drain back is measured from the start of the dose to the first evidence of effluent flow from an orifice. This time added to the dose time (or the volume is added to the dose volume), but is not used to calculate distribution uniformity.

The most favorable dose volume or dose time can then be calculated. This is typically planned so that the distribution network is fully pressurized for 67% of the dose time (pressure distribution) or 80% of the dose time (SDD). This means that 33% (0.33 as a proportion) of the total dose time can be used to fully pressurize a pressure distribution system, or 20% (0.2 as a proportion) for a SDD system.

At the planning stage, a preliminary dose time or volume is determined and a minimum number of doses per day at DDF is specified. This dose volume can be adjusted at commissioning to allow the use of as small a dose as practical.

Typically, the minimum dose frequency (so the largest dose time or volume) is determined at the planning stage to ensure the system will meet standards for dose frequency and HAR. Then at commissioning a smaller dose time or volume can be used to improve performance, but still provide adequate distribution uniformity.

This smaller dose will result in a dose frequency that is higher than the minimum specified in the standards.

At commissioning distribution uniformity can be confirmed in one of two ways:

- By checking the amount of water discharged by a sample of orifices in different parts of the distribution network and confirming that the volume discharged per dose (total discharge, including pressurization, dose and drain down phases) does not vary by more than 20% between any two orifices, or
- by checking that the system is fully pressurized for at least 67% of the dose time (pressure distribution) or 80% of the dose time (SDD), as illustrated below.

III- 6.12.3.5.(a) Pressure distribution system dose time example

For example, a pressure distribution system is tested and pressurization time is found to be 30 seconds (0.5 mins.) and the timed dose total dose time is initially planned for 1.7 mins. Is dose time at full pressurization adequate? Could a smaller dose be used?

Is Time to pressurize ÷ Total dose time ≤ 0.33?

0.5 mins ÷ 1.7 mins = 0.29, so this is OK

Dose time could be reduced, so that Time to pressurize ÷ Total dose time = 0.33, or

Time to pressurize ÷ 0.33 = minimum dose time allowed.

0.5 mins ÷ 0.33 = 1.51 mins minimum dose time.

For the same system, if the force main and manifold drain back to the pump chamber at the end of the dose and the time to refill the force main and manifold is measured to be 1 minute, then the actual timed dose setting would be the minimum dose time plus 1 minute, as follows:

Minimum dose time + time to refill pipes that drain back to the pump chamber = Dose timer setting

1.51 min + 1 min = 2.51 mins.

III- 6.12.3.5.(b) Subsurface drip dispersal system dose time example

For a SDD system where the flush main drains back to the pump chamber or treatment tanks after a dose, then the filling of the flush main is part of the dose because effluent is flowing through the dripline laterals to fill the flush main and so the field is dosing. Pressurization time is measured from the time effluent finishes filling the dose force main to full pressurization.

In the following example, a SDD system has both dose force main and flush main draining back after a dose. Time from pump start until effluent is seen at the dose manifold is measured to be 45 seconds (0.75 mins) (this is the time to fill the force main). The time from pump start until the flush manifold air valve reaches operating pressure is 1.75 mins. The dose time calculations are as follows:

Pressurization time = total time to full pressurization – force main fill time

= 1.75 mins - 0.75 mins = 1 mins

For a SDD system, Time to pressurize ÷ Total dose time ≤ 0.20

Time to pressurize ÷ 0.20 = minimum dose time allowed.

1 mins ÷ 0.20 = 5.0 mins minimum dose time

Minimum dose time + time to refill force main = Dose timer setting

5.0 min + 0.75 min = 5.75 mins.

III- 6.12.3.6 Zones and Distributing Valves

Unless dosing is controlled by a panel capable of dosing zones at different pump run times, all gravity, pressure distribution or SDD zones should be the same size.

Dosing of separate zones could be achieved by either:

- Multiple pumps; or
- floating outlet devices or siphons with separate transport lines; or
- using a single transport line and alternation of zones at the field.

Solenoid valves, motorized valves or hydraulic distributing valves can be used to distribute effluent to multiple zones.

III- 6.12.3.6.(a) Hydraulic distributing valves

Hydraulic distributing valves (also called "indexing valves") use water flow and pressure in the line to actuate the valve. Each time the pump is turned on, the valve rotates to the next outlet port of the valve, and hence to the next dispersal zone.

Where these valves are used, calculations should allow for the head losses in the valve and fittings.

Install distributing valves with the following features:

- A flushing port at the end of the force main (before the valve).
- A ball valve on the inlet, for quick testing of valve operation, and to isolate the valve when flushing the force main.
- Unions to allow easy removal of the valve.
- Pea gravel or similar bedding to improve maintenance access.

- Clear sections of pipe, or some other indicator on the valve, for visual inspection of valve operation by the maintenance provider.
- Provisions to prevent freezing.

These valves should be installed at the high point of the distribution network, or check valves should be used to prevent back pressure on the valve. Ensure the force main to the valve remains full to prevent air slugs causing erratic operation of the valve. An air vacuum valve may be used to improve drainage of the valve and filling of the force main.

III- 6.13 At-grade beds

III- 6.13.1 DESCRIPTION

An at-grade bed is a type of at grade system. An aggregate bed placed on contour on the scarified native grade. Effluent is distributed to this bed by pressure. The technique is intended for use with pressure distribution only. On a sloping site the bed is not installed level across its width, the bed follows the ground slope. See Figure III- 20 and Figure III- 21. If the bed is levelled on a sloping site by excavation or adding sand media, then follow the Seepage Bed standards.

An at-grade bed may use a sand blinding layer below the aggregate, scarified into the native soil over the basal area. However, if the bed is to be raised above grade, then the standards for above grade Seepage Beds or sand mounds should be followed.

Figure III- 20. At-grade bed on sloping site, schematic cross section

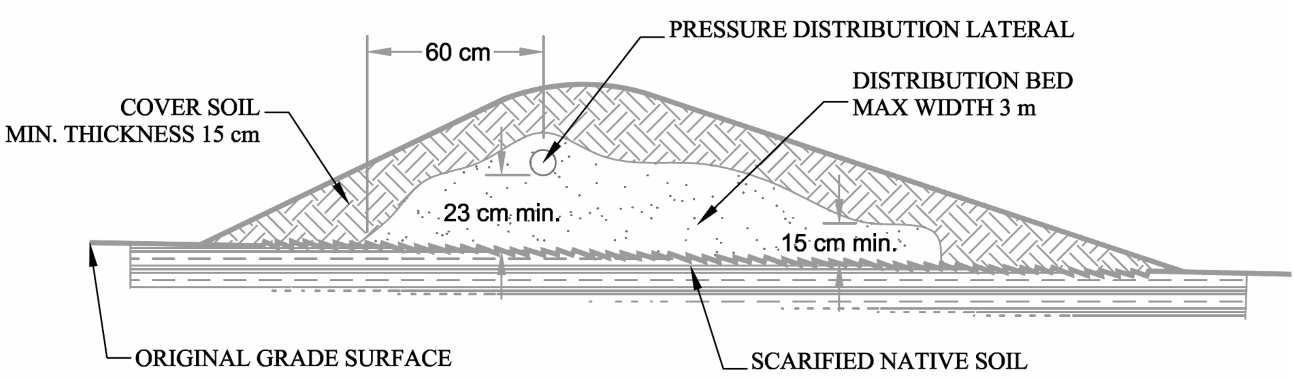
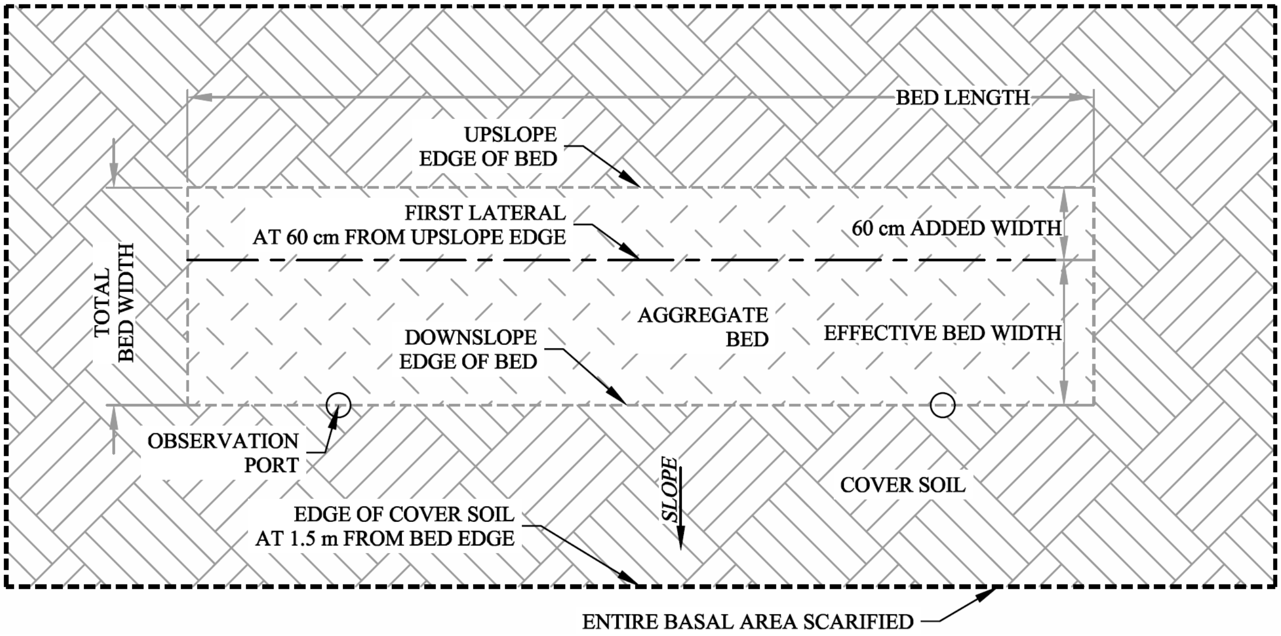


Figure III- 21. At-grade bed on sloping site, schematic plan



III- 6.13.2 SIZING AND LAYOUT

III- 6.13.2.1 Bed total width

For a flat site, the bed total width is the same as the effective bed width.

On a sloping site 60 cm extra bed width is added to the upslope edge of the effective bed width, see Figure III- 21.

III- 6.13.2.2 Distribution network

Narrow at-grade beds may be used with a single lateral, with 60 cm orifice spacing along the lateral. For wider beds, use a maximum lateral spacing of 90 cm on flat and low slope sites, and maximum 60 cm on sloping sites.

Each lateral should have maximum 60 cm orifice spacing, and orifices on adjacent laterals should be staggered.

III- 6.13.2.2.(a) For a flat site of gentle slope (<2%), the horizontal location of the distribution lateral should follow these guidelines:

- If using one effluent distribution lateral; the lateral is located in the center of distribution cell.
- If using more than one effluent distribution lateral; the laterals are equally spaced apart and centered in the bed, with a minimum 30 cm to the bed edge, and laterals spaced at a maximum 60 cm on center.

Table III- 19 summarizes the minimum number of laterals for a range of bed widths, and shows the location for common bed widths.

Table III- 19. Lateral layout for at-grade beds on flat and low slope sites (≤ 2%)

BED WIDTH	MINIMUM NUMBER OF LATERALS	BED WIDTH	LATERAL LOCATION
0.6 to < 1.2 m	1	0.6 to < 1.2 m	1 lateral, centered in bed
1.2 to < 1.8 m	2	1.2 m	2 laterals, spaced 30 cm from bed edges
1.8 to < 2.4 m	3	1.8 m	3 laterals, outer laterals spaced 30 cm from bed edges and laterals 60 cm on center
2.4 to < 3 m	4	2.4 m	4 laterals, outer laterals spaced 30 cm from bed edges and laterals 60 cm on center
3 m	5	3 m	5 laterals, outer laterals spaced 30 cm from bed edges and laterals 60 cm on center

III- 6.13.2.2.(b) For a site with a slope of 2% or steeper, the location of distribution lateral should follow these guidelines:

- If using one effluent distribution lateral; the lateral is located 60 cm down slope from the up slope edge of the distribution bed (so it is at the upper edge of the effective bed width).
- If using more than one effluent distribution lateral; one lateral is located 60 cm or less down slope from the up slope edge of the distribution bed, and the other laterals are down slope of the upper lateral, and up slope of the mid-point of the distribution bed effective width (no pipe in the lower half of the bed effective width), keeping lateral spacing to 60 cm or less.

Table III- 20 summarizes lateral layout and minimum number of laterals in relation to effective bed width for beds on sloping sites. More laterals can be used, provided that no laterals are installed in the downslope half of the effective bed width, and no laterals are installed closer than 60 cm to the upslope edge of the bed.

Table III- 20. Minimum number of laterals for at-grade beds on sloping sites (> 2%)

EFFECTIVE BED WIDTH	LATERALS AND LOCATION
0.6 to < 1.2 m	1 lateral, 60 cm downslope from upper bed edge
1.2 to < 2.4 m	2 laterals, first at 60 cm downslope from upper bed edge, second at centerline of effective bed width or at 60 cm on center from the first lateral.
2.4 to 3 m	3 laterals, first at 60 cm downslope from upper edge second and third at 60 cm on center.

III- 6.13.2.3 Example of sizing, low slope or flat (≤2% slope) site

Site slope 1.5%, DDF 1300 L/day, HLR selected 27 L/day/m^2, LLR selected 45 L/day/m. Contour is not concave.

Determine minimum bed length = DDF ÷ LLR

= 1300 (/day) ÷ 45 L/day/m = 29 m

Determine minimum effective AIS for the bed = DDF ÷ HLR

= 1300 L/day ÷ 27 L/day/m^2 = 48 m^2

Calculate effective bed width needed = AIS ÷ length (max. 3 m)

= 48 m^2 ÷ 29 m = 1.65 m (less than 3 m so OK)

For a flat site, the total bed width needed is = effective bed width

Total bed width = 1.65 m

Total system width (minimum) = Bed width + 3 m = 1.65 m + 3 m = 4.65 m

Total system contour length (minimum) = Bed length + 3 m = 29 m + 3 m = 32 m

Establish number of laterals for pressure distribution to the bed:

Number of laterals: Table III- 19 recommends minimum of two laterals

Two laterals, orifices 60 cm on center (stagger orifices).

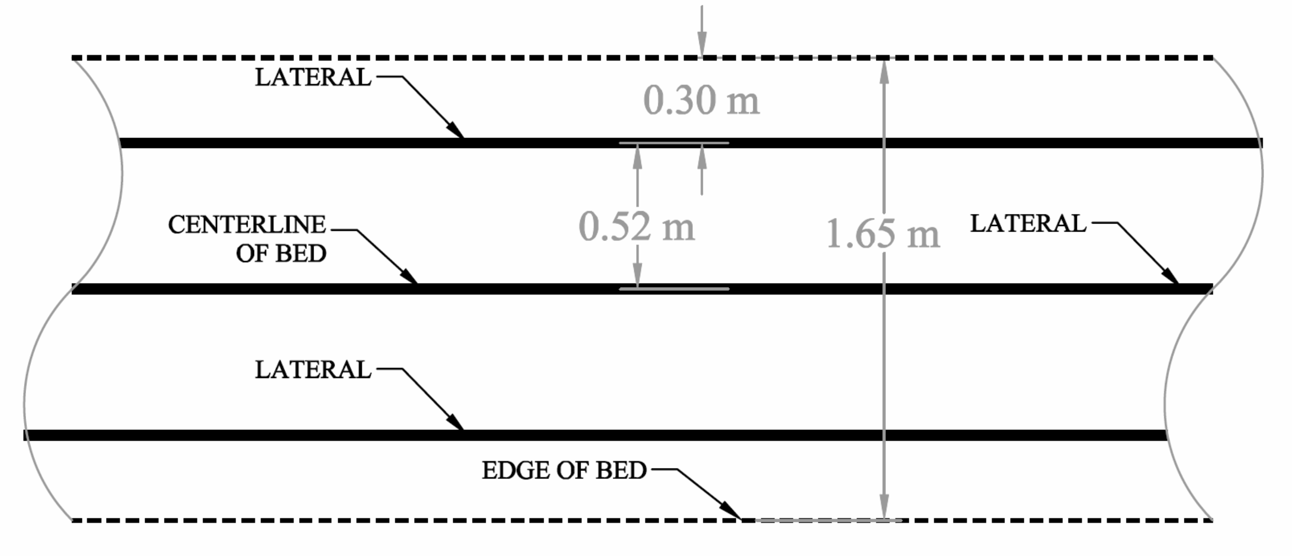
Establish Horizontal location of distribution lateral in the distribution cell for a low slope or flat site:

For two laterals:

Minimum lateral spacing to bed edge 30 cm

Place laterals equal distance either side of bed centerline

Lateral spacing to bed edge = bed width ÷ 4 = 1.65 m ÷ 4 = 0.41 m = 41 cm



III- 6.13.2.4 Example of sizing, sloping site

Site slope 8%, DDF 1300 L/day, HLR selected 27 L/day/m^2, LLR selected 70 L/day/m. Contour is not concave.

Determine minimum length = DDF ÷ LLR

= 1300 L/day ÷ 70 L/day/m = 18.6 m

Determine minimum effective AIS for the bed = DDF ÷ HLR

= 1300 L/day ÷ 27 L/day/m^2 = 48 m^2

Calculate effective bed width needed = AIS ÷ length (max. 3 m)

= 48 m^2 ÷ 18.6 m = 2.58 m (less than 3 m so OK)

For a sloping site, total bed width = effective width + 60 cm added to upper edge of bed

2.58 m + 0.6 m = 3.18 m

Total bed width = 3.18 m

Establish number of laterals for pressure distribution to the bed:

Number of laterals: For effective width of 2.58 m Table III- 20 recommends three laterals

Three laterals, orifices 60 cm on center (stagger orifices)

Establish Horizontal location of distribution lateral in the distribution cell for a sloping site:

Half of effective distribution bed width = 2.58 (m) ÷ 2 = 1.29 m

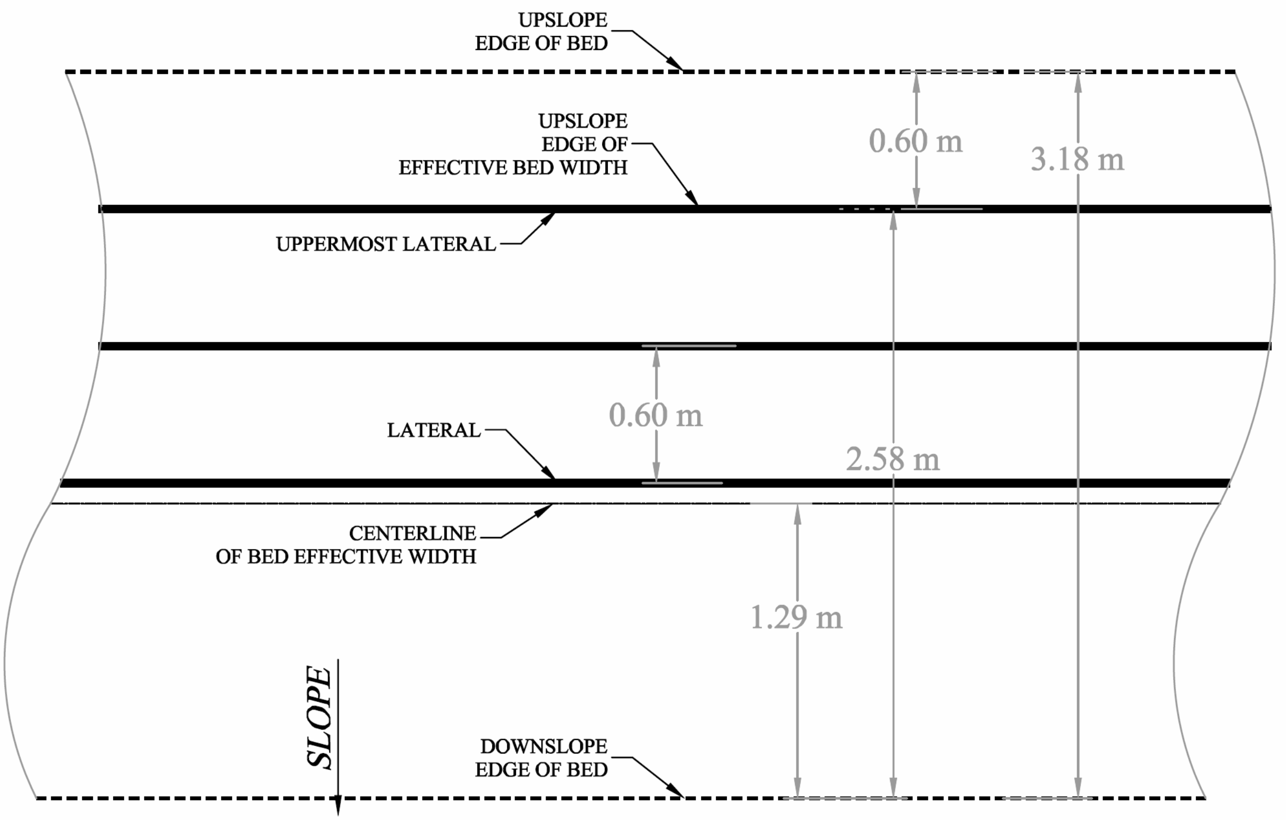
First lateral at 60 cm from upslope edge of bed

Second and third lateral at 60 cm on center

Third lateral at 120 cm from first lateral = 1.2 m from upslope edge of effective bed

Check that this is still in upper half of effective bed width:

Half of total distribution bed width = 2.58 m ÷ 2 = 1.29 m, 1.2m is in upper half.



III- 6.13.3 SPECIFICATION AND INSTALLATION

When preparing the site and installing the bed, follow the same general practice as for sand mounds. See Section III- 6.15.3.2. Preparation (including scarification) of the basal area of the bed is critically important.

Install a minimum 15 cm layer of aggregate on the bed area immediately after scarification. Do not drive equipment on the bed or on the area downslope of the bed.

Protect the bed and the receiving area from traffic.

Follow installation considerations for pressure distribution systems. See Section III- 6.10.3.

At-grade beds have limited storage capacity for storage of surge flows. For this reason timed dosing is recommended. If demand dosing is used, do not exceed 50% of DDF for pump or dosing chamber alarm reserve volume.

III- 6.14 Alberta At Grade system (AAG)

III- 6.14.1 DESCRIPTION

An Alberta At Grade system is a type of at grade system. A chamber bed is placed on the undisturbed organic litter layer of a site, into which highly treated effluent is distributed by pressure. The technique is intended for use with pressure distribution only. On a sloping site, the bed is not installed level across its width, but follows the ground slope. See Figure III- 22.

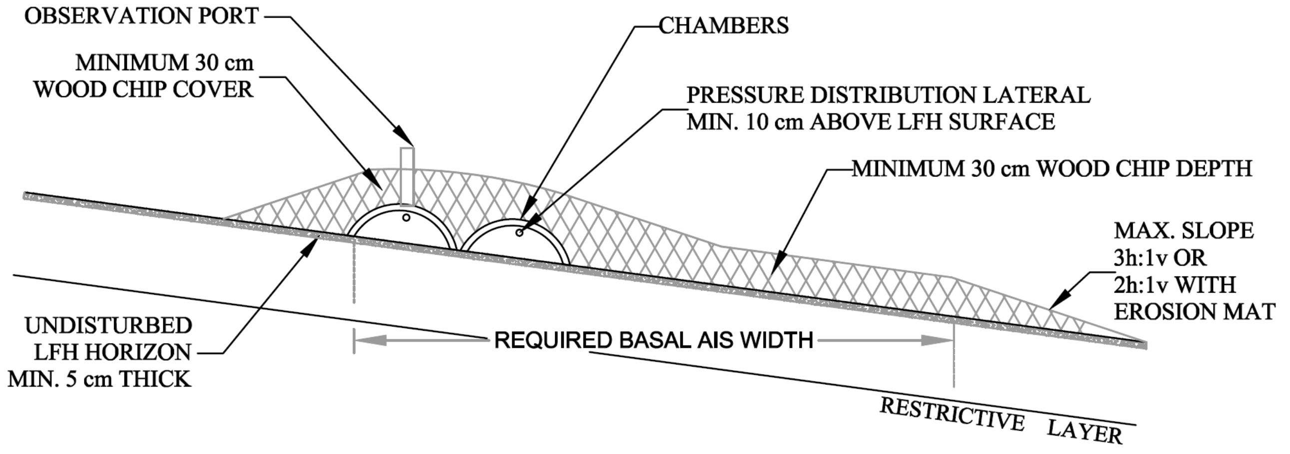
III- 6.14.1.1 Soil type

These systems are intended for use **only** on forest floor soils with a litter or "duff" layer. This is termed the "L-F-H" horizon. The horizon is made up of a sandwich of three organic layers (the L, F and H layers) developed primarily from needles, leaves, twigs, and woody materials, with a minor component of mosses:

- L – The structures of the organic material (needles, leaves, twigs) are easily recognized (litter layer).
- F – The accumulated organic material is partly decomposed (fermentation layer).
- H – The original structures of the organic material are unrecognizable (humus layer).

This horizon is left undisturbed below the chambers and in the receiving area during and after installation. This is **not** the "A" horizon, the A horizon is a mineral soil horizon located underneath the litter layer.

Figure III- 22. Alberta At Grade system schematic cross section



III- 6.14.2 SIZING AND LAYOUT, SPECIFICATION AND INSTALLATION

For guidance on planning, specification, installation and maintenance refer to: *LFH At-grade System Soil Based Sewage Treatment and Dispersal System* Alberta Municipal Affairs-Safety Services, 2014, or as updated over time by Alberta Municipal Affairs.

http://www.municipalaffairs.alberta.ca/cp_private_sewage_standata.cfm

When referring to this guideline, follow SPM standards where they differ from those in the guideline.

It is preferable to use Type 2 effluent meeting a 10/10 mg/L (BOD/TSS) standard for Alberta At Grade systems.

III- 6.15 Sand mounds and sand lined trenches and beds

III- 6.15.1 DESCRIPTION

Sand mounds, and sand-lined trenches and beds, are sand-based dispersal systems where the effluent is dispersed to a bed on the sand, using pressure distribution or subsurface drip dispersal. The bed is level and installed long and narrow on contour, with a bed length selected to meet a specified linear loading rate (LLR).

A sand mound is installed with the bed above grade on minimum 30 cm of sand media fill.

Sand lined trenches and beds are installed with the bed at or below grade on minimum 30 cm of sand media fill.

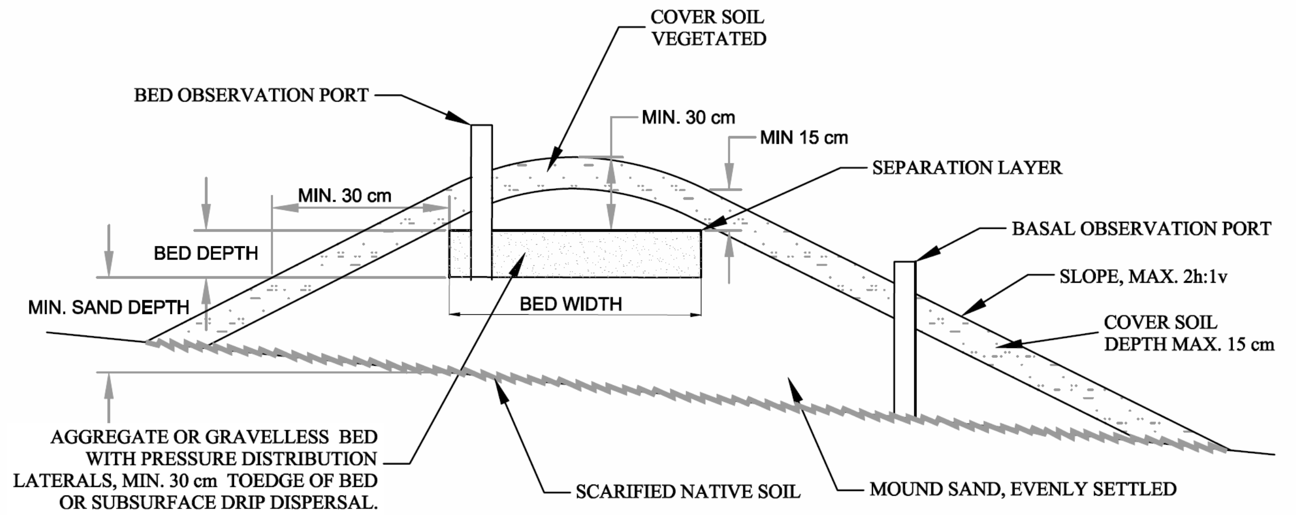
A bottomless sand filter is a sand lined bed in an enclosure and is installed with the bed above grade.

Treatment in the sand is used to reduce BOD/TSS levels and pathogen levels at the basal area. For this to be successful, the effluent should disperse through the sand by unsaturated flow, and the effluent should be well distributed to the surface of the sand.

For this reason all systems of this type need pressure distribution (or SDD) and timed dosing.

Figure III- 23 illustrates a typical sand mound on a sloping site. For sand lined trenches and beds, refer to the appendix, Section III- 8.10 for diagrams.

Figure III- 23. Sand mound schematic cross section, showing terminology



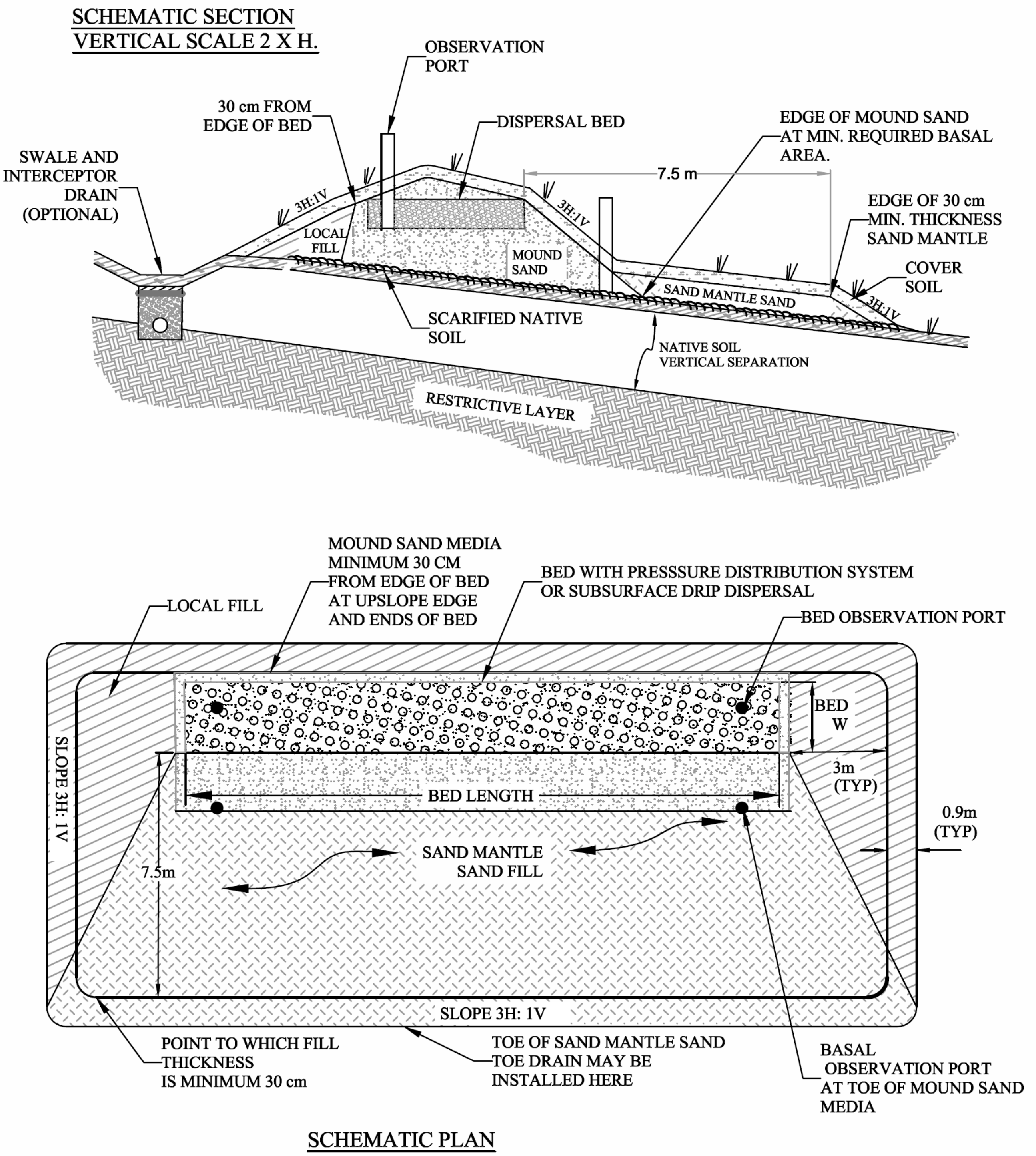
III- 6.15.1.2 Sand mantle sand mounds

On shallow low permeability soils, particularly on gentle slopes, a special form of sand mound can be used, if there is not enough room to fit a long sand mound.

These mounds have a deeper sand depth and a deep toe blanket (or mantle) in the receiving area. The mantle is at least 30 cm deep (plus cover soil), and extends at full depth to at least 7.5 m downslope from the lower edge of the dispersal bed. The mantle may extend further, if the receiving area soils are shallow. See Figure III- 24.

Instead of extending the mantle 7.5m from the dispersal bed, the AP may specify a drain at the toe of the mantle.

Figure III- 24. Sand mantle sand mound



III- 6.15.2 SIZING AND LAYOUT

The standards indicate minimum spacing between beds or trenches. This spacing is not necessary between the ends of beds or trenches (for example, if the bed steps up or down or for a center fed trench system). If more than one mound, sand lined trench or bed is installed, the overall system contour length is determined in the same way as for trench systems.

These sand based systems use two hydraulic loading rates, one for the sand surface under the bed and one for the native soil surface at the base of the sand (known as the "basal area").

III- 6.15.2.1 Sand mound sizing

III- 6.15.2.1.(a) Example of sand mound loading rates and AIS calculation

Site and soils:

- In this example, the soil at the infiltrative surface, and at least 30 cm below that, is a Sandy Clay Loam, with strong angular blocky structure, friable consistence (structure and consistence category is "Favorable"), and coarse fragment content 10%. The median tested Kfs is 350 mm/day.
- The soil depth is 30 cm to the SHWT. The land slope is 12%, and is even or convex.
- The system DDF is 1300 L/day, with Type 1 effluent.
- Sand media to be used is Mound Sand.

Calculate the minimum system contour length:

Select LLR following SPM standards based on the native soil, see Section III- 5.6.

For this site and soil selected LLR is 35 L/day/m.

Determine minimum bed length, = DDF ÷ LLR = 1300 L/day ÷ 35 L/day/m = 37 m

Select bed HLR and AIS:

For bed area select HLR from SPM standards for Mound Sand and Type 1 effluent.

Selected HLR 40 L/day/m^2.

Calculate minimum bed area of infiltrative surface:

Minimum AIS = 1300 L/day ÷ 40 L/day/m^2 = 32.5 m^2.

Calculate the Bed width:

Calculate the minimum bed width, = AIS ÷ minimum system contour length

= 32.5 m^2 ÷ 37 m = 0.88 m

Select basal HLR and calculate basal (native soil) AIS:

Type 1 effluent is to be applied to the sand mound. Therefore use Type 2 basal HLR.

Select HLR following SPM standards (see Section III- 5.5.3) for the native soil (and adjust for coarse fragment content if needed).

The selected HLR is 25 L/day/m^2.

Calculate the minimum basal area = DDF ÷ basal HLR

$$= 1300 \text{ L/day} \div 25 \text{ L/day/m}^2 = 52 \text{ m}^2.$$

Sizing of the mound:

- Determine the minimum allowable sand depth following Volume II standards for VS.
- Increase the sand depth to a minimum of 60 cm if "cold climate" timed dosing frequency is used.
- Size and lay out the mound to suit the site, following guidance in the Washington State mound guideline. Check that basal area (the native soil infiltrative surface, as defined in the standards) is large enough and adjust if necessary.

III- 6.15.2.1.(b) Basal area obstructions

If there are obstructions in the basal area, such as boulders or large stumps, increase the basal AIS by the same area as that covered by these obstructions.

III- 6.15.2.2 Sizing and specification of sand mantle sand mounds

III- 6.15.2.2.(a) Conditions

This section provides a pre-designed toe blanket configuration and method for calculating the length of the bed. This standard design applies **only** if the following four conditions are met:

- A DDF of up to 2400 L/day; and
- a sand mound on any soil type with a soil depth of 25 cm or greater; and
- timed or micro-dosing; and
- a land slope up to 25%.

All other aspects of the planning and installation are as for sand mounds.

III- 6.15.2.2.(b) Mound and mantle configuration

Sand for the mound and mantle is to be clean and have a minimum Kfs of 3000 mm/day (perc rate of maximum 3 min/inch). It is preferable to test the Kfs after installation and settling of the fill, alternatively the permeability may be tested at the source, in the bank or on a test pile of settled sand fill.

The sand, for the area measured from the upslope edge of the bed to the edge of the basal (native soil) area of infiltrative surface, should meet the standards of Table II- 25 (page II-37). For the remainder of the sand mantle; other permeable sand fill may be used, provided the Kfs of the sand exceeds the guideline above.

The recommended sand depth, below the bed infiltrative surface, is as follows:

- For Type 1 effluent with timed dosing: at least 75 cm.
- For Type 1 or 3 effluent with micro-dosing: at least 60 cm.
- For Type 2 effluent with micro-dosing: at least 75 cm.

This thickness of sand is greater than that specified for a normal sand mound. This greater thickness allows for saturation of the native soil below the bed and lateral movement of water in a layer of the sand above the native soil, while still achieving pathogen removal in the sand mound.

The sand mantle should be at least 30 cm thick, and the cover soil should be at least 10 cm thick. The sand mantle should extend the following distance from the edge of the aggregate bed:

- At least 7.5 m downslope, if the land slope is > 2%.
- At least 7.5 m in all directions from the perimeter of the bed, if the slope is 2% or less.

See Figure III- 24 for minimum dimensions and configuration for the sand mantle. Note the additional length needed at the ends of the bed.

In the sand mantle downslope from the bed, a key trench can be installed by excavating a trench along contour in the native soil, excavated to the usable soil depth, and backfilled with sand fill. Scarify the trench as for a dispersal system trench. This is recommended on steeper (>15%) slopes, but can be used on any site to improve contact of the sand mantle fill to the native soil.

At the edge of the sand mantle, in the toe area, the slope of the fill and cover soil is to be a maximum of 3h:1v. Note that, as for other sand mound systems, the fill of lower permeability may be used for some parts of the system. In particular, lower permeability fill may be used for the upslope to and the end slope toe areas (from 30 cm upslope of the bed edge).

If the depth of permeable native soil is less than 15 cm at the toe of the mantle, extend the mantle at a minimum 15 cm depth for a further 7.5 m.

Alternatively, install a relief (toe) drain located 7.5 m from the dispersal bed. Note that the horizontal separation standards specify a larger separation if the drain discharges directly into a water body.

III- 6.15.2.2.(c) Bed length for the mound

When following the sizing standards and guidelines in this Manual, the bed length may be based on a LLR of 50 L/day/m.

III- 6.15.2.2.(d) Example of sizing calculation for a sand mantle sand mound

Site and soils:

- The soil at the infiltrative surface, and for at least 30 cm below that, is a Silty Clay, strong angular blocky structure, friable consistence (structure and consistence category is "Favorable"), coarse fragment content 10%. Kfs 125 mm/day.
- Soil depth is 30 cm to SHWT. Site slope is 4 %. Contour is not concave.
- System DDF 1600 L/day. Type 1 effluent. Sand media to be used is Mound Sand.

Calculate minimum system contour length:

Select LLR following SPM standards based on the native soil, see Section III- 5.6.

For this site and soil selected LLR is 25 L/day/m.

Determine minimum bed length, = DDF ÷ LLR = 1600 L/day ÷ 25 L/day/m = 64 m

Length is not practical on the site. Choose to use sand mantle sand mound as solution (slope is < 15% and DDF is < 2200 L/day).

LLR for sand mantle sand mound = 50 L/day/m

Determine minimum bed length, = DDF ÷ LLR = 1600 L/day ÷ 50 L/day/m = 32 m

Length including sand mantle (sloping site) = bed length (m) + 3 (m) + 3 (m)

= 32 m + 3 m + 3 m = 38 m (plus end toe slopes)

Select bed HLR and calculate bed AIS:

For bed area select HLR from SPM standards for Mound Sand and Type 1 effluent.

Selected HLR 40 L/day/m^2.

Calculate bed AIS, minimum AIS = 1600 L/day ÷ 40 L/day/m^2 = 40 m^2.

Calculate bed width:

Minimum bed width = AIS ÷ minimum system contour length

= 40 m^2 ÷ 32 m = 1.25 m

Select basal HLR and calculate minimum basal (native soil) AIS:

Type 1 effluent is to be applied to the sand mound. Therefore use Type 2 basal HLR.

Select HLR following SPM standards; refer to Section III- 5.5.3 (and adjust for coarse fragment content if needed).

For this soil the selected HLR is 15 L/day/m^2.

Minimum allowable basal area, = DDF ÷ basal HLR

= 1600 L/day ÷ 25 L/day/m^2 = 106.7 m^2

Continue sizing the sand mantle mound following the same procedures used for a sand mound, referring to Section III- 6.15.2.2.(b) for minimum sand depth.

For this example, the mound sand will need to extend downslope of the bed to achieve the minimum basal AIS:

Area needed downslope = minimum basal AIS - Area under bed

$= 106.7\ m^2 - 40\ m^2 = 66.7\ m^2$

Minimum width of mound sand needed downslope of bed = Area ÷ Bed length

$= 66.7\ m^2 \div 32\ m = 2.08\ m$

After this point, sand mantle permeable fill may be used.

III- 6.15.2.3 Sand lined trench and bed design

For a sand-lined trench or bed, size the bed and basal area following the same method as for sand mounds. See the appendix, Section III- 8.10for diagrams illustrating sand lined trench and bed configuration and applications.

III- 6.15.3 SPECIFICATION AND INSTALLATION

For sand-based systems, ensure that the aggregate and the sand are kept clean during installation. Wear clean shoes when walking on the sand, prevent contaminating the sand. Keep equipment tracks clean for the same reason.

The system should be constructed in a manner that does not damage the native soil structure by smearing or compacting the soil surface, or compacting soils below the basal area or in the receiving area. The soil moisture at depth should be checked, even if the ground surface is dry.

III- 6.15.3.1 Permeable fill media for sand mound toe areas

For parts of a sand mound toe area, sand mantle or toe blanket, clean permeable fill may be used instead of specified sand. This alternate fill may be used provide that:

- It is placed outside of the required native soil infiltrative surface (the required basal area);
- the fill has an installed Kfs of at least 3000 mm/day (perc rate of maximum 3 min/inch) after settling; and
- cover soil is placed over the fill.

It is preferable to test the Kfs after installation and settling of the fill, alternatively the permeability may be tested at the source, in the bank or on a test pile of settled sand fill.

On slopes over 2%, for parts of the mound toe area located more than 30 cm upslope from the bed, fill with a lower permeability may be used. In some cases, low permeability fill may be suitable in the upslope area, to help divert surface water to a swale or an upslope interception drain.

III- 6.15.3.2 Sand mound installation

Basal area preparation and protection is critical for sand mound systems. See the appendix Section III- 8.9 for detailed installation guidance. Key points include:

- Wherever it is practical to do so, work only from sides and top of mound area and avoid travel on receiving area or mound area. For work on the sand mound, use only tracked vehicles with maximum 7 psi ground pressure. Keep a minimum of 15 cm of sand under the machine tracks.

- For a sand mound the basal area soil should be prepared by scarifying the surface along the contour to a depth of not less than 15 cm. The purpose is to roughen the surface and provide for better infiltration from the sand to soil. This will also reduce flow concentration in macropores and the potential for saturated flow. Excessive disturbance that destroys soil structure should be avoided. Rototillers should not to be used. Sand may be scarified into the surface.

III- 6.15.3.3 Sand lined trench or bed installation

Installation of these sand lined systems is similar to installation of trenches or Seepage Beds. Avoid risk of short circuiting from the sides of the bed to highly permeable native soils. See the appendix, Section III-8.10for diagrams illustrating options.

III- 6.15.3.4 Uniform Density for Sand Media

Ideally, sand fill should be settled into a medium of uniform density. During installation, consider the following:

- If the sand is so dry that it can be poured (like salt or sand in an hourglass), then it can simply be poured, then settled by raking and packing by foot or by track packing (not compacted) to allow about 5% volume reduction.
- If the filter media is moist enough that it cannot be poured, it should be placed in successive 15 – 20 cm thick lifts, with each lift settled by track packing or a single pass with a light plate compactor.

Excessive wetting of the sand during settling should be avoided as this may encourage particle sorting and stratification. Avoid compacting the sand.

A penetrometer can be used to check even density through the depth of sand. A recommended target bulk density is 1.4 – 1.6 g/cm^3 or maximum 85% standard proctor maximum dry density (SPMDD).

Bulk density = oven dried mass (weight in grams) ÷ sample volume (size in cubic cm). Therefore, a 10cm by 10cm by 10 cm cube of the dried sand will weigh 1.3 – 1.4 Kg.

When building a bottomless sand filter, avoid stretching or damaging the liner when walking the sand into the edges of the filter. Careful packing at the edges will reduce short-circuiting of effluent.

III- 6.15.3.5 Burrowing animals

If burrowing animals are expected to be an issue, cover the sand mound sand with hot dip galvanized chicken wire or other suitable material. For chamber systems, the base of the chambers may need to be protected.

III- 6.16 Combined Treatment and Dispersal Systems (CTDS)

III- 6.16.1 POINT OF APPLICATION

The AP will specify the Point of Application, and draw an elevation schematic that shows the Point of Application and the vertical separation. This is not a geometric "point", but is a location or elevation.

This is the same process as defining the "point" (location or elevation) at which effluent is applied in a conventional system, i.e. the infiltrative surface (for example to the bed of a sand mound or to a trench lateral).

Vertical separation is measured from the defined Point of Application to the limiting layer. This may be in native soil (native soil VS), or may include some sand media as well as native soil (as constructed VS). Again, this is the same process as establishing the vertical separation for a conventional system. The location of the point of application should be supported by evidence, including manufacturer test results.

III- 6.16.1.1 Example of Combined Treatment and Dispersal System Point of Application and vertical separation

Figure III- 22 shows an example of a Combined Treatment and Dispersal System (CTDS) placed on sand media fill. This fill is, in turn, placed on top of a native soil (in this example, Loamy Sand, with a Kfs of 10,000 mm/day) with usable soil depth of 60cm.

In the example, a Type 2 CTDS has been specified which results in uniform distribution and flow equalization that meets standards for uniform distribution and timed dosing (Section II- 5.2) at the Point of Application.

The vertical separation (VS) has been selected to meet the Volume 2 standards for uniform distribution and timed dosing, with Type 2 effluent. As a result, the standard for VS (Table II- 16 (page II-27) for uniform distribution with timed dosing and less than 30 cm sand fill) would be as follows:

- Minimum as constructed VS: 75 cm.
- Minimum native soil VS: 60 cm.

The Point of Application for this CTDS has been defined by the AP as at the base of a 30 cm thick layer of sand, which forms part of the treatment system. This is the point at which the system has been tested (or designed) to meet Type 2 treatment method standards. Typically, the manufacturer will provide the AP with the information needed to define the Point of Application for a particular level of treatment.

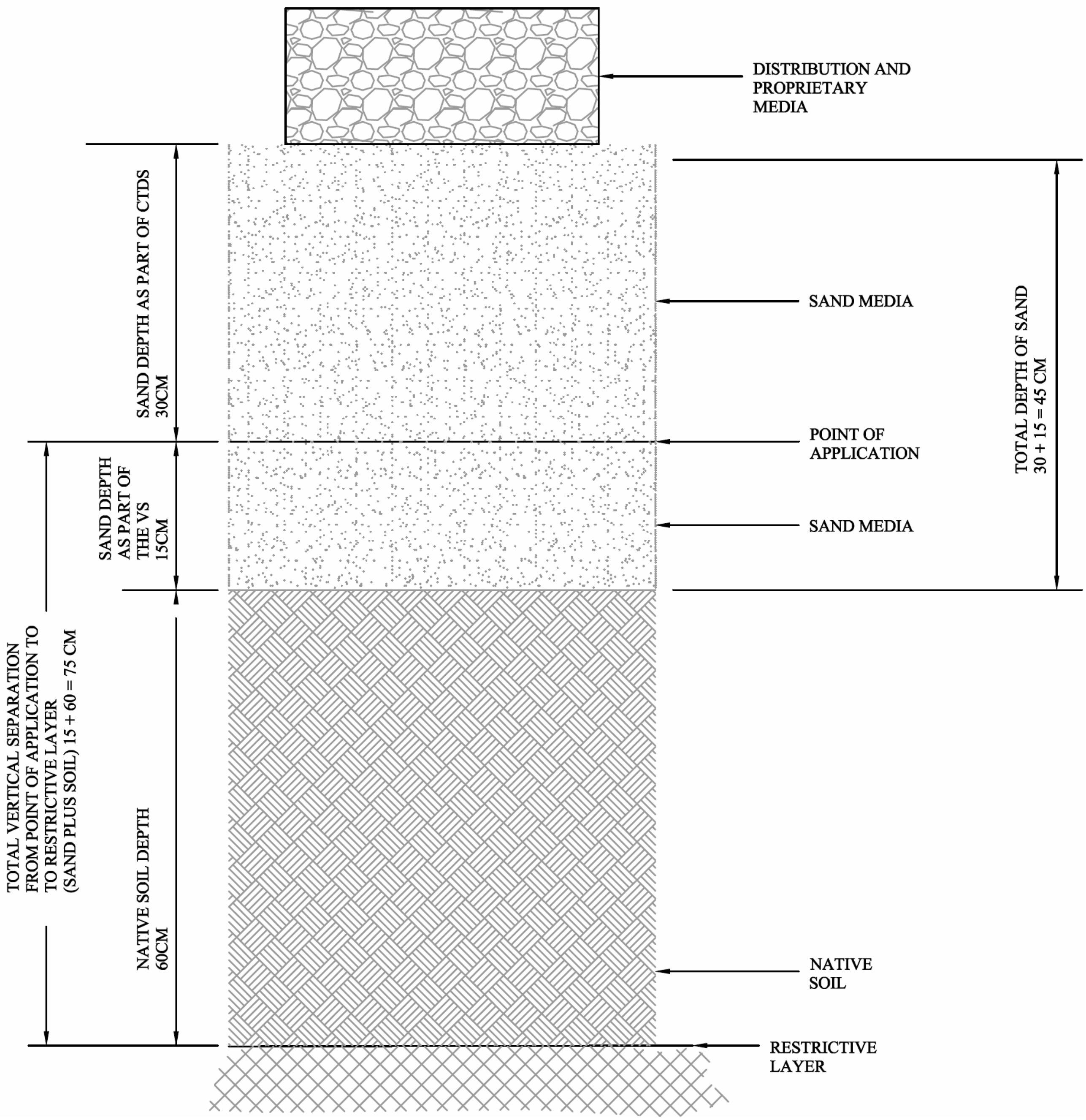
This "system sand" forms part of the proprietary treatment system. Type 2 effluent quality will be monitored at the Point of Application, to confirm that it meets the Type 2 standard. Note that the 30 cm thickness is purely for this example—the CTDS may have a thinner or thicker layer of sand above the point of application, or may not use sand at all.

This definition is comparable to that for a separate treatment system and dispersal system. In that case the AP would select a treatment method needed for a site, in this example Type 2, and then would select a treatment system to meet the standards for Type 2 treatment. The AP would then define a "point of application"—which is the infiltrative surface of the trench or bed to which this effluent will be applied. For the CTDS the only difference is that the discharge from the treatment system flows directly into to the dispersal system, without any piping or pump chambers in between.

Returning to the above example, the native soil VS available is 60 cm, so the planner has specified an additional 15 cm of sand media, below the point of application, to make up the minimum standard for as-constructed VS. So that:

60 cm soil + 15 cm sand media = 75 cm vertical separation below the point of application

Figure III- 25. Example of Point of Application and Vertical Separation



III- 6.16.2 CTDS ON A DISTRIBUTION BED

In some cases a CTDS may discharge to native soil using a coarse aggregate bed or other gravity distribution system, similar to a Seepage Bed. Typically this may be by placing a CTDS unit on top of a coarse aggregate bed.

If an aggregate bed or other gravity distribution system is used to distribute treated effluent from the CTDS to native soil (or native soil with a blinding layer), the bed is considered as a seepage bed or trench (depending on width) and standards for gravity distribution apply, including site capability and VS, aggregate specifications and a maximum trench or bed length of 15 m (measured from the centerline of the CTDS unit along the bed or trench). Linear Loading Rate is calculated based on the contour length of the bed as for Seepage Beds.

III- 6.17 Evapotranspiration (ET) and Evapotranspiration Absorption (ETA) beds

III- 6.17.1 DESCRIPTION

Evapotranspiration beds (ET) and evapotranspiration absorption beds (ETA) are well-suited to areas with a high net positive evapotranspiration balance and low permeability soils, some parts of the province are not suited to exposed ET and ETA systems due to high rainfall, for example coastal BC.

Evapotranspiration beds use an impermeable liner, so that no effluent infiltrates into the surrounding soil. These may be used in any structurally sound soil, or even on a site with no soil.

Evapotranspiration of water from a well-designed bed should exceed lake evaporation or pan evaporation and should continue throughout the year (even in cold weather or with un-compacted shallow snow cover); however, it will be lower at some times of the year than at other times.

Aerobic ETA beds typically perform more efficiently.

III- 6.17.2 SIZING AND LAYOUT

For an evapotranspiration system, sizing and layout calculations should consider the following:

- Total rainfall and snowfall based on a reliable source with long-term records (example Environment Canada);
- The percentage of the rainfall and snowfall that will infiltrate into the soil and the percentage that can be expected to runoff the system;
- The annual land evaporation rate of the area and the expected annual Evapotranspiration and snow sublimation (evaporation of snow direct to water vapor), based on a reliable source;
- Calculated net Evapotranspiration (rainfall/snowfall into the system minus Evapotranspiration and snow sublimation out) for each month and for the year;
- The permeability of the underlying soil;
- A design loading rate and rationale for selection;
- The vertical rise of water than can be expected in the cover soil/sand due to capillary action; and,
- A water balance calculation (water budget) demonstrating that the bed will not saturate to grade based on water inputs (rainfall, snowfall, effluent input) minus evapotranspiration, sublimation and absorption to the native soil.

For any ETA bed system, it is important to retain a reserve area so that a new bed or beds can be built. Inform the system owner of the risk of needing to install additional beds, and warn the owner about the cost and site impact associated with this.

The reserve area is to allow for adjustment of bed area, and is also to allow for bed replacement or long term alternation in case of excessive salt accumulation. See the appendix, Section III- 8.4for information on the impact of sodium and salinity on soil permeability.

III- 6.17.3 SPECIFICATION AND INSTALLATION

There are several standard designs for evapotranspiration beds. Common features for aerobic ETA beds (in addition to the standards) include the following:

- Shallow depth in native soil (30 to 50 cm), with part of the bed installed above the ground surface to divert storm water (swales may be needed).
- Long and narrow shape, with width of 3 m or less.
- On steeply sloping sites (slope > 15%), sequential trench systems are used in place of the bed.
- A sand blinding layer may be scarified into the native soil at the base.
- The design may include vented distribution pipes (for gravity systems) or vent pipes (for pressure systems), and secondary vent pipes above and below distribution pipes. In some cases, the pipes are mechanically ventilated.
- Sub drain pipes at the base of the aggregate layer to permit cleaning or flushing of the bed aggregate. These pipes are often extended to ground surface, for connecting a vacuum pump. The risers may be used as observation ports.
- These systems use a “capillary layer”, a layer of sand or loamy sand placed over the aggregate bed or chambers. This layer is typically 18 to 25 cm deep. It provides capillary rise of water to the ground surface, and promotes oxygen transport to the aggregate. The cover soil is crowned to a slope of 2%, or greater, to divert storm water.
  - This sandy soil layer is separated from the aggregate layer by an aggregate filter (for example a pea gravel layer), rather than using a geotextile filter cloth.
  - With chamber systems, the capillary layer is installed between the chambers as well as above them.
  - This sand or loamy sand is selected to provide capillary rise that is greater than the bed depth (example 45 cm), but should be permeable enough to allow oxygenation of the bed, typical range of capillary rise is 45 cm to 90 cm.
- The capillary layer is covered by up to 5 cm of loamy sand cover soil (topsoil) or sod—as for sand mounds (shallow topsoil is important for improved evaporation).
- The finished surface is planted with sod (turf) and low evergreen bushes of a type that have a rooting depth of 30 to 45 cm (but not of a type that will be invasive) and which are salt tolerant.
- The surface should be protected from access and compaction.
- Snow cover is encouraged by use of snow fences and bushes, and the maintenance plan indicates that the snow should not to be compacted.

An ET bed can be specified to pond internally, and to be anaerobic for much of its depth, during large parts of the year. A sectional bed (similar to celled lagoons) can be used to encourage ponding during dry weather to improve capillary rise—which will improve evapotranspiration.

ET and ETA beds may be used seasonally. In this situation, covers may be used in the winter to prevent rainfall accumulation.

III- 6.18 BC zero discharge lagoons

III- 6.18.1 DESCRIPTION

The BC zero discharge lagoon is a system unique to BC. The lagoon disperses effluent by infiltration into the soil and by evaporation from the pond surface, similar in concept to an evapotranspiration absorption (ETA) bed.

A BC zero discharge lagoon system consists of one or more large excavated cells surrounded by a berm. Sewage is fed directly or from a septic tank by gravity - if topography allows – otherwise a septic tank is used and effluent is discharged to the lagoon by pump, siphon or other dosing device. Excavated clay material is placed and compacted in an elevated berm intended to prevent surface water from entering the lagoon and to provide reserve capacity.

Fencing is installed on the berm, or immediately adjacent to the berm to prevent entry of animals and to provide security/safety.

Preventing problems associated with odour, mosquito breeding, disease transmission by insects and exposure to animals are key considerations. Managing the long term growth of vegetation is important, particularly as trees can cause leakage.

III- 6.18.1.1 Diagrams of BC zero discharge lagoons

The following diagrams illustrate lagoons built to meet the standards.

Figure III- 26. Rectangular Lagoon

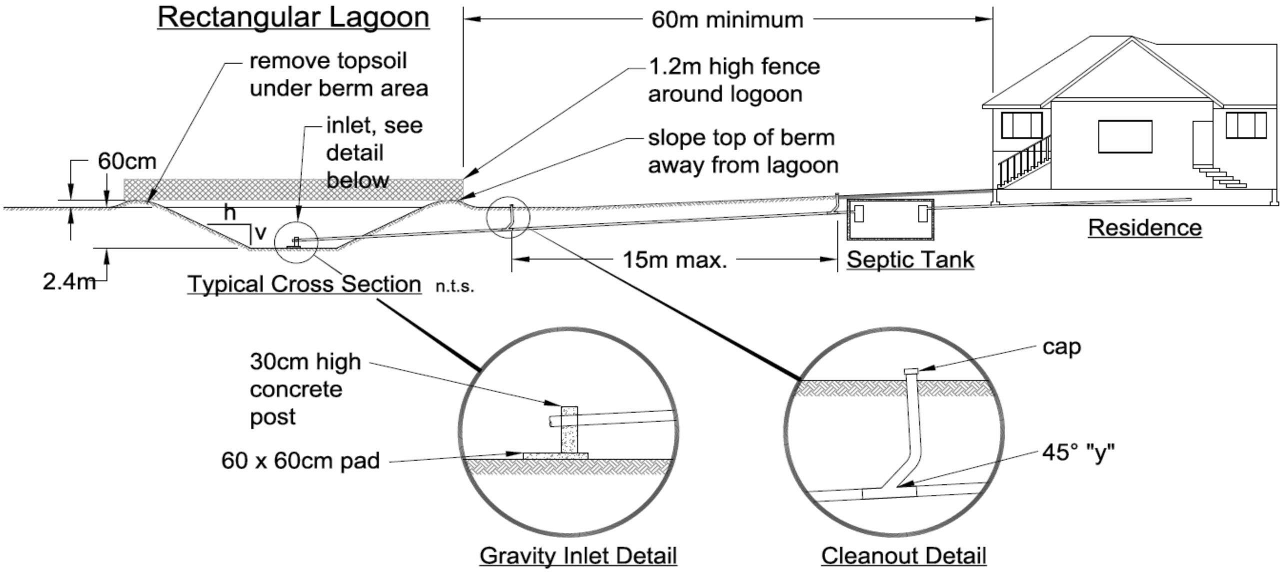
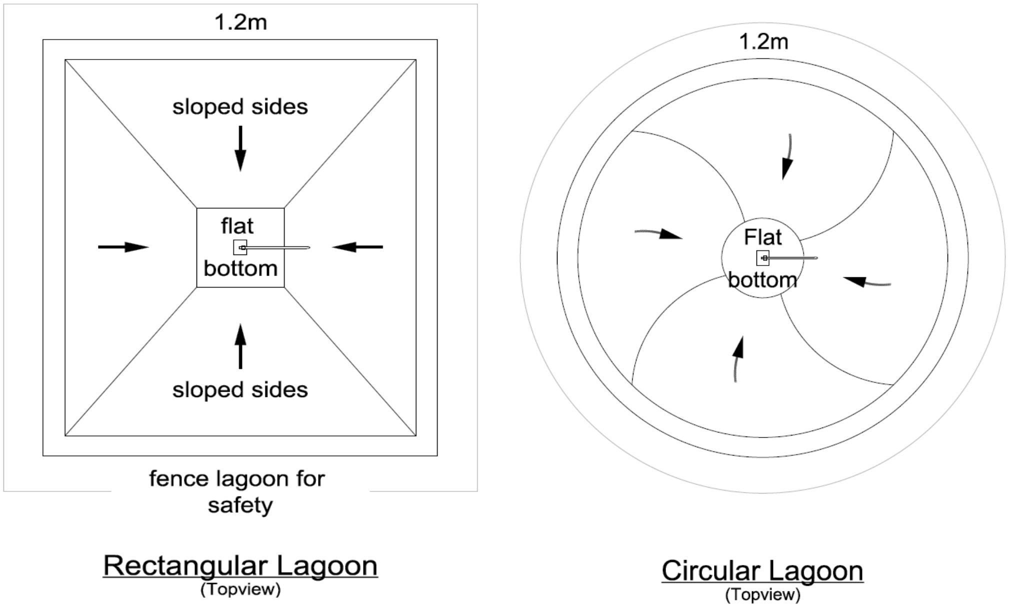


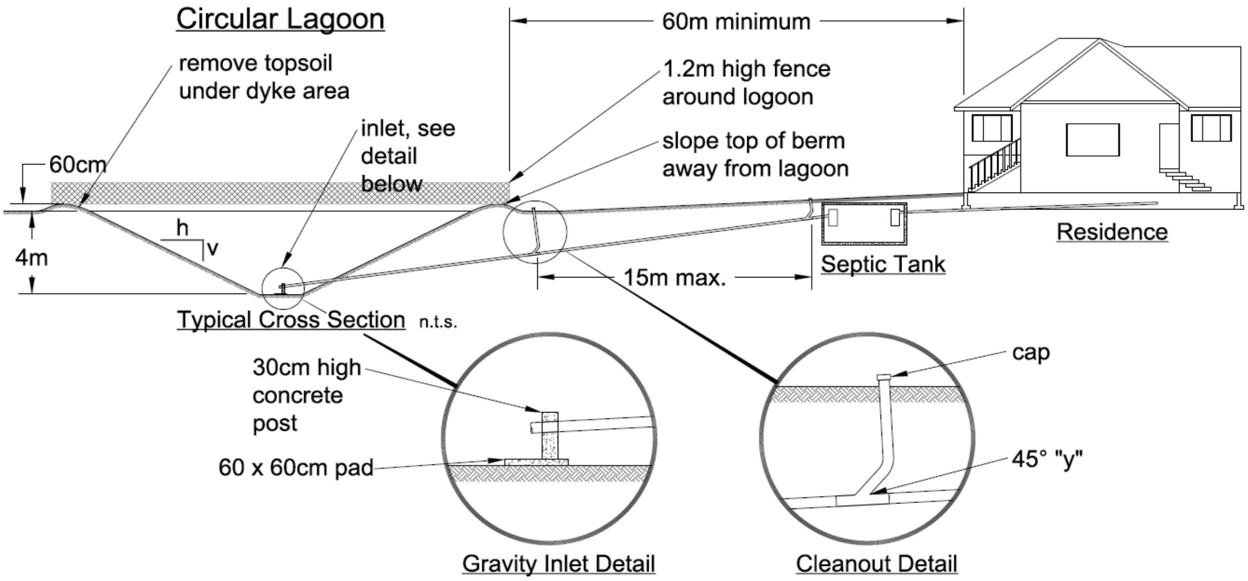
Figure III- 27. Rectangular and Circular Lagoons (top view)



Rectangular Lagoon
(Topview)

Circular Lagoon
(Topview)

Figure III- 28. Circular Lagoon



III- 6.18.2 SIZING AND LAYOUT

III- 6.18.2.1 BC zero discharge lagoon Sizing

Lagoon sizing is dependent on the water balance throughout the year of precipitation, evaporation and soil infiltration. This varies widely over the province. Lagoons do not need the use of a peaking/safety factor for Daily Design Flow due to their large capacity for flow equalization.

Lagoons should contain one to two years average sewage flow depending on the area in which they are installed. An adequate water surface area is needed to facilitate evaporation; the standards provide recommended surface areas.

Over sizing of lagoons is not advisable as this will lead to freezing, choking with emergent vegetation and may encourage mosquito breeding.

In the Volume II standards, lagoon sizes are based on the lagoon shapes described above. If other shapes are used or different side slopes are used, check that volume is sufficient and that the surface area is at least that in the selected standards table.

Where lagoons are sized to hold less than two years average design flow, reserve an area next to the installed cell for a second cell of sufficient size to make up to two years average flow.

Lagoons can also be sized based upon considerations of net evaporation, infiltration and individual site characteristics. However, as these are low cost systems, the simplified approach, following Volume II standards, may prove more economical.

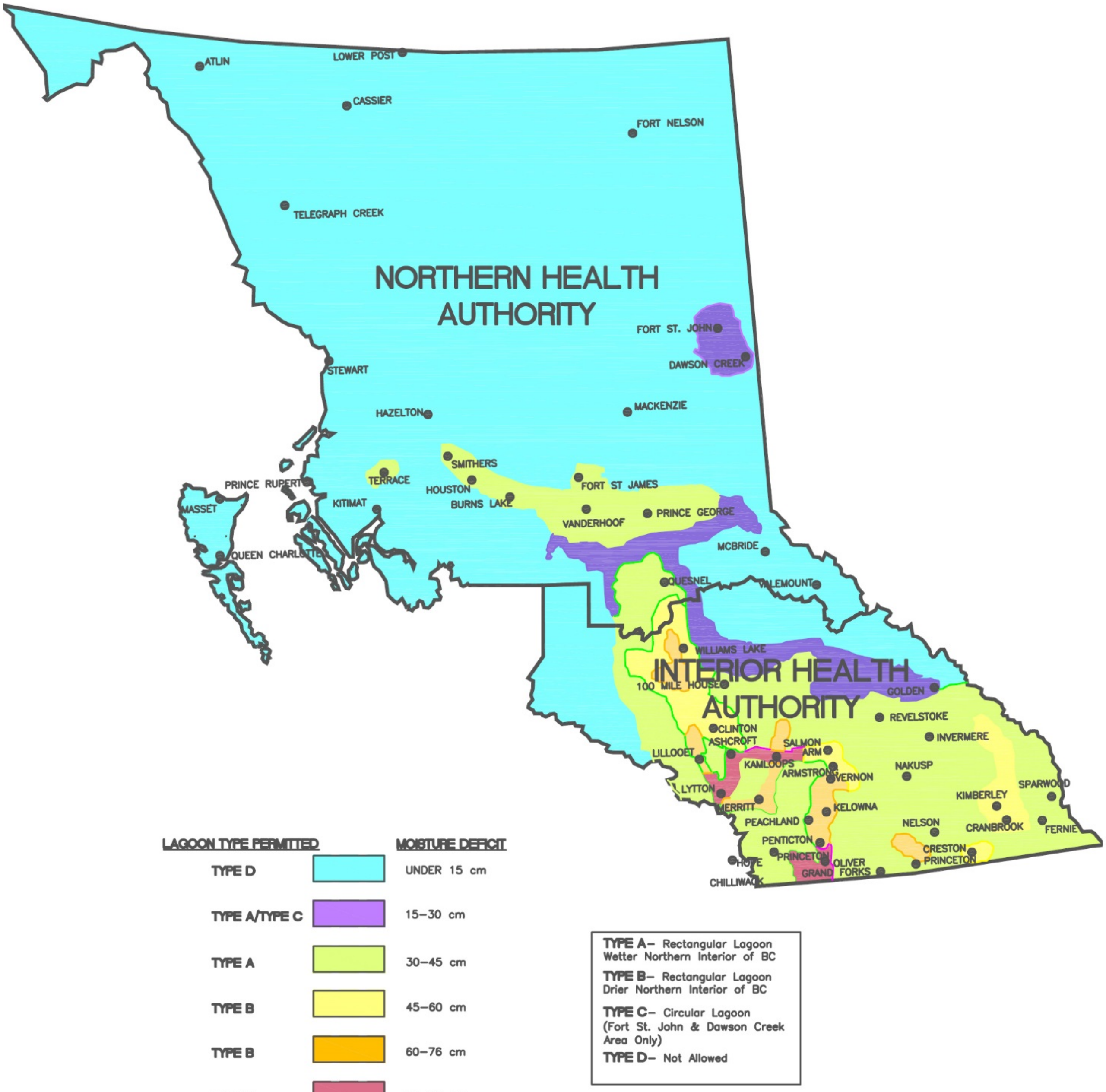
III- 6.18.2.1.(a) Wet or dry area sizing for rectangular lagoons

The standards include two tables for rectangular lagoons, one for “dry” areas and the other for “wetter” areas.

As a guideline Figure III- 29 provides recommended north to south separation for use of these two sizes of lagoon, and for the circular lagoons. This map should **not** be taken as indication that a particular lagoon will work in a specific location.

The lines on this map are very approximate and as the elevation changes (i.e. near any mountains) the dry lagoons may need to be made larger even in the “dry" region. When using the smaller (“dry”) size lagoon sizing, the AP should review nearby lagoons to confirm whether the smaller lagoons will work in the specific area.

Figure III- 29. Recommended north to south separation for wet and dry area lagoon sizing



III- 6.18.3 SPECIFICATION AND INSTALLATION

BC zero discharge lagoons should be oriented along the surface contours in order to reduce slope variation.

When laying out a lagoon consider potential for future replacement or addition of further cells.

Remove all trees from the lagoon and berm area, and around the lagoon for at least 15 m to encourage evaporation.

When constructing the lagoon it is important to observe soil and groundwater conditions. If a sand lens or other high permeability layer is seen, investigate and consider relocating the lagoon. This is to avoid risk of the lagoon draining to the layer and also to avoid risk of groundwater entering the lagoon and over filling it.

III- 6.18.3.1 Berm construction

The berm should be constructed so that:

- The clay soil making up the berm is well compacted in 30 cm lifts and void of all topsoil and organics
- The area below the berm has been stripped of all topsoil, organics and soils of permeability >60 min/inch.
- The berm should be keyed to the native soil; and,
- The berm basal area and the completed berm have a soil percolation rate equal to or slower than 60 min/inch or Kfs less than 20 mm/day.

Surface drainage should be directed away from the base of the berm, the minimum berm height standard is intended to ensure snow melt water and other surface water does not flow into the lagoon.

III- 6.18.3.2 Freezing risk

Freezing potential is reduced by the construction of an internal berm, which increases the depth of water over the inlet pipe and insulates it. The internal berm should be:

- Situated ⅓ of the distance along the length of the lagoon from the end that has the inlet pipe; and,
- Approximately 1.2 m in height.

III- 6.18.3.3 Fencing

A fence should be built at the outside base or top of berm, that:

- completely encloses the lagoon area;
- is made of woven wire or barbed wire
- If barbed wire, to be a minimum of 7 strands with the first strand starting 3 inches from the ground and the following strands spaced evenly;
- is 1.2 m tall or higher; and,
- has access from one side by a locking gate (any gate should be kept locked).

And has signs located on each gate with a warning of “NO TRESPASSING — WASTEWATER LAGOON.”

III- 6.18.3.4 Backflow Prevention

Lagoons can pose a risk for sewage backups into the building under the following conditions:

- Freezing effluent can block the service line discharging to the lagoon. Even if the lagoon is substantially below the building sewer and the septic tank, a blocked discharge will cause sewage to back up into the building.
- When the lagoon is supplied by a pump or other dosing device, there is a potential siphoning effect that can draw effluent from the lagoon back to the building.
- If the liquid level in the lagoon rises above the sewer service elevation, effluent will flow back to the building.

III- 6.18.3.4.(a) For gravity discharge to a lagoon

The highest potential liquid height in a lagoon is the lowest elevation of the containment berm. Gravity flow discharge to a lagoon should only be used if the berm elevation (lowest portion) is at least 30 cm below the sewer outlet from the building.

III- 6.18.3.4.(b) For pumped discharge to the lagoon

Methods to prevent back flow from lagoons include the following:

- Install check valves or similar mechanical back flow prevention devices at the pump chamber that will prevent flow to the building. These are prone to failure, so do not rely on them as the only method, and are not used if the force main drains back.
- Install an air relief valve or vacuum breaker valve installed in the force main at the berm as a siphon break. Consider the potential for valve failure, freezing, or flooding by water height reaching the top of berm. The vacuum breaker should be at an elevation higher than the lowest point of the berm (this will mean elevating a small portion of berm with additional fill)
- Provide a small chamber (example a D-box) with an air gap in the force main piping system at the high point of the berm. The chamber outlet invert should be at an elevation higher than the lowest point of the berm (this will mean elevating a small portion of berm with additional fill).
    - The recommended practice is to provide multiple (2 or 3) gravity discharge lines from the D-box to differing points and elevations within the lagoon. Consider the potential for blockages of flow from the box (e.g. freezing or other cause) - use backflow prevention at the building as an additional precautionary feature.

If draining the force main back to the pump tank after each dose, ensure that the drainback orifice is large enough to drain the force main in less than 30 minutes. Check this at commissioning, and drill the orifice larger if necessary.

Note that elevating a part of the berm to allow use of the siphon break systems described above is allowed even if it raises that part of the berm above the maximum 1.5 m berm height.

III- 6.19 Site drainage

III- 6.19.1 DESCRIPTION

Interception drains may be used on a wide range of sites, and with a range of types of systems. These drains divert water away from the discharge area, lowering the water table. They are also known as "curtain drains". See Figure III- 30.

Relief drains are used to lower the water table in the dispersal and receiving areas. Relief drains can be used on flat as well as sloping sites to compensate for groundwater mounding. They are also known as "toe drains" (if downslope of a system or at the downslope edge of a toe blanket), "tile drains" or "field drains."

All drains need to be installed to meet the horizontal separation standards of this Manual. See Section III-5.4.4 for information on upslope and side slope drain separations.

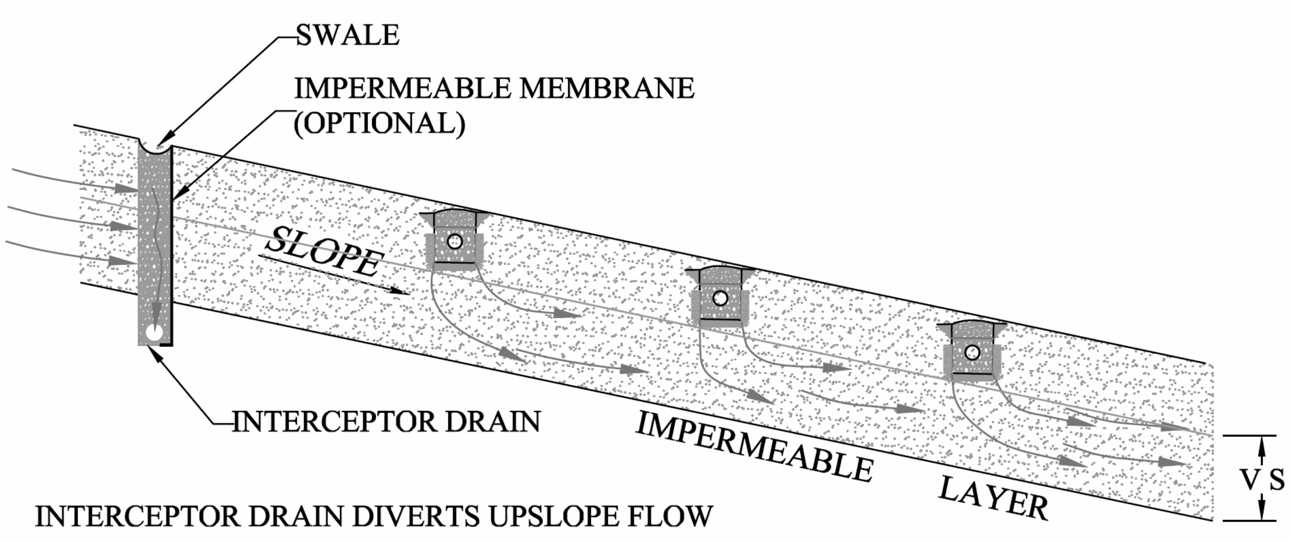
III- 6.19.1.1 Interception drain

A typical interception drain consists of a trench penetrating the restrictive layer by more than 20 cm, with a drainage pipe and drain gravel or drain rock (or a non-aggregate system).

In some cases, an impermeable membrane is installed on the downslope wall of the trench to provide a subsurface dam and to reduce the risk of seepage from the dispersal area into the drain. This could be a lateral drainage material which also provides drainage paths.

The drain can have a surface swale to divert surface flows, with the water entering the drain system or being diverted separately.

Figure III- 30. Interception drain schematic cross section



III- 6.19.2 SIZING AND LAYOUT

Swales and drains should be sized to handle the peak flows expected from the upslope watershed or aquifer.

In cases where large flows are expected, specialized design of the swale and drain is strongly recommended. Planners should seek a hydrologist's opinion on expected flow volumes and peaks.

An interception drain should effectively intercept subsurface flow, and be capable of carrying this flow away, without causing flow concentration in parts of the discharge area or the receiving area.

If practical, the drain should penetrate the low permeability restrictive layer deeply enough so that water flowing around the drain cannot escape downslope. Alternatively a groundwater dam can be sealed to the low permeability layer.

Typically, a swale is provided at the top of the interception drain trench to divert surface water. Where large surface flows are expected, the base of the swale can be lined with a plastic or rubber membrane or with low permeability material to reduce infiltration of the collected water.

Drains should be sized and specified using good field drainage practice. A recommended design manual is the National Engineering Handbook Part 624 Section 16 *"Drainage of Agricultural Land"* published by the US National Resources Conservation Service and available online at:

http://directives.sc.egov.usda.gov/viewerFS.aspx?id=3887

If a drainage system is being relied on to lower the water table in order to achieve vertical separation standards, it is best to pre-install the drainage system to confirm that the drain can lower the water table to an adequate depth. This would involve measuring the depth of the water table in the proposed dispersal area during the wet season, using observation standpipes as discussed in Section III- 3.3.2.2.(a).

III- 6.19.3 SPECIFICATION AND INSTALLATION

Drains should be installed using good field drainage practice.

When specifying an interception drain that is to be installed in erodible soils, such as silty or fine sandy soils, then use a filter could be to reduce erosion of soil into the aggregate and drainpipe. Three basic types of filters are commonly used:

- Geotextile filter cloth.
- One or more granular soils, typically fine gravel and coarse sand.
- Filter cloth or geotextile systems combined with coarse sand.

Where the water drains into a solid pipe, take care to avoid surcharged water continuing to flow down the trench. Consider using a low permeability plug (clay dam) at that point in the trench.

III- 6.19.3.1 Monitoring of vertical separation

In addition to observation ports for the drains, if the drain is used to ensure vertical separation (VS) is met and maintained, then one or more observation standpipes should be installed above and or below the dispersal area. See Section III- 6.5.2.5 (observation standpipes) for installation guidelines.

These standpipes should be minimum 60 cm from the closest dispersal system trench or bed edge or dripline.

III- 6.19.3.2 Outfall

The outfall of the drain should be planned and installed to prevent erosion or other problems.

If the drain is discharged to a subsurface infiltration system, the in-ground dispersal unit should be capable of dispersing the flow without causing adverse impact to slope stability or the sewerage dispersal system and receiving area. The in ground dispersal system should be provided with a water table observation standpipe.

III- 7 MAINTENANCE GUIDELINES

Note that in this section the word “inspect” is used to represent inspection of components by the maintenance provider.

III- 7.1 Maintenance and monitoring frequency

The Volume II standards show the minimum intervals for initial maintenance and testing. Start with frequent maintenance, sampling and testing. Then, based on the results of the first year, and on a discussion between the AP who filed the system and the maintenance provider, develop a new maintenance and sampling frequency for the next five to ten years.

For systems that are more complex than normal for the type of system, consider shorter maintenance intervals.

Then, at the end of the five to ten year period, the maintenance provider should re-evaluate the sampling frequency, consulting with the AP who filed the system (or another suitably qualified AP) and establish procedures for the next time period.

These consultations need not be onerous, and may be as simple as a telephone conversation and follow-up memo.

Establish the time period for review of the plan based on the type of system, for Type 2 or 3 systems use a five year period. For Type 1 systems and lagoons, use up to a ten year period between reviews.

As a guideline, maintenance and testing frequency should be at minimum:

- Every 5 years for gravity dispersal Type 1 systems and BC zero discharge lagoons.
- Every 2 years for other systems, including ET and ETA beds.

If a system sometimes fails to meet the effluent quality standards, then consider more frequent sampling and testing. If the system consistently meets the effluent quality standards, then consider less frequent testing.

III- 7.2 Maintenance Procedures

III- 7.2.1 HOMEOWNER EDUCATION

It is of critical importance that the homeowner understands the need for maintenance of their onsite system, and the need to control what is discharged to the system.

The AP should educate owners, both at system commissioning and at subsequent maintenance visits, about their system.

III- 7.2.2 LOCAL MAINTENANCE BYLAWS

If a local government maintenance bylaw is in place the AP should forward a copy of the summary table(s) of maintenance requirements and schedule to the local government.

III- 7.2.3 WRITTEN REPORT OF MAINTENANCE

After maintaining the system, provide the owner or client a written report. In the report include at least the following:

☐ The date maintenance and monitoring was carried out, the name of the client or owner, the civic address.

☐ The weather on the day.

- Describe if the system is being used in a manner consistent with its design capacity and condition. F*or the initial maintenance service report only - an evaluation of the system's Filing document, maintenance plan or original permit (if available) in relation to the actual system found and the current usage. This may include analysis of any flow records or flow meter readings that are available.*
- *For the initial maintenance service report only - a general description of the type and components of the system with a summary of what was located and tested - as well as anything that was not located or tested and an explanation of the reason why it was not.*
- An evaluation of the system's current performance summarizing the results of the maintenance service and monitoring in layman's terms, and making conclusions about system operation and malfunction.
- A listing of monitoring data such as cycle counts, pump run time, pump run amperage, alarm events and any other flow or performance data provided by the pump control panel, flow meter, cycle counters or other monitoring features. *This data will be useful at subsequent maintenance service to determine the flows received by the system since the last service.*
- Squirt heights for pressure systems, pressures for drip systems and any other relevant data regarding distribution performance.
- A list of recommended repairs or improvements, with descriptions of how minor or serious these are, how soon these should be corrected, and the reason why it should be done.
    - Indicate any repairs that will require filing under the SSR.
- AP seal with signature.

III- 7.2.3.1 Terminology for system operation and malfunction

ASTTBC has established guidelines which include terminology to be used to describe conclusions about system condition and performance. Use this terminology when reporting on system maintenance.

See http://owrp.asttbc.org/p/documents.php

III- 7.2.3.2 Photographic Evidence

Take photographs to document maintenance and maintenance inspection. Keep the photographs as a long-term record. It often helps to include photographs in the report to the owner.

Photos should be obtained to meet the goal of supporting the conclusions within the maintenance report - positive or negative. Obtain photographic evidence sufficient to show the following:

- The overall site and the specific system component locations **before** the site is disturbed and components are exposed.
- The exposed system components, with adequate detail to show the internal conditions of components such as septic tanks, dosing chambers, D-boxes and similar serviceable points (before and after cleaning, adjusting etc.).
- Adequate detail to document any components needing immediate repair, performance malfunction, any illegal or prohibited features, and potential health or safety hazards.

The overall site and the specific system component locations **after** access points and all components are secured, backfilled as applicable, and put back in operating condition.

III- 7.2.4 FIRST MAINTENANCE SERVICE

- Determine the number of occupants or users, and compare this to the design capacity of the system.
- Check for leaking plumbing fixtures that cause unnecessary flow volume.
- Check for oversized tubs, multi head showers or other potential sources of large flow volumes and surge flows.
- Check the discharge points of any hot tubs, swimming pools, reverse osmosis wash water, floor drains and RV sewage dumps (or any other source not indicated in the original design) to confirm they are not connected to the onsite sewerage system.
- Determine if appliances are relatively new, with water saving features, or older high volume types.
- Discuss and educate the owners or users about water use that could contribute to peak flows, such as doing multiple loads of laundry on one day, or similar uses that could overload the system.
- Check for water treatment devices. Check if the type and configuration produces any back flush cycles discharged to the onsite system. Check for devices that use chlorine, other chemicals or sodium salts, all of which may harm a sewerage system.
- Check the property for any drainage systems such as interceptor drains, retaining wall footing drains, surface drainage, etc., and assess the potential impact on the wastewater system. These drainage systems may be critical to the proper functioning of the wastewater system, or may be potential breakout points for effluent. Drainage systems should be monitored and maintained.
- Check to ensure that no discharges reach the system from any groundwater or surface water drainage system, such as roof water or foundation drains, catch basins, driveway grates, etc.
- Conduct a flow test to confirm that all flows, from every plumbing fixture (including from any secondary buildings), arrive at each component of the onsite system in a correct manner.
  - Run these tests with small to moderate flows that reflect normal water use in the building; do not flood the sewerage system. The run time for each fixture should be only long enough to confirm the appropriate arrival of flows, confirm that there is only one system in operation, determine if a soapbox or grease trap is used, and confirm there is no diversion of wastewater.
  - Check for flows arriving in the septic tank in a consistent manner without surging or ‘gurgling’, which could indicate bowed, damaged or clogged sewer lines.

At subsequent maintenance visits, the AP should re-check the components listed above, but the scope of examination may be reduced. For example, the flow test may not be necessary, and a brief discussion with the owner or occupants may confirm that water use has not changed.

III- 7.2.5 MINIMUM SCOPE OF MAINTENANCE

At each maintenance service, in addition to any specific provisions in the maintenance plan:

- Examine, test, and document the condition and performance of the entire system including the soil dispersal system.
- If media is used in treatment systems such as sand filters, any packed bed filter, CTDS, or any other products using proprietary media – assess the condition and serviceability of the media and determine when the media should be replaced.
- Make written conclusions regarding the operation and performance of the system. Key points include reporting any performance malfunction, illegal features, or any health or safety hazard.

- Carry out any maintenance and monitoring tasks as prescribed by the maintenance plan as filed. If no filing or maintenance plan is available, determine and document appropriate maintenance tasks based on standard practice to ensure proper operation as intended by the system design.
- Confirm the security and structural integrity of lids and access points to tanks, treatment systems and D-boxes.
- If backups of the dispersal system are observed, use a pipe camera to check for structural damage or clogging of the piping system.
  - If there are no obvious signs of blockages, excavating by hand should be done to determine the degree of clogging of drain rock and infiltrative surface by biomat and oil and grease, Check for other potential causes of backups, such as excessively high groundwater levels (above dispersal piping).
  - This assessment by hand excavating should be done for clogged systems, but is also recommended practice for any system that has been in use for 10 years or more to identify premature clogging and to observe the overall condition of the dispersal soil. Adequate VS can also be confirmed by hand excavation or augering.
- Any drainage systems (interceptor drains, swales, ditches, etc.) that have a potential effect on the wastewater system should also be maintained, as follows:
  - Confirm that the drainage system continues to divert surface or sub surface flows in or adjacent to the wastewater dispersal area, as intended by the original plans and specifications. This could include pipe camera examination. *Camera inspection may only be appropriate during the initial service, and when problems are suspected*.
  - Locate and examine any cleanouts or observation ports, clear the drain outlet, and flush any plugged drainpipes.

See Section III- 7.3for minimum maintenance tasks.

III- 7.2.6 WRITING A SIMPLIFIED OPERATION AND MAINTENANCE PLAN

If there is no maintenance plan available, the maintenance provider should write one for the owner. This may have less detail than the comprehensive maintenance plan and owner's manual outlined in Section III- 3.7.2. This simplified version is intended to support future maintenance, and to provide the basic information for the owner or user.

III- 7.2.7 REPAIR WORK BY MAINTENANCE PROVIDERS

Minor repairs, and replacement of some components, can be included within the scope of maintenance. However, major repairs, alterations, or replacement of major components, fall outside the scope of maintenance.

Major repairs require a Filing, and must only be carried out by APs that have been qualified and accredited to plan or install systems. See Section II- 2.1.2.

III- 7.3 Minimum Maintenance Tasks

III- 7.3.1 GENERAL MAINTENANCE TASKS

Refer to Section III- 7.2for checklists covering maintenance procedures and reporting.

Specific maintenance tasks for systems are described under the specific system type, below and may be expanded on in the system maintenance plan prepared by the system planner or designer.

General maintenance tasks include:

- Confirmation of suitable access provisions to facilitate ongoing maintenance and monitoring (e.g. risers exposed at or above grade, lawn boxes).
- Confirmation of continuing safety provisions, including, but not limited to, secure tank lids, and prevention of contact with electrical components and junctions.
- Examine electrical connections and components for corrosion and general condition and safety. Check for proper sealing of conduit and components to prevent passage of gases or moisture. Follow the BC Electrical Code. Be aware of restrictions on which work must only be done by a qualified electrician.
- Check records of flow. Compare this data to records of commissioning or previous maintenance; calculate the actual average flows since the last record; and compare to the average flow allowance (50% of DDF) over the intervening period.
- Perform system testing to confirm proper operation of all control features and alarms.
- Observe and confirm proper operation of all isolation valves, check valves, air release and vacuum valves, water hammer arrestors, solenoid valves, back flushing valves, and indexing valves.

Specialized information and specific maintenance and monitoring tasks will be included in the Maintenance Plan created by the system planner or designer.

III- 7.3.2 COLLECTION AND CONNECTION SYSTEMS

Pump system maintenance in the house is a plumbing issue and falls outside of the onsite system; however, the owner should be encouraged to follow the minimum maintenance standards for pump dosing systems.

These minimum standards should also be applied to STEP, grinder pump and vacuum systems maintenance.

- Gravity collection systems should be monitored for adequate flow and proper scouring.
- Piping systems should be evaluated for leaks and the infiltration of water.

III- 7.3.3 SEPTIC TANKS AND EFFLUENT FILTERS, OTHER TANKS

- Examine the inlet and outlet baffles in the septic tank for proper configuration, condition, alignment, and blockages.
- Check for signs of current or past backing up (e.g. liquid levels, residue, solids, or scum at elevations higher than the normal working level).
- Check for proper liquid levels in the tank. Working level should be equivalent to the outlet invert. Generally this is from 3 to 8 cm below the inlet invert. Lower levels may indicate a leaking tank. Higher levels may indicate a blockage downstream from the tank, misaligned piping, or a tank that is out of level.
- Check for leaks, and evidence of settling of the tank or settling or misalignment of the inlet or outlet piping.
- Check for flows arriving in the septic tank in a consistent manner without surging or ‘gurgling’, which could indicate bowed, damaged, or clogged sewer lines.

- Check for trickle flows entering the septic tank when no water fixtures are running. This may indicate groundwater infiltration into the tank, or a leaking fixture in the building. Also, check for evidence of leak at other locations, including: (1) caulking or seals around inlet and outlet, (2) tank risers, (3) tank lids, (4) mid seam seals on two compartment tanks, (5) tank cracks, and (6) pipe connections.
- Check for venting and integrity of vent screens.
- Assess the sewage characteristics in the septic tank. Look for signs of excessive household use of materials harmful to bacteria, unusual solids build up, and non-biodegradable materials. Check for excessive fats, oils and grease. Confirm that appropriate biological activity is established.
- Assess the sludge and scum accumulations. Pump out when any of the following are noted:
  - Total solids accumulations are more than 1/3 of the internal height of the tank.
  - The scum layer reaches the top of outlet T in a one compartment tank.
  - The scum layer reaches the top of inlet T in a two compartment tank.
  - Any obvious carry-over of solids to the second compartment.
  - Premature effluent filter clogging.
  - An increase in TSS or O&G noted in downstream components.

Before pumping the tank, check for a high water table that might cause the tank to buckle or float. Check for monitoring wells or ports. After pumping, refill the tanks with water, if so specified in the maintenance plan or manufacturer guidelines.

- Examine and clean the effluent filter(s). If no filter is present, consider retrofitting the tank with a suitable filter.
  - When cleaning the effluent filter, avoid scum or sludge exiting the tank.
- Check and test the operation of the effluent filter alarm, if installed.
- Visually observe the effluent.
  - For trickle gravity systems, this is generally done in the D-box.
  - For dosed systems, this is done in the dosing chamber.
  - Consider the effluent colour, odour, and a visual assessment of turbidity as an indication of suspended solids. Look for signs of appropriate settling of solids and biological treatment from the septic tank.
  - Consider the degree of growth or attachment of residue on interior surfaces.
  - Laboratory or field testing of effluent may be specified in the maintenance plan for Type 2 or 3 systems, or if problems are indicated for Type 1.

III- 7.3.3.1 Tank integrity

When the tank is pumped, use a camera suited for tank examination to check the interior of tanks.

Plastic or fibreglass tanks should be checked for distortion, cracks, and bruising (i.e. as may result from excessive pressure by backfill material or groundwater, or by damage during installation).

Concrete tanks should be checked for cracking and concrete degradation.

Many older systems use tanks made from wood, steel, concrete blocks, or other materials and styles that are prone to degradation, leakage, and structural failure. All tanks can be damaged by poor installation procedures or excessive weight (i.e. from machinery, other traffic, or excessive depth of burial) after installation.

At each visit examine all tanks to determine if there are any signs of structural failure, distortion, degradation, damage, or leaks (this does not require pump out at each service).

III- 7.3.3.2 Abandoning or Decommissioning Tanks

To decommission and abandon a septic or other tank, pump out all contents, and safely dispose the contents at an approved facility.

Tanks may be removed and disposed of at an approved facility. Tanks may be abandoned and decommissioned in place.

To abandon and decommission tanks in situ:

- Avoid any substantial retention of groundwater in the tank by creating holes in the bottom, or breaking away at least one side of the tank.
- Backfill the tank in a manner that provides uniform and complete soil fill of the tank, with minimal risk of settling later. This may involve completely removing the lid. Alternatively, the lid can be cut or broken, and placed within the tank in such a way that large voids are prevented.

Fill material should be selected to minimize potential settling. Well-drained native soil, such as sand or loamy sand, may be considered. Avoid cohesive or organic soils.

III- 7.3.4 SEWAGE TREATMENT SYSTEMS

For sewage treatment plants, and for CTDS, in addition to checks related to tanks and enclosures, check the following:

- ☐ Confirm proper operation of (as applicable) air blowers, and re-circulating pumps. Consider scheduling rebuild or replacement at a suitable interval.
- ☐ Check that the treatment system enclosure, access and venting are properly sealed or screened to prevent human or animal (flies, rodents etc.) contact with effluent.
- ☐ Examine and confirm the condition of any media used; clean or replace ineffective media.
  - ☐ Dispose of any used media at approved disposal site as noted below.
- ☐ Examine and clean UV bulbs and related hardware. UV bulbs should typically be replaced every 12 months.
- ☐ Sample and test the effluent quality, as directed by the maintenance plan. If there is no plan, then test the effluent following the minimum interval standards of Section II- 7.1.
- ☐ Include other maintenance tasks included in the manufacturer’s recommendations and the maintenance plan.
- ☐ If a sand or manufactured media is used for treatment in a CTDS, a packed bed filter, a sand filter, or a similar application, then check the condition and serviceability of the media should. Assess when the media should be replaced.
  - ☐ If it is time to replace the media, then check that the media is disposed of in a safe manner that minimizes health risks. Arrange disposal at a waste handling facility that is approved by the Ministry of Environment.

III- 7.3.5 DISPERSAL SYSTEMS, GENERAL

- ☐ Check for indications of leaks such as wet or spongy grass, excessive growth, or surface ponding around tanks and throughout the system.
- ☐ Observe the dispersal system for evidence of surfacing effluent, excessive settling, or soil or sand erosion. Confirm appropriate vegetative cover.
- ☐ Confirm that the dispersal system is protected from:
    - ☐ cover by structures or impervious materials
    - ☐ surface and sub-surface drainage into the dispersal area
    - ☐ soil compaction (e.g. traffic, livestock)
    - ☐ soil removal, addition, or grade alteration
- ☐ Examine all observation ports in the dispersal area, and assess any liquid levels found.
- ☐ Examine all observation standpipes, and assess vertical separation.
- ☐ Although unusual, the maintenance plan may specify collecting of samples from observation ports or monitoring wells.
- ☐ For a dosed system, check the observation ports before and after a dose.

III- 7.3.6 GRAVITY DISTRIBUTION

- ☐ Evaluate the D-box or other flow splitting device for degradation, settling, signs of backups, and solids accumulations. Check for leaks, and evidence of trickle flows or groundwater infiltration into the septic tank or D-box.
    - ☐ Confirm even distribution to the laterals from the D-box, splitter tee, drop box or pressure manifold.
    - ☐ For dosed systems, check to see if the dose reaches the ends of laterals
    - ☐ Check that cycle the counter is operating correctly for tipping D-box systems
- ☐ For troubleshooting, consider examining the laterals using a pipe camera.
- ☐ Flush, jet, or vacuum clean any plugged laterals.
- ☐ Any pressurized system component should be evaluated for leakage.

Where a serial or sequential distribution system is used:

- ☐ Consider taking the upper laterals out of service for resting to allow the biomat to degrade;
- ☐ Check all drop boxes for degradation etc. as for single box systems. *Even if only the first one or two drop boxes are in active use, all drop boxes should be checked during monitoring and maintenance as the non-used boxes have a tendency to deteriorate due to* H_2S *gases rolling downhill from one box to the next*;
- ☐ Observe flow behaviour with some tracing dye; and
- ☐ Inspect pipes and laterals using the pipe camera for the same reasons as the single box system.

III- 7.3.7 PRESSURE DISTRIBUTION

- Perform a residual pressure test and record distal pressure (squirt height). Compare this to the commissioning record, and to previous maintenance records. Use same size and type of orifice used at commissioning. When pressure testing:
  - Avoid contaminating the site with effluent on the surface; direct the flow back into the trench, or use clear pipe or tubes;
  - check for equal distribution; and
  - check for drain back to lower laterals;
  - if effluent is draining to lower laterals, evaluate the check valves, or other design feature, that was intended to prevent this;

If commissioning records are not available, the minimum recommended distal pressure is 60 cm for 3/16" or larger orifices, and 150 cm for smaller orifices.

- Flush the system. If the force main has cleanout(s), then isolate all laterals, and then flush the force main first. Next, use the lateral isolation valves to increase the scouring velocity by directing the full pump flow to each lateral individually.
  - Based on the results of the flushing (above), consider additional pressure flushing, jetting, or vacuuming;
  - Flush the system on the established schedule, or when residual head falls more than 25% below commissioning records;
    - note that if tubes or clear pipes are used for testing, a 10% variation may be detectable;
  - when flushing laterals, note the extent, colour and consistency of any solids discharging from the cleanouts of each lateral;
  - When flushing laterals, the liquid that is flushed out of the laterals should be directed back into the distribution trench or bed. The liquid could also be directed into an acceptable container and disposed of properly *(example to the septic tank or to a vacuum truck)*; this is preferable where there are significant solids.
- The infiltration surface, as observed through a cleanout access or observation port, should drain quickly after the pump switches off. If it does not drain quickly, the cause should be investigated.
- If lateral valves were closed to flush the laterals, then reset the distal pressures (squirt heights) to ensure even distribution, consistent with the design and commissioning records. Record the squirt heights or pressures.
- Any flow control orifices should be cleaned, and checked for correct sizing with design specifications.
- Test the dosing application rate, and test the pump tank drawdown, and compare these to the commissioning data.

III- 7.3.8 SUBSURFACE DRIP DISPERSAL

For subsurface drip systems, advise the owner to ensure that vegetation re-establishes in the dispersal and receiving areas, and that access is restricted during the first year. On some sites, fencing may be needed until vegetation establishes, to avoid damage by deer or other animals.

After the first year of operation, lightweight track equipment may drive over the areas, but heavy rubber-tired vehicles should be kept off the drip dispersal area.

Regular maintenance should include collection of data as collected at commissioning, see Section III-6.11.3.6.

Maintenance tasks and considerations include those generally applicable to dosing and dispersal systems. An AP should consider the following additional tasks:

- Inspect and hand clean the fine filter(s).
- Open the field flush valves and manually flush the system.
- Check system pressures, and compare the pressures to the baseline data from commissioning records.
- Inspect and clean the air valve/vacuum breakers, and confirm proper operation. Consider regular replacement.
- Inspect and clean the field and filter flush valves, and confirm proper operation.
- Check the dispersal field for signs of breakout, surfacing effluent, leaks, and rodent problems, and confirm appropriate vegetation.
- Confirm continued protection of the dispersal area from traffic, animals, or other use that could compact soil or damage components.

See Section III- 6.11.2 for reference to the EPRI manual which includes guidance on maintenance for SDD systems.

III- 7.3.9 DOSING SYSTEMS AND CONTROLS

III- 7.3.9.1 Pump tanks:

- Inspect tanks as per Section III- 7.3.3.
- Visually inspect all electrical connections for signs of corrosion, black deposits on copper items that may indicate leakage of sewer gases and physical deterioration.
- Check that the high level or other alarm(s) are in working order.
- Check that float switches are performing properly.
- Visually inspect the control panel box for water tightness, condensation or corrosion.
- Check that the timer or control relays are functioning and that the control panel is functioning to design;
- Inspect the float levels and measure the drawdown time (demand), or the drawdown per dose and timer function (timed systems).
- Where a flow meter (installed or ultrasonic) is available, check and record the dosing flow rate and compare this to the commissioning record.
- Where a pressure test port is available, record the pressure during a dose event.
- Record pump run amperage. If the maintenance provider is not a certified electrician, then the pump amperage should only be recorded using a non-contact meter (for example, a clamp on meter) or a pre-installed meter.
- Use of a flow meter is an alternate method of assessing pump performance, and may be more easily used to analyse pump wear.

- Record the counter and pump run time information, and analyse this to determine the system flows. Check the run time against the dose time multiplied by pump starts. Due to inflow events on demand dosed systems, this will only provide an approximate check.
- For timed dose systems, record the pump cycle counter, the lag or override counter (if used) and the low and high level alarm log. Analyse this information in relation to design flows. Check the pump drawdown for one dose, and relate this to the commissioning tests. Where a pump run time meter is installed, check the run time is as expected.
- Inspect all plumbing fittings and connections.
- Check that the anti-siphon air valve, orifice (or other provision) is operating effectively to prevent pump tank contents siphoning to the field between doses.
- Check that all components are operating as per design.
- At 3 – 6 year intervals, or as needed based on monitoring, vacuum and clean out the pump tank. The pump and floats should also be washed down at this time, which will assist in assessing their condition.

III- 7.3.9.2 Siphon Systems

- A siphon system should be monitored for trickling failure. If this is found to have occurred, the cause should be determined.
- At 3 – 6 year intervals, or as needed based on monitoring, vacuum and clean out the tank. Wash down the siphon.
  - *As even a momentary blockage of the snifter tube may cause the siphon to enter trickling mode, the siphon chamber should be kept clean and leaves or other floating debris should not be left in the chamber.*
- Check the bell to ensure it is sitting level.
- Test siphon operation over one cycle by adding water to the dosing chamber.
  - Check that cycle counter is operating correctly.

III- 7.3.9.3 Floating outlet device systems

- Inspect the device for damage and test operation over one cycle by adding water to the dosing chamber.
  - Check that cycle counter is operating correctly.
- At 3 – 6 year intervals, or as needed based on monitoring, vacuum and clean out the tank. Wash down the floating outlet device.

III- 7.3.9.4 Zones and alternating systems

Maintenance of alternating fields should include proper alternation, and this should include monitoring of trenches for biomat condition. In a gravity system, a pipe camera can be used to assist in monitoring of biomat condition. Observation port monitoring, or the observation ports of a chamber system will also assist.

Zone valves should be checked for proper operation. Any check valves should be checked for proper operation.

III- 7.3.10 AT-GRADE BEDS, ALBERTA AT GRADE SYSTEMS, SAND MOUNDS AND SAND-LINED TRENCHES AND BEDS

- Follow the general maintenance provisions for dispersal systems and pressure distribution systems.
- Protect sand mounds and receiving areas from compaction by traffic.
- For bottomless sand filters, check the integrity of the membrane and any support materials.
- For Alberta At Grade systems, check the depth of wood chip cover over the chamber bed and in the toe area and add wood chips to maintain the minimum depth specified by the standards.
- Monitor all observation ports, both before and immediately after a dose from the pump tank
  - If effluent is observed ponding on the native soil surface, then find the cause and fix the problem. Potential causes include excess biomat accumulation due to poor oxygen infiltration resulting from over compacting cover soils, poor basal area preparation, hydraulic overloading, or water table mounding.
  - Severe clogging or hydraulic overloading at natural soil interface may cause surface seepage at the base of the mound. This may be due to improper installation, or to other factors such as overloading. If overloading is not the cause, this area should be permitted to dry; the downslope area re-prepared, and filter sand added. If this does not correct the problem, the system may need to be replaced (with a new filing).

For additional guidance, refer to Section III- 6.15.1.2(sand mounds), Section Figure III- 21 (at-grade beds) and Section III- 6.14.2 (Alberta At Grade systems).

III- 7.3.11 ET AND ETA BEDS

- Follow the relevant provisions of the Seepage Bed, gravity and pressure distribution systems sections.
- Vegetation should be maintained to provide good surface evaporation from the bed, as well as transpiration from the plants. Evapotranspiration will be lower with a thick grass mat.
- Check vegetation and the soil surface of the bed for signs of salt accumulation, if salt appears to be accumulating, consider application of gypsum and flushing of the bed. *Construction of additional bed capacity (under a new filing) may be helpful to allow alternating of beds, this can help to manage salt concentration in the soil.*
- Monitoring for ponding of effluent in the bed is critical, and should be carried out during times of the year when evapotranspiration is low. Monitor the observation ports for evidence that the bed needs cleaning.
- Instruct the owner to avoid compaction of snow cover over beds, to improve evaporation and sublimation.

If the fluid level in the bed consistently exceeds the maximum level established as part of the original design, inform the owner that it will be necessary to construct a new bed or bed section. This will require a filing

III- 7.3.12 BC ZERO DISCHARGE LAGOONS

Maintain the collection system, septic tank, dosing system etc. as for other systems.

- Check all plumbing fittings and ensure that piping is in operating condition.
- Measure the level of water in the lagoon, relative to the top of the berm.
- Maintain the fence and gate.

- Control vegetation growth, including both emergent aquatic vegetation, and trees or shrubs that may reduce evaporation potential, or may damage the berms.
- Check for animal damage and burrowing in the berms.

If the lagoon fluid level consistently exceeds the maximum freeboard level, then plan to enlarge the lagoon by constructing a new cell or a new lagoon. This will require a filing.

III- 7.3.13 DRAINAGE SYSTEMS

Standpipes may be installed to observe the water table in the dispersal area. The depth of the water table should be monitored annually, during the wet season. If the water table rises steadily over a period of years, consult a qualified AP for remedial action.

During the wet season, the drainage system itself should be checked and maintained, as follows:

- Check the drain observation ports, and record the water levels.
- Check the discharge point for adequate disposal, and check that the outflow is not eroding the soil, or causing other problems.
  - For drainage ditches: (1) Clear any vegetation that is restricting the flow; (2) Protect the ditch from erosion by regarding the ditch, planting grass, or armouring the ditch with drain rock or some other suitable protection.
- For drainage pipes, consider using a camera to check the following:
  - Restrictions due to rodent nests, or soil erosion;
  - If the pipe is uniform in shape and grade; and
  - the point(s) where groundwater is being intercepted.
    - Note that the rate of collection is important. Incoming flows that are very fast may carry dirt that may clog the drain rock or geotextile fabric.
  - Iron that may be leaching into the pipe (which can lead to a serious form of clogging over time.) If this or other mineral accumulation is a problem, agricultural drain cleaning and jetting techniques could be used.
- Repair broken or damaged outlet screens.

SEWERAGE SYSTEM
STANDARD PRACTICE MANUAL

VOLUME III APPENDICES

VERSION 3 SEPTEMBER 2014

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

BRITISH
COLUMBIA

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TECHNOLOGY
PROFESSIONALS
QUALIFIED. REGISTERED. ACCOUNTABLE.

Volume III Appendices Table of Contents

III- 8 APPENDICES

These appendices are provided for information only and do not form part of the standards of this Manual.

III- 8.1 Owner declaration

The following checklist is provided as a guideline to be considered when preparing an owner declaration:

- ☐ Legal description, civic address and tax assessment roll number for the subject property.
- ☐ The full legal name of the owner(s), and contact information.
- ☐ Lot plan and size of lot.
- ☐ Current or planned water source. For example, an approved community water system, an on-site water well or fresh water body such as lake or creek.
- ☐ Current and planned uses of the property e.g. residential only, commercial uses including home based business, or mixed commercial/residential.
- ☐ Current or planned size and use of non-residential buildings.
- ☐ Information regarding any wells located on the property, including well logs.
- ☐ Current or planned residence information including:
  - ☐ Living area and non-living area of the residence.
    - ☐ Caution owner that if an unfinished area is finished later, an upgrade to the sewerage system may be needed.
  - ☐ Number of bedrooms.
  - ☐ Anticipated typical number of occupants.
  - ☐ Water treatment devices e.g. water softeners, filtration systems, disinfection or similar devices.
  - ☐ Garbage grinders/in-sink garbage disposal units.
  - ☐ Any other anticipated usage patterns that may affect sewage volume or constituents. Examples include:
    - ☐ Frequent large numbers of guests.
    - ☐ Non-typical food processing such as canning, high volume of baking or deep frying, beer or wine making.
    - ☐ Home based businesses with associated sewage discharges.
    - ☐ Hobbies with associated sewage discharges (e.g. photography, painting, pottery).
- ☐ Information for the owner on their responsibilities under the SSR.
- ☐ A signed declaration statement by the owner(s) including the following:
  - ☐ Identification of ownership (who are the legal owners?).
  - ☐ Confirm the accuracy of information provided.
  - ☐ Understanding that system use (including the design flow) is to be per the filing submitted to the Health Authority.

The AP may choose to add a simple letter of engagement to the declaration, describing project roles, budget, etc.

III- 8.2 Residual Chlorine, water softener and other backwash water

This Manual recommends that water softener backwash water and other filter backwash, as well as any highly chlorinated water, is not discharged to the sewerage system.

This is to reduce risk of negative impact on treatment processes due to toxic compounds or due to high sodium levels causing stratification, as well as to avoid potential impact on soil structure from elevated sodium levels in effluent. A further risk that is avoided is the potential impact on water volume from the structure.

For water applied to the soil a residual Chlorine level of <1 mg/L is recommended as avoiding impact on plants. Refer to: R. R. Duncan, R. N. Carrow, and M. T. Huck, *Turfgrass and landscape irrigation water quality: Assessment and management.* CRC, 2008, for further information.

A properly maintained water softener of a type which is water conserving and which flushes only on demand (Demand Initiated Regeneration Control Device or "DIR") could discharge flush water to an onsite system without causing significant damage (and could, in some cases, assist, in relation to the same system with separate discharge, by replacing the calcium and magnesium removed by the softener). The low regeneration water use would also reduce the impact on the septic tank settling process.

However, the additional water flow and the risk of discharge of high concentrations of sodium (if the softener is not properly used or is not properly maintained) and of Chloride (in all cases) support the utilization of separate discharge. For further information refer to:

- R. J. Otis, J. Kreissl, Frederick, R. Goo, P. Casey, and B. Tonning, *Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008.* United States Environmental Protection Agency, Office of Water, Office of Research and Development., 2002; and
- A. Amoozegar, *"Impact of wastewater quality on the long-term acceptance rate of soils for on-site wastewater disposal systems,"* 1998.

III- 8.3 Soils

III- 8.3.1 SOIL TEST PIT LOG FORM

A template for record of soil test pit evaluation is provided (sized to copy to survey book sized paper at 4.5 by 7 inches); the AP can use these forms or can develop their own equivalent forms. An example of a filled form follows the blank forms.

The test pit log should record at minimum the information as shown in this template and as recommended in the standards.

Job:	Site:	Date: Recorded by:
Weather:	No/type of pits:	Surface water:
Slope:	Slope type:	Freq/duration:
Vegetation:	Sub storey:	Type of bedrock/limiting layer:
		Rock outcrops:
Notes:		

Slope type: LL, LV, LC, VL, VV, VC, CL, CV, CC Slope position: SU, SH, BS, FS, TS
Coarse fragments are > 2mm
Structure: GR, ABK, SBK, PL, WEG, PR, COL, SGR, MA, CDY Grade: 0, 1, 2, 3 (where 0 = structureless, 1 = weak, 2= moderate, 3 = strong)
Consistence dry: L, S, SH, MH, HA, VH, EH, R, VR Wet: L, VFR, FR, FI, VFI, EF, SR, R, VR. Cemented: NC, EW, VW, W, M, ST, VS, I
Redoximorphic: Quantity: f, c, m. Size: 0, 1, 2, 3, 4, 5, Distinctness: Faint = F, Distinct = D, Prominent = P
Roots: Size: VF, F, M, C, VC Quantity: few=1, common=2, many=3.

Profile Description

TP #: Site: Date: Slope: Veg.:

	Depth		Matrix Colour	Texture	C. Frags	Structure		Consis.	Roots Depth, sz/qty	Mottles Depth, qty.	Moist Seepg.
	From	To			Kind, %	Grade	Type				

Notes (Pores, cracks, other tests, samples):

Estimated WT: SHWT: R. Layer (Type, depth): Usable soil depth to limiting layer:

Example of filled site and test pit logs

Job: EXAMPLE OF FILLED TEST PIT LOG	Site:	Date: 11 Jan 2013 Recorded by:
Weather: Sun, 9C, wet weather in last week.	No/type of pits: 3, Machine dug	Surface water: NA
Slope: 4% in disp. Area and rec. area	Slope type: LL, BS (fld and rec area)	Freq/duration: NA
Vegetation: Douglas Fir, Arbutus	Sub storey: Dominant in field and receiving area: Oregon Grape, some Salal	Type of bedrock/limiting layer: Sandstone, fractured, fractures open
		Rock outcrops: None in field area
Notes:		

Profile Description

TP #: 1 Site: Date: 11 Jan 2013 Slope: 3.5%, LL, BS Veg.: As cover sheet

	Depth		Matrix Colour	Texture	C. Frags Kind, %	Structure		Consis	Roots Depth, sz/qty	Mottles Depth, qty	Moist Seepg
	From	To				Grade	Type				
1	0	6cm	Dk Brown	LS	10% gravel	0	SGR	L	6, F, 3	None	Moist
2	6	90	Brown	SL	15% gravel	2	GR	FR	90, C, 3	None	Moist
3	90	145	Brown	SL	45% gravel, C gr. and rock frag.	2	SBK	FI	145, F, 1	None	Moist
	145		Bottom of TP	Sandstone							No seep

Notes (Pores, cracks, other tests, samples): Hor. 3 (C Hor), large fissures, risk of macropore flow, high coarse frag content.

Estimated WT: None SHWT: None R. Layer (Type, depth): Frac Rock, 145 Usable soil depth to limiting layer: 145

III- 8.3.2 PERCOLATION TEST PROCEDURE

Use the following instructions to conduct a percolation test. This is the procedure for a percolation test in BC; other provinces and states may use a different procedure:

1. Perc test holes should be made at points and elevations selected as typical in the area of the proposed absorption field.
2. Typically, test holes are be dug at each end of the area of the absorption field and near the centerline. Testing of the receiving area may also be necessary. Further holes could be needed, depending upon the nature of the soil, the results of the first tests and the size of the proposed dispersal area.
3. Test holes should be 30 cm (12") square or 36 cm (14") round and excavated to the proposed depth of the absorption field (or as instructed by the designer). It is generally easiest to dig a larger hole part way down, then dig a 18 to 20 cm (7 to 8") deep accurately sized test hole in the base of the larger hole.
4. To make the percolation test more accurate, any smeared soil should be removed from the walls of the test holes. This is best achieved by digging the hole approximately 5cm undersized (2") and then enlarging the hole to the accurate size as follows: using a rigid knife, insert the blade into the top side of the hole opposite you approximately 2.5cm (1") deep, holding the blade with its cutting edge vertical. Pull the blade away to break out a chunk of soil, repeat about an inch (2.5cm) apart around the hole, then repeat for another "ring" below until reaching the base. The result will be a hole with a ragged inner surface which looks like a freshly broken clod of soil.
5. The base of the hole should be cleaned of debris and be approximately flat, use a metal scoop or similar. It should also be picked to present a natural surface. Note that a picking action (use a pointed tool) is needed, not a scratching action (which just produces smears that are indented).
6. Place 5 cm (2") of clean fine gravel in the bottom of the hole. If the sidewalls are likely to collapse, use a paper basket to support the sidewalls (see note below). Place a piece of white plastic or similar provided with clear marks at 5" and 6" from the bottom of the test hole prior to adding the gravel. For greater accuracy a float and pointer arrangement can be set up.
7. If the soil contains considerable amounts of silt or clay, and certainly for any soil with "clay" as part of the texture description, the test holes should be pre-soaked before proceeding with the test. Pre-soaking is accomplished by keeping the hole filled with water for 4 hours or more. The water should be added carefully and slowly to avoid disturbing the soil (including the sidewall soils). The test should be carried out immediately after pre-soaking;
8. To undertake the test, fill the test hole (the accurately sized test hole) with water. The water should be added carefully and slowly to avoid disturbing the soil (including the sidewall soils). When the water level is 5" or less from the bottom of the hole, refill the hole to the top. No recording of time needs be done for these 2 fillings.
9. When the water level, after the second filling (procedure (8)) is 5" or less from the bottom of the hole, add enough water to bring the depth of water to 6" or slightly more. Note that these measurements are from the base of the soil bottom (using the marker installed in step (6)), not the gravel layer.
10. Observe the water level until it drops to the 6" depth, at precisely 6", commence timing, when the water level reaches the 5" depth, stop timing, record the time in minutes.
11. Repeat procedures (9) and (10) until the last 2 rates of fall do not vary more than 2 minutes per inch or by more than 10% (whichever is less).
12. Report slowest rate for each hole.

13. Backfill the holes with the excavated soil and flag and label their locations so you can pick them up for the plan.

If a test hole is discarded due to flow in a root channel or similar, record the information and make a replacement test. If there is a large variation (greater than or equal to 50%) between tests in the same soil layer, increase the number of tests.

III- 8.3.2.1 Paper basket to protect hole

If sidewalls of the hole are likely to collapse, one option is to make a paper basket to protect and support the sidewalls as follows:

1. Cut the bottom out of a large paper bag (grocery bag) and cut the bag open along a side.
2. Lay bag on a soft surface. Punch holes in the bag about 5 to 7.5 cm (2 to 3 inches) apart using a pencil or similar.
3. Roll into a tube, with the short dimension being the axis of the tube, and place in the test hole.
4. Open the tube until the paper is in contact with the sidewalls of the test hole, then roll the top of the tube over to stiffen it.
5. After placing the tube in the hole, place the plastic marker and add the base gravel layer.

III- 8.3.2.2 Percolation rate for design

Select the percolation rate to be used for sizing of the dispersal area. This will be the median (middle) value from all the tests conducted.

III- 8.3.2.3 Percolation test form

Percolation test

Location (address):								File #:
Date:		Tested by:						
Weather:								
Test number	Depth of base of hole from surface (cm)	Timings, mins per inch for water to drop from 6″ to 5″ from base of hole.						Lowest rate (min per inch)
		#1	#2	#3	#4	#5	#6	
1								
2								
3								
4								
5								
6								
7								
8								
Percolation rate for system sizing								
Notes:								

III- 8.3.3 CONSTANT HEAD BOREHOLE PERMEAMETER TEST PROCEDURE

Use the following instructions to conduct a constant-head borehole permeameter test using a Pask (constant head borehole) Permeameter. Other borehole permeameters may be used; however, these instructions relate only to the Pask permeameter. This information is based on Appendix C of the Nova Scotia Sewage Disposal Guideline that can be found at the following web site:

http://www.gov.ns.ca/nse/wastewater/sewagedisposalguide.asp

The permeameter test measures the permeability (also called hydraulic conductivity) of the soil at the bottom of a borehole, above the water table. The test measures the hydraulic conductivity by temporarily saturating the soil at the bottom of the borehole. It measures the "field-saturated hydraulic conductivity", which is commonly abbreviated as Kfs.

The first step is to make or buy a permeameter. See the Nova Scotia Guideline for instructions on building a permeameter. This is a simple device to make, but the clear plastic tube (pipe) may be expensive or difficult to source. To avoid the clear plastic pipe, common white PVC pipe may be used with a sight gauge constructed from clear plastic tubing (Tygon or similar). Many permeameters have a screw cap rather than a rubber stopper at the bottom. Some permeameters have a ball valve on the lower tube; this is useful but not necessary. There are companies that make and sell permeameters and suitable soil augers.

The upper clear plastic tube or pipe is a small water reservoir. Convenient dimensions are 9-10 cm inside diameter and 60 cm length, but this reservoir can be different diameters or lengths. A smaller diameter reservoir is more accurate for low-permeability soils and uses less water. You will need to know the inside diameter of the tube in order to calculate the volume of water draining into the borehole.

III- 8.3.3.1 Equipment and supplies:

MANDATORY:

- Permeameter.
- Supply of water. The test uses about 4 liters per test, if using a 10 cm diameter permeameter. A 5-cm permeameter uses about one liter per test. Water is usually supplied by garden hose or Gerry cans.
- Hand auger. A commonly used auger has a 7 cm auger bit, but you can use augers of different diameters.
- Wristwatch with second hand, or other timer with minutes and seconds.
- Pre-printed forms. See the following pages for a blank form and an example completed form.

OPTIONAL:

- Wire brush, or length of pipe with protruding screws, or similar device to roughen smeared soils.
- Tripod, sawhorse, or other method to hold the permeameter vertical during the test. This can be useful for shallow auger holes, or if conducting two of more tests at the same time.
- Digging bar or steel probe. This is useful for gravelly or stony soils.

III- 8.3.3.2 Test procedure:

Select the locations and depths for the auger holes. A common layout is to auger four holes, one at each corner of the proposed dispersal area. Testing in the receiving area may also be needed, and testing of deeper soil layers may also be useful or needed.

Holes should be augered to the same depth as the planned depth of the infiltration surface. For sand mounds and at-grade beds, the auger hole depth should be 25 to 35 cm. When augering the hole, do not use excessive downward pressure on the auger and in general it is best to remove the auger after maximum two turns to remove soil, this is intended to reduce soil compaction.

- At each location, auger a hole to the required depth. In stony soil, it may help to probe using a digging bar or steel rod, to find a suitable location to auger a hole.
  - If the sides of the auger hole are smeared, gouge, pick or roughen the side walls with a wire brush, ice pick or other sharp object. Important: If you roughen or gouge the side walls of the auger hole, you will also need to take equal care to prepare the bottom and side walls (the infiltration surface) of the dispersal system.
- Measure and record the diameter of the auger hole.
- Complete the top part of the permeameter form.
- Write down the soil texture and structure.
- Turn the permeameter upside down, remove the plug, fill with water up to the "air inlet hole", and then replace the plug.
- Fill the auger hole to a water depth of about 25 cm.
- Place the permeameter in the auger hole, with the "water drain slots" at the bottom of the hole.
- Watch the clear plastic tube for large bubbles rising from the bottom.
- As soon as the large bubbles appear, start taking readings of the height of water in the clear plastic tube (in millimeters), taking one reading every minute. If the rate of fall is very fast, you can take one reading every 30 seconds. If the rate of fall is very slow, you can take one reading every two minutes or more.
- During the test, record the rate of fall of the water level in mm per minute.
- When the rate of fall stabilizes, the test is complete. The rate of fall is stable if the fall is nearly equal for three consecutive readings. With most soils, this takes 4 to 20 minutes.
- After the test, if a flow restrictive horizon is suspected close to the base of the hole, then auger or probe to this horizon and measure the depth.
- Repeat for the remaining auger holes.
- Calculate the Kfs for each of the test holes, using the calculation method below.

III- 8.3.3.3 Calculation Method:

- Write down the final stable rate of fall in the water level, in millimetres per minute.
- Calculate the Flow Rate (Q) by multiplying the rate of fall by the volume Conversion Factor. Table III- 21 shows the factor for permeameters of various diameters.

Table III- 21. Permeameter calculation factors

INSIDE DIAMETER OF THE RESERVOIR (CM)	FACTOR
10.23	8.22
10.16	8.10
5.25	2.17

- For other sizes of permeameters, the conversion factor may be calculated as follows:
    - R = Radius in cm = Inside Diameter ÷ 2.
    - Conversion Factor = 0.3142 x R x R.
- Write the flow rate on the form, in mL / minute.
- Use the chart (at the bottom of the page) to select the Soil Factor (F), based on the type of soil and the diameter of the auger hole.
- Calculate the Kfs. This is the Flow Rate (Q) multiplied by the Soil Factor (F), Kfs = Q x F.
- Write this in the space at the bottom left part of the form.
- If the highest measured Kfs is more than 10 times higher than the lowest, then the minimum allowable number of tests is six. *This is because of the high variability of the soil.*
- Select the Kfs to be used for sizing of the dispersal area. This will be the median or middle value from all the tests conducted.

Mathematical-minded APs may want to set up a spreadsheet to calculate Kfs from the measured rate of fall, using the formulas in the referenced web site and other technical papers.

III- 8.3.3.4 Special Situations:

Site with a very shallow flow-restrictive horizon:

If the flow-restrictive horizon is within about 30 cm of the bottom of the auger hole, then the calculated Kfs may be lower than the true Kfs. If it is important to calculate a more accurate Kfs, then one option is to use the modified Glover formula, as outlined in the Permeameter Appendix (below).

III- 8.3.3.4.(a) Testing in hot weather:

If the temperature of the water used for the permeameter test is above 25 degrees Celsius, then the test results should be adjusted according to the procedure on pages C-2 and C-3 of the following reference:

http://www.gov.ns.ca/nse/water/docs/OSTG_11-Section11-TechGuideAppendix.pdf

III- 8.3.3.5 Troubleshooting:

III- 8.3.3.5.(a) Water level falls too fast:

If the reservoir water level falls too fast to measure, then it is only practical to estimate the lower limit of the soil permeability. The Kfs should be reported as: “greater than 30,000 mm/day”. In this situation, conduct at least eight permeameter tests.

A rapidly falling water level could also be caused by a large pore, such as an old root channel. In this case the problem can be noted and further tests done to confirm the soil permeability.

III- 8.3.3.5.(b) Water level is static; does not change:

In soils of very low permeability, if the auger hole fills with water to above the air hole, the water will drain slowly, delaying the start of the test. Gently remove some water from the auger hole to expose the air hole and start the test. If the reservoir still does not drain, this indicates soil of very low permeability, and the Kfs should be reported as "less than 10 mm/day".

The soil can be re-tested using a smaller diameter permeameter and a larger diameter auger hole.

It may help to try permeameter tests at different depths or at different locations. Testing at different depths and locations will help in selecting the best location for the dispersal system and the best depth for the infiltration surface.

III- 8.3.3.5.(c) Water level drops very slowly:

In soils of low permeability, the permeameter water level may drop very slowly, about one millimeter per minute. Potential strategies for low permeability soils include: (1) re-test at different locations on the property; (2) re-test at different depths; (3) roughen or scarify the side walls of the auger hole; (4) re-test using a smaller diameter permeameter and larger diameter auger hole; (5) use an alternate permeability test method, such as a ring infiltrometer.

III- 8.3.3.6 Permeameter test form

Location (address):		File #:
Auger hole #:	AH location:	
AH depth:	AH diameter (at bottom of hole): cm	Date:
Height of air hole: 20 cm	Permeameter inside diameter: cm	Tested by:

Constant Head Borehole Permeameter Test Results

Time of day	Total elapsed time *min*	Interim time *min*	Water level reading *Mm*	Drop in level *mm*	Rate of fall *mm/min*	Remarks or Observations
	0					Start of test
						Soil texture:
						Structure:
Stable rate of fall in mm / minute =						

For small (5.25 cm) permeameter: Flow rate (Q) = (Rate of fall) x 2.17 = ... mL / min

For large (10.23 cm) permeameter: Flow rate (Q) = (Rate of fall) x 8.22 = ... mL / min

Calculations Reference: Mooers, J.D., and D.H. Waller, 1993.

Soil factor (F) as a function of auger hole diameter and soil type:

AH diameter	7 cm	8 cm	9 cm	10 cm	11 cm	12 cm	18 cm	20 cm	22 cm	
Gravelly sand and coarse sand	8.9	8.1	7.5	7.0	6.6	6.2	4.5	4.2	3.9	
Fine-medium sand, loamy sand, sandy loam, structured soils	7.2	6.6	6.1	5.7	5.3	5.0	3.7	3.4	3.2	
Massive clays and silts	4.4	4.1	3.8	3.6	3.4	3.2	2.5	2.3	2.1	

Kfs = Q x F = x = mm/d

Example of a completed permeameter test form:

Location (address): Lot 11, Any Road, No Town, BC		File #: PLS-3
Auger hole #: 2	AH location: 5 m east of test pit TP-3	
AH depth: 60 cm	AH diameter (at bottom of hole): 18 cm	Date: 22 July 2008
Height of air hole: 20 cm	Permeameter inside diam: 10.23 cm (4")	Tested by: JPL

Constant Head Borehole Permeameter Test Results

Time of day	Total elapsed time *min*	Interim time *min*	Water level reading *mm*	Drop in level *mm*	Rate of fall *mm/min*	Remarks or Observations
09:41	0	1.0	155			Start of test
	1		140	15		
	2		125	15		
	3		110	15		
	4		98	12		
	5		82	16		
	6		70	12		
	7		55	15		Soil texture: Sandy loam.
						Structure: ABK 2
						Angular blocky – moderate
Stable rate of fall in mm / minute =					15	

For small (5.25 cm) permeameter: Flow rate (Q) = (Rate of fall) x 2.17 = N/A mL / min

For large (10.23 cm) permeameter: Flow rate (Q) = (Rate of fall) x 8.22 = 123 mL / min

Calculations

Reference: Mooers, J.D., and D.H. Waller, 1993.

Soil factor (F) as a function of auger hole diameter and soil type:

AH diameter	7 cm	8 cm	9 cm	10 cm	11 cm	12 cm	18 cm	20 cm	22 cm
Gravelly sand and coarse sand	8.9	8.1	7.5	7.0	6.6	6.2	4.5	4.2	3.9
Fine-medium sand, loamy sand, sandy loam, structured soils	7.2	6.6	6.1	5.7	5.3	5.0	**3.7**	3.4	3.2
Massive clays and silts	4.4	4.1	3.8	3.6	3.4	3.2	2.5	2.3	2.1

Kfs = Q x F = 123 x 3.7 = 455 mm/d

Comment: The Kfs can be rounded off to 460 mm/d.

III- 8.4 Sodium and soil dispersion

Sodium and salinity in wastewater can affect clay-rich soil in the dispersal area.

Over time, sodium may build up in the soil. This can disperse or expand the clay, breakdown of the soil peds, and collapse the soil structure. These processes reduce the soil permeability.

In high rainfall areas, infiltrating rainfall may leach the sodium from the soil, reducing the impact of sodium. On the other hand, in areas with lower rainfall and higher evapotranspiration, sodium concentrates in the soil over time, either from effluent or from irrigation water. This may also occur with ET and ETA beds, where the sodium may affect plants growing in the beds.

The effect of structural degradation of soil, resulting from sodium levels in wastewater, will tend to be more evident with Type 2 and 3 effluents. This is because:

- With Type 1 effluent, the Biomat itself tends to be the limiting factor for long term acceptance rate.
- Type 2 and 3 effluents are typically applied at higher rates, leading to higher mass loading of sodium to the soil.

It is important to limit sodium concentrations in domestic wastewater, particularly in low rainfall areas. One way to decrease sodium loading is to use low-sodium detergents.

For further information on Sodium, salinity and dispersive soils see the following references:

- *Environment & Health Protection Guidelines On-site Sewage Management for Single Households*, NSW EPA
  - http://www.dlg.nsw.gov.au/DLG/Documents/information/onsite.pdf
- van de Graaff, R and Patterson, R.A. (2001) *Explaining the Mysteries of Salinity, Sodicity, SAR and ESP in On-site Practice* in Proceedings of On-site '01 Conference: Advancing On-site Wastewater Systems by R.A. Patterson & M.J. Jones (Eds). Published by Lanfax Laboratories, Armidale
  - http://www.lanfaxlabs.com.au/papers/P47-mysteries.PDF
- *Impact of Wastewater Quality on the Long-Term Acceptance Rate of Soils for On-Site Wastewater Disposal Systems* Report 316 July 1998 , Aziz Amoozegar Department of Soil Science, North Carolina State University
- Crites and Tchobanoglous, *Small and decentralized wastewater management systems*, WCB, (1998).
- USEPA *Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3,* included in R. J. Otis, J. Kreissl, Frederick, R. Goo, P. Casey, and B. Tonning, *Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008.* United States Environmental Protection Agency, Office of Water, Office of Research and Development., 2002.
- *Dispersive soils: a review from a South African perspective*, BELL F. G.; MAUD R. R.; Quarterly journal of engineering geology (Q. J. Eng. Geol.) ISSN 0481-2085, 1994, vol. 27, no3, pp. 195-210.
- CSA B65, which provides (Table 3) guidance on suitability of soils for effluent loading based on soil sodium absorption ratio, exchangeable sodium percentage and salinity.

III- 8.5 System Selection Worksheet template

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil texture			
Soil structure and consistence			
Other soil notes			
Kfs			
Percolation rate			
Soil depth			
Slope %			
Slope shape, location			
Elevation house sewer to dispersal area			
Temperature			
Net positive evapotranspiration?			
Rainfall?			
Soil constraints?			
House bedrooms			
House area			
Occupants			
Daily Design Flow			
Daily Design Flow, option 2			

ITEM	VALUE	CONSTRAINT, OPPORTUNITY, RESULT	SOLUTION AND RATIONALE
Soil depth and VS options, distribution and dosing options			
Horizontal separation constraints?			
HLR for Type 1			
HLR for sand			
HLR for Type 2			
Minimum system contour length			
Dispersal area size and options			
Length constraint?			
Other considerations			
System summary			

III- 8.6 Imperial conversion of standards tables

For information only this appendix provides selected standards tables converted from metric to Imperial measurements. Where gallons are shown, these are Imperial gallons (IG).

This Manual uses measurements and volumes in metric units. The AP may use conversion tables or calculators to convert those measurements to Imperial measurements.

APs may use these converted tables if working in Imperial measurement. However, in case of any inconsistency with the standards tables, the standards are the definitive version. Refer to the standards for table footnotes and other supporting information.

Since conversions include rounding of figures some converted figures may result in slightly larger system size or slightly larger separations.

III- 8.6.1 DESIGN FLOW TABLES

Table III- 22. Minimum Daily Design Flow (DDF) for Residences (IG/day)

NUMBER OF BEDROOMS	MAXIMUM FLOOR AREA (FT^2)	DDF IG/DAY
1	1500	150
2	2500	220
3	3000	290
4	3500	350
5	4500	420
6	5500	480
Additional bedroom, add		66
Additional 10 ft.^{2}		0.66

Table III- 23. Per capita Daily Design Flow for Residences (IG/day)

USE	PER PERSON FLOW (IG/DAY)
Single family dwelling	77
Multi-family (apartment)	66
Luxury homes	154
Seasonal cottage	55
Mobile home	66
NUMBER OF BEDROOMS	**MINIMUM NUMBER OF OCCUPANTS**
1	2
2	3
3	3.75
4	4.5
5	5.5
6	6.5

III- 8.6.2 MINIMUM VERTICAL SEPARATION TABLES

Minimum vertical separations are shown in inches.

Table III- 24. For gravity distribution systems (inches)

SOIL TYPE	EFFLUENT TYPE	MINIMUM VERTICAL SEPARATION (VS) IN NATIVE SOIL
o Gravelly Sand or Coarse Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand o Or Kfs from 1,500 to 17,000 mm/day o Or Perc rate 0.5 to less than 5 min/inch	All types (I, 2 or 3)	60
Fine Sand, Loamy Fine Sand, Sandy Loam, Loam	1 or 3	36
	2	48
Silt Loam, Silt	All types	48

Table III- 25. For uniform distribution with demand dosing to native soil or native soil plus less than 12 in. sand fill (inches)

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
o Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand o **Or** Kfs from 1,500 to 17,000 mm/day o **Or** Perc rate from 0.5 to less than 5 min/inch	Demand dosing	1 or 3	24	24
		2	24	34
	Low frequency demand dosing	1 or 3	30	30
		2	36	36
Other soils	Demand dosing	All types	24	24
	Low frequency demand dosing	All types	28	28

Table III- 26. For uniform distribution with timed or micro-dosing to native soil or native soil plus less than 12 in. sand fill (inches)

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR)	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
○ Very or Extremely Gravelly Sand or Coarse Sand ○ **Or** Kfs greater than 17,000 mm/day ○ **Or** Perc rate faster than 0.5 min/inch	Timed dosing	All types	24	34
	Micro-dosing	All types	18	30
○ Gravelly Sand, Coarse Sand, Loamy Coarse Sand, Sand and Loamy Sand ○ **Or** Kfs from 1,500 to 17,000 mm/day ○ **Or** Perc rate from 0.5 to less than 5 min/inch	Timed dosing	1 or 3	18	24
		2	18	30
	Low frequency Timed dosing	1 or 3	24	30
		2	28	34
	Micro-dosing	All types	18	22
Other soils	Timed dosing	All types	18	24
	Low frequency timed dosing	All types	28	28
	Micro-dosing	All types	18	22

Table III- 27. For sand mounds and sand lined trenches and beds (inches)

SOIL TYPE	TYPE OF DOSING	EFFLUENT TYPE (HLR USED)	MINIMUM VS IN NATIVE SOIL	MINIMUM SAND MEDIA THICKNESS	MINIMUM AS CONSTRUCTED VS
All soil types	Demand dosing	1	10	24	34
	Timed dosing	1	10	18	30
	Micro-dosing	1 or 3	10	12	24
		2	10	18	30

Table III- 28. For Subsurface Drip Dispersal (SDD) systems with micro-dosing (inches)

SOIL TYPE	INSTALLED IN	EFFLUENT TYPE	MINIMUM VS IN NATIVE SOIL	MINIMUM AS CONSTRUCTED VS
o Gravel and Very or Extremely Gravelly Sand or Coarse Sand o Or Kfs greater than 17,000 mm/day o Or Perc rate faster than 0.5 min/inch	Native soil	All types	24	
	Fill material	All types	18	24
Other soils	Native soil	All types	18	
	Fill material	All types	18	24

III- 8.6.3 HORIZONTAL SEPARATION TABLES

Numbered notes refer to footnotes to the standards table. See Section II- 5.4.1.

Table III- 29. Minimum required horizontal separation distances (feet)

MINIMUM HORIZONTAL DISTANCE TO	FROM DISPERSAL SYSTSEM	FROM WATERTIGHT TREATMENT OR PUMP TANK
	FEET	FEET
Wells		
Surface source of drinking water	100	50
Domestic water supply well[1]	100	100
Domestic water supply well, high pumping rate[2]	200	100
Domestic water supply well, high pumping rate, in unconfined aquifer[2]	300	100
Irrigation well or open loop geothermal well	50	25
Deep monitoring well or closed loop geothermal well[3]	20	20
Shallow monitoring well[4]	10	0
Drinking water lines and cisterns		
Drinking water suction line	100	50
Drinking water suction line, sleeved	25	10
Drinking water lines, under pressure	10	10
Drinking water lines, under pressure, sleeved[5]	3	3
Drinking water supply cistern, below ground	50	10
Water bodies and surface breakout		
Permanent fresh water body[6]	100	33
Intermittent fresh water body[7]	50	33
Marine water body[8]	50	25
Break-out point or downslope drain[9]	25	0

Table III- 30. Minimum required horizontal separation for BC Zero discharge lagoons (feet)

MINIMUM HORIZONTAL DISTANCE TO	FROM LAGOON
	FEET
Wells	
Surface source of drinking water	100
Domestic water supply well[1]	100
Domestic water supply well, high pumping rate[2]	200
Domestic water supply well, high pumping rate, in unconfined aquifer[2]	300
Irrigation well or open loop geothermal well	50
Deep monitoring well or closed loop geothermal well[3]	20
Shallow monitoring well[4]	10
Drinking water lines and cisterns	
Drinking water suction line	100
Drinking water suction line, sleeved	50
Drinking water lines, under pressure	25
Drinking water lines, under pressure, sleeved[5]	25
Drinking water supply cistern, below ground	100
Water bodies and surface breakout	
Permanent fresh water body[6]	100
Intermittent fresh water body[7]	50
Marine water body[8]	100
Break-out point or downslope drain[9]	50
Other	
Building, dwelling	60
Building, other than dwelling	15
Property line	15

III- 8.6.4 HYDRAULIC LOADING RATES

Table III- 31. Maximum allowable HLR based on soil type (IG/day/ft^2)

SOIL TEXTURE GROUP	STRUCTURE AND CONSISTENCE CATEGORY	TYPE 1 (IG/DAY/FT^2)	TYPE 2 (IG/DAY/FT^2)	TYPE 3 (IG/DAY/FT^2)
Gravel and Very or Extremely Gravelly Sands	F or P	0.91	1.32	3.06
Gravelly Sands and Coarse Sand	F	0.81	1.32	2.65
	P	0.71	1.32	2.45
Sand, Loamy Sand	F	0.61	1.22	1.83
	P	0.55	1.02	1.63
Fine Sands, Loamy Fine Sands, Sandy Loams	F	0.55	1.02	1.63
	P	0.47	0.91	1.43
	VP	0.34	0.81	1.02
Loam, Silt Loam, Silt	F	0.47	0.81	1.43
	P	0.30	0.61	1.02
	VP	0.24	0.51	0.71
Clay Loam, Sandy Clay Loam, Silty Clay Loam	F	0.30	0.51	0.81
	P	0.24	0.30	0.40
	VP	NA	NA	NA
Sandy Clay, Silty Clay, Clay	F	0.24	0.30	0.40
	P	NA	0.30	0.30
	VP	NA	NA	NA

Table III- 32. Maximum allowable HLR based on permeability or percolation rate (IG/day/ft^2)

KFS RANGE (MM/DAY)	PERCOLATION TEST RANGE (MIN/INCH)	TYPE 1 (IG/DAY/FT^2)	TYPE 2 (IG/DAY/FT^2)	TYPE 3 (IG/DAY/FT^2)
> 8000	< 1.0	0.91	1.32	3.06
4000 – 8000	1 – 2	0.91	1.32	2.65
2000 – 4000	2 – 4	0.71	1.32	2.04
1000 - 2000	4 – 7.5	0.61	1.22	1.83
550 – 1,000	7.5 – 15	0.55	1.02	1.63
300 - 550	15 – 30	0.47	0.81	1.43
150 – 300	30 – 60	0.30	0.51	0.81
75 – 150	60 – 120	0.24	0.30	0.40
< 75	> 120	NA		

III- 8.6.5 LINEAR LOADING RATES

Table III- 33. LLR based on soil type (IG/day/ft.)

SOIL TEXTURE GROUP	CATEGORY	SLOPE 0 TO < 5%				SLOPE 5 TO < 10%				SLOPE 10% TO < 15%				SLOPE ≥ 15%			
		(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE			
		10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36
Very or Extremely Gravelly Sands	F or P	10.1	17.5	22.8	26.9	19.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
Gravelly Sands and Coarse Sand	F	5.7	9.4	12.1	16.8	10.1	16.8	22.2	26.9	17.5	26.9	26.9	26.9	24.2	26.9	26.9	26.9
	P	3.4	5.4	7.4	9.4	5.4	9.4	12.1	16.8	9.4	16.1	20.8	26.9	13.5	22.2	26.9	26.9
Sand, Loamy Sand	F	3.1	4.1	4.7	6.1	3.7	5.7	7.4	10.1	6.1	9.4	12.1	16.1	8.1	12.8	16.1	22.8
	P	3.1	3.7	4.7	4.7	3.4	4.1	5.1	6.1	4.1	6.1	7.4	9.4	5.4	8.1	10.1	13.5
Fine Sands, Loamy Fine Sands, Sandy Loams	F	3.1	3.7	4.7	4.7	3.4	4.1	5.1	5.1	4.1	5.1	6.1	6.8	5.1	6.1	7.4	8.8
	P	2.7	3.1	3.7	3.7	3.1	3.4	3.7	4.1	3.4	3.7	4.1	4.4	4.1	4.4	5.1	5.4
	VP	1.7	2.1	2.4	2.4	1.7	2.4	2.7	2.7	2.1	2.4	2.7	2.7	2.4	3.1	3.4	3.4
Loam, Silt Loam, Silt	F	2.7	3.1	3.7	3.7	3.1	3.4	3.7	4.1	3.4	3.7	4.1	4.4	4.1	4.4	5.1	5.4
	P	2.1	2.4	2.7	2.7	2.4	2.7	3.1	3.1	2.4	3.1	3.4	3.7	3.1	3.4	4.1	4.4
	VP	1.2	1.5	1.8	1.8	1.3	1.7	1.9	1.9	1.5	1.7	2.1	2.1	1.7	2.1	2.4	2.4
Clay Loam, Sandy Clay Loam, Silty Clay Loam	F	2.1	2.4	2.7	2.7	2.4	2.7	3.1	3.1	2.4	3.1	3.4	3.7	3.1	3.4	4.1	4.4
	P	1.7	2.1	2.4	2.4	1.7	2.4	2.7	2.7	2.1	2.4	2.7	2.7	2.4	3.1	3.4	3.4
	VP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sandy Clay, Silty Clay, Clay	F	1.7	2.1	2.4	2.4	1.7	2.4	2.7	2.7	2.1	2.4	2.7	2.7	2.4	3.1	3.4	3.4
	P	1.2	1.5	1.8	1.8	1.3	1.7	1.9	1.9	1.5	1.7	2.1	2.1	1.7	2.1	2.4	2.4
	VP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table III- 34. LLR based on permeability or percolation rate (IG/day/ft.)

KFS (MM/DAY)	PERCOLATION RATE (MIN/INCH)	SLOPE 0 TO < 5%				SLOPE 5 TO < 10%				SLOPE 10% TO < 15%				SLOPE ≥ 15%			
		(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE				(IN) SOIL DEPTH BELOW INFILTRATIVE SURFACE			
		10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36	10 – 18	18 – 24	24 – 36	≥ 36
> 17,000	< 0.5	10.1	17.5	22.8	26.9	19.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
8000-17000	0.5 – 1.0	5.7	9.4	12.1	16.8	10.1	16.8	22.2	26.9	17.5	26.9	26.9	26.9	24.2	26.9	26.9	26.9
4000 – 8000	1 – 2	3.4	5.4	7.4	9.4	5.4	9.4	12.1	16.8	9.4	16.1	20.8	26.9	13.5	22.2	26.9	26.9
2000 – 4000	2 – 4	3.1	3.7	4.7	6.1	3.7	5.7	7.4	10.1	6.1	9.4	12.1	16.1	8.1	12.8	16.1	22.8
1000 - 2000	4 – 7.5	3.1	3.7	4.7	4.7	3.4	4.1	5.1	6.1	4.1	6.1	7.4	9.4	5.4	8.1	10.1	13.5
550 – 1,000	7.5 – 15	3.1	3.7	4.7	4.7	3.4	4.1	5.1	5.1	4.1	5.1	6.1	6.8	5.1	6.1	7.4	8.8
300 - 550	15 – 30	2.7	3.1	3.7	3.7	3.1	3.4	3.7	4.1	3.4	3.7	4.1	4.4	4.1	4.4	5.1	5.4
150 – 300	30 – 60	2.1	2.4	2.7	2.7	2.4	2.7	3.1	3.1	2.4	3.1	3.4	3.7	3.1	3.4	4.1	4.4
75 – 150	60 – 120	1.7	2.1	2.4	2.4	1.7	2.4	2.7	2.7	2.1	2.4	2.7	2.7	2.4	3.1	3.4	3.4
< 75	> 120	NA															

III- 8.7 Septic tank projected pump out intervals

Table III- 35 provides likely pump out intervals for septic or trash tanks. However, regular monitoring of the scum and sludge levels is the best way to determine a pump out frequency for a specific installation.

As some digestion of sludge and reduction of sludge volume occurs after approximately three years, it is not appropriate to pump out tanks when sludge/scum accumulations do not need pump out.

Table III- 35. Estimated Septic Tank Pumping Frequencies in Years

TANK VOLUME (LITRES)	TANK VOLUME (IMP. GAL.)	HOUSEHOLD OCCUPANCY (NUMBER OF PEOPLE)					
		2	4	6	8	10	12
		PUMPING FREQUENCY IN YEARS					
2,300	500	8.0	2.9	1.6	1.0	0.7	0.6
2,700	600	10.5	3.7	2.1	1.3	1.0	0.7
3,405	750	14.6	5.2	2.9	1.9	1.3	1.0
4,100	900		6.8	3.7	2.4	1.8	1.3
4,500	1,000		8.0	4.4	2.9	2.1	1.6
5,000	1,100		9.2	5.0	3.3	2.4	1.8
5,900	1,300		11.8	6.5	4.2	3.0	2.3
6,800	1,500			8.0	5.2	3.7	2.9
7,300	1,600			8.8	5.7	4.1	3.1

Notes:

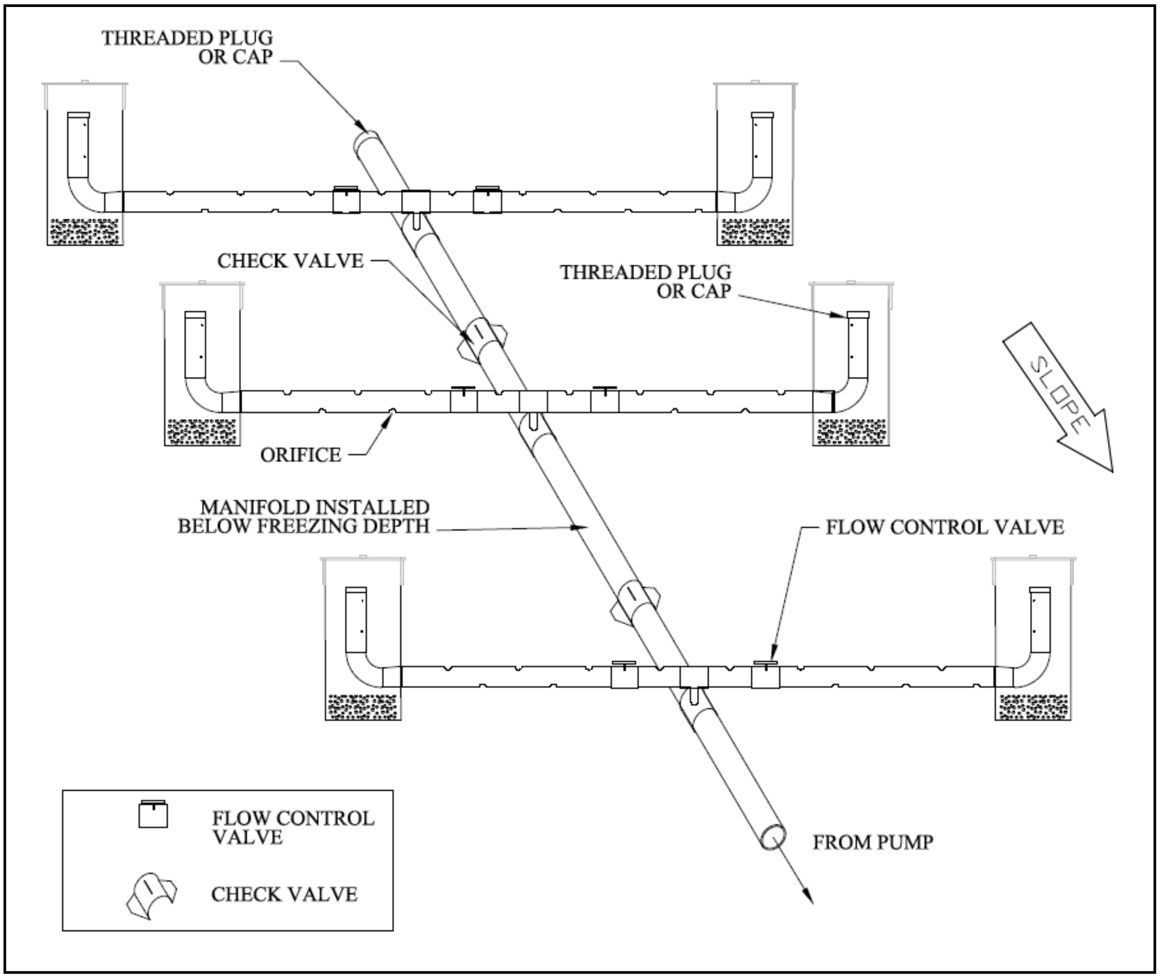
- For year-round residences, based on accumulation rates from Bounds;
  - T. R. Bounds, "Design and performance of septic tanks," Site Characterization and Design of On-Site Septic Systems, p. 217, 1997.
- Entries above thick line show septic tank sizes that are not recommended.
- Local government bylaws may require pump out at a particular schedule.

III- 8.8 Pressure distribution system information

III- 8.8.1 OPTIONS FOR PREVENTING DRAIN DOWN OF UPPER TO LOWER LATERALS ON SLOPING SITES

On sloping sites, prevent effluent draining from higher laterals to lower laterals after a dose. Ensure that all laterals operate at equal flow per basal area. See the schematic diagrams below for strategies.

Figure III- 31. Tee to Tee Manifold, with Check Valves.



Note: Check valves should be installed with unions and access boxes for service.

This technique can also be used with the laterals dipping from the manifold connection tee to the lateral trench. If the dip is sufficient, this will prevent upper laterals siphoning down to the lower laterals. In this case the check valves will not be needed. This also allows a good undisturbed soil dam to be left between the manifold and lateral trenches.

Prevent effluent concentrating in the manifold or force main trenches.

Figure III- 32. **Cross Manifold, with Check Valves.**

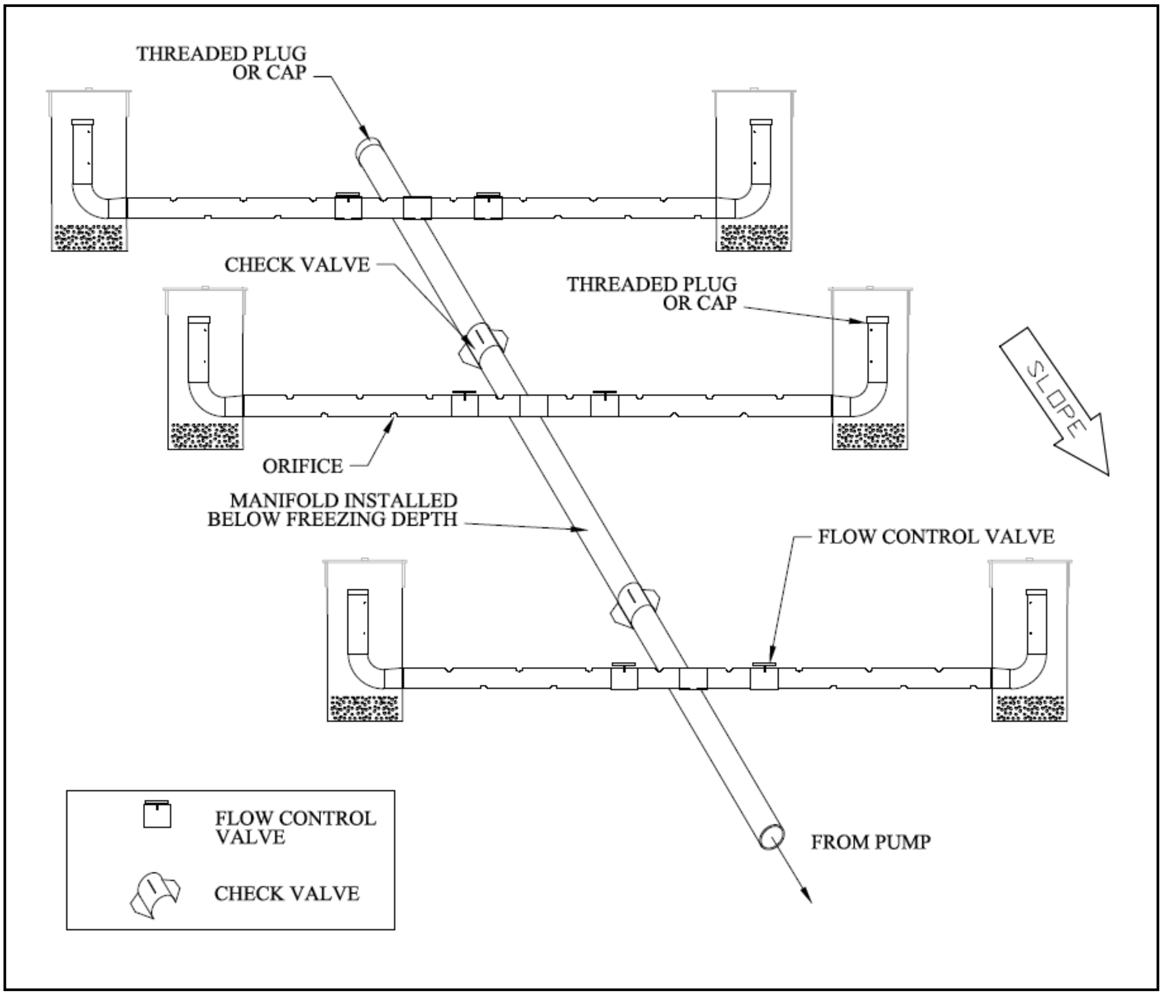
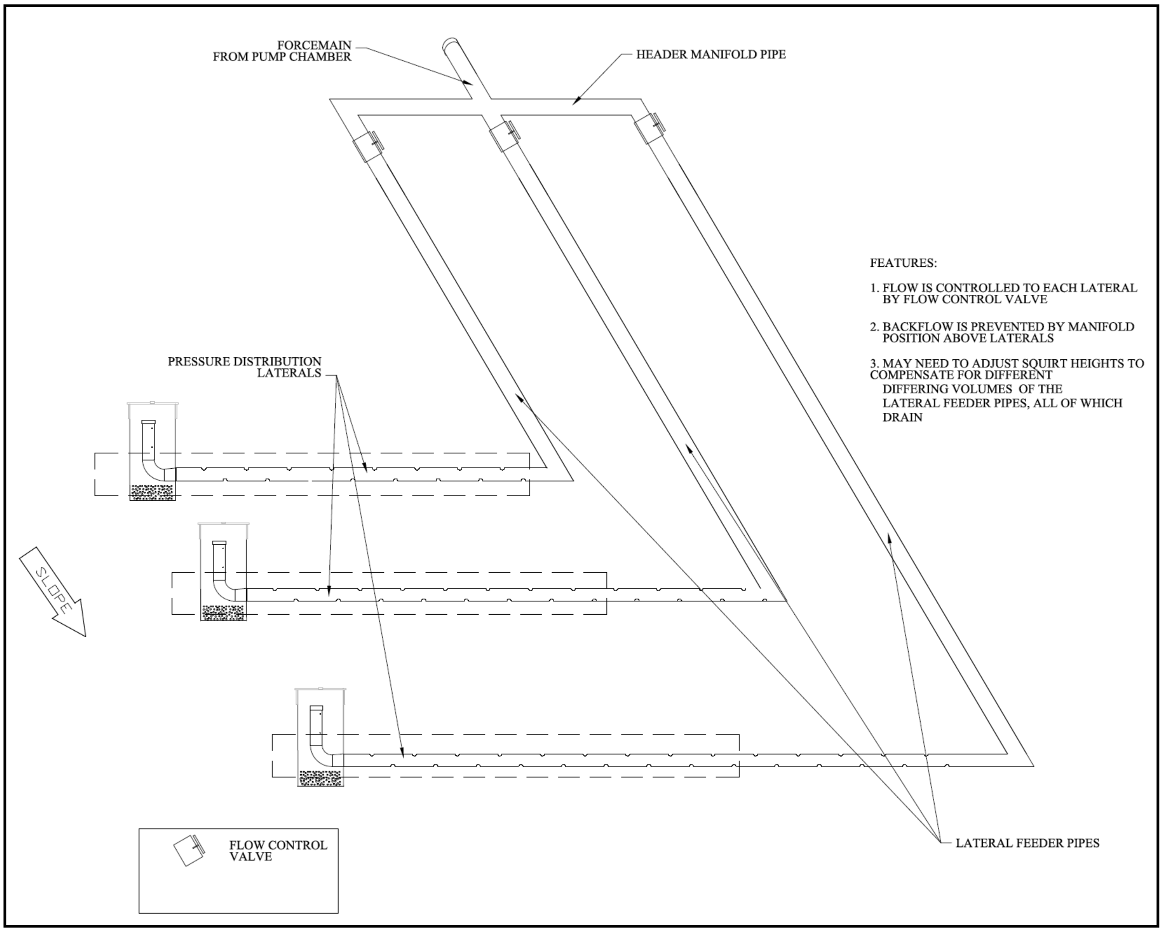


Figure III- 33. Short Upslope Header Manifold, with Feeder Pipes to Laterals.



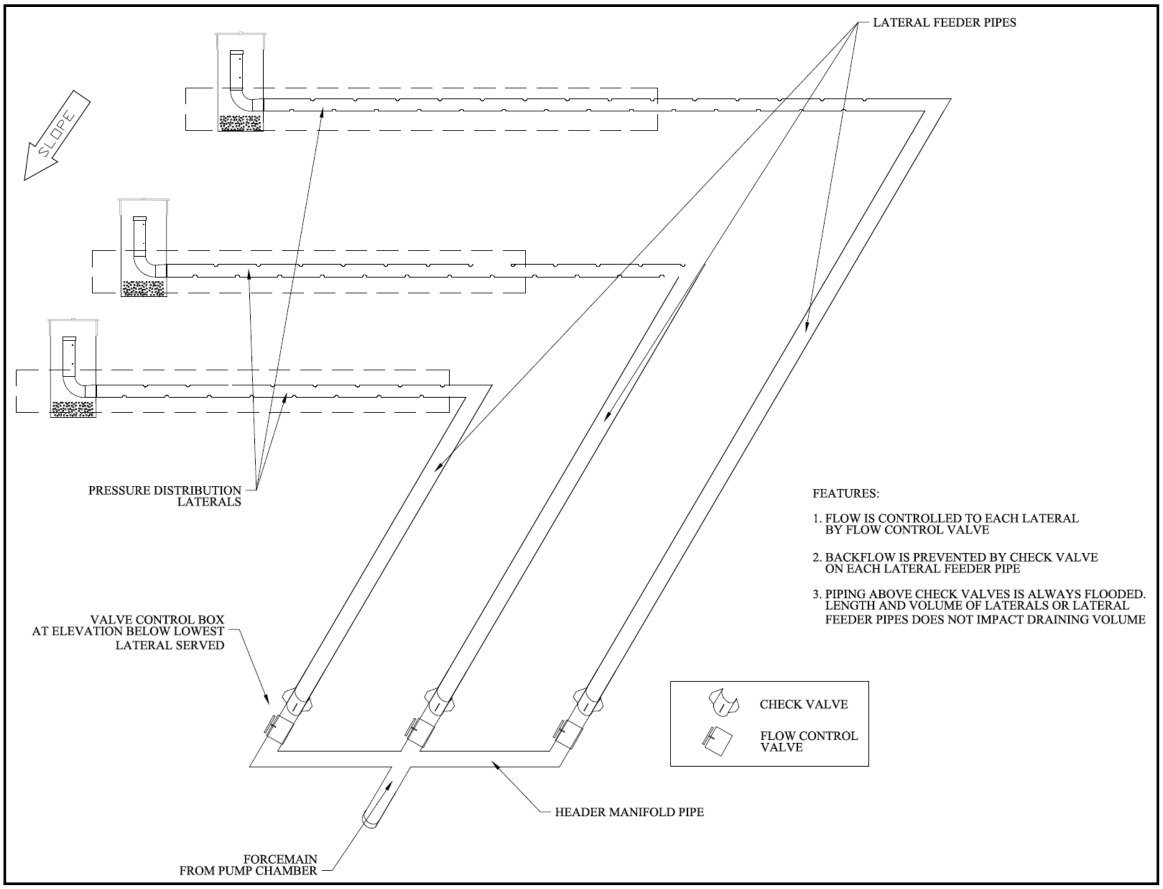
Note: Header location will prevent siphoning.

When selecting a size for the feeder pipe, account for head losses. Small feeder pipes will reduce the problem of feeder pipe drain down. Sufficient slope could compensate for head losses.

To compensate for excess flow to lower laterals (due to feeder pipes), squirt height could be adjusted based on careful design. During commissioning, this could be tested by collecting and measuring the volume dosed at each lateral’s test orifice.

Attention should be paid to prevent effluent concentrating in the feeder line trench.

Figure III- 34. Short Downslope Header Manifold, with Check Valves.



FEATURES:

1. FLOW IS CONTROLLED TO EACH LATERAL BY FLOW CONTROL VALVE
2. BACKFLOW IS PREVENTED BY CHECK VALVE ON EACH LATERAL FEEDER PIPE
3. PIPING ABOVE CHECK VALVES IS ALWAYS FLOODED. LENGTH AND VOLUME OF LATERALS OR LATERAL FEEDER PIPES DOES NOT IMPACT DRAINING VOLUME

Where check valves are used, these should be accessible for service. The check valves should be installed with unions, to permit maintenance and repair.

III- 8.9 Sand mound installation instructions

The following is a step by step procedure for mound system construction that has been tried and proven. Other techniques may also work satisfactorily, but the basic principles of mound system planning, construction and operation should not be violated.

1. Check the moisture content of the soil at 20 cm depth. If it is too wet, smearing and compaction will result, reducing the infiltration capacity of the soil. Soil moisture can be determined by rolling a soil sample between the hands. If it rolls into a wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. If the site is too wet to prepare, do not proceed until the soil moisture decreases—THIS IS ESSENTIAL. Consider the receiving area as well as the mound area to ensure that there is no negative impact to the receiving area.
2. Stake out the mound area on the site according to the system design, so the infiltration bed runs parallel to the contours. Reference stakes offset from the corner stakes are recommended in case corner stakes are disturbed during construction. If the site conditions do not allow for layout according to the approved design, contact the system planner or designer.
3. Measure the average ground elevation along the upslope edge of the bed or the upper trench and reference this to a benchmark for future use. This is used to determine the bottom elevation of the bed.
4. Determine where the pipe from the pump chamber connects to the distribution system in the filter media. The location and size of this transport pipe is determined from the pressure distribution guideline.
5. Trench and lay the effluent pipe from the pump chamber to the mound. Cut and cap the pipe one-foot beneath the ground surface. Lay pipe below frost line or sloping uniformly back to the pump chamber so that it drains after dosing.
6. Backfill and compact the soil around the pipe to prevent effluent seeping back along the pipe. Backfill around the pipe before plowing, to avoid compacting and disturbing of the ground surface. Consider placing a bentonite or other clay trench dam.
7. Cut trees to ground level, remove excess vegetation by mowing. Rake cut vegetation if it is, or will become, matted. Prepare the site using a spring-loaded agricultural chisel plow and plowing parallel to contours. Note for sand or gravel soils, may wish to reduce disturbance in order to retain lower permeability surface layer, take care to avoid breakout and use surface layer for basal loading rate check. If there is a compacted soil layer such as a plow pan, consider deep ripping to loosen this layer.

   The function of this preparation is to provide a cleared ground surface with a series of vertical channels to enhance transfer of moisture from the sand fill to the original soil, while inhibiting lateral movement at the sand-soil interface. In addition the vertical furrows aid in stabilizing the sand at the sand-soil interface in an inter-locking fashion.

   The site should be plowed using a spring loaded agricultural chisel plow, or other acceptable apparatus or method to prepare the soil before constructing the mound system. Shallow hand spading the surface is also an acceptable alternative and may be the preferred method on some sites. Rototilling is not an acceptable substitute. Do not compact the infiltrative area.

   The important point is that a rough, un-smeared surface should be left, especially in fine textured soils. Careful observation is required to assure that the soil moisture content is not so high that the soil surface is smeared by the action of the plow. Plowing should not proceed until the soil is sufficiently dry so as not to smear in the plowing process.

Any sod layer should be broken up, yet the topsoil should not be pulverized. The objective of this step is to break up any surface mat that could impede the vertical flow of liquid into the native soil.

Immediate construction after plowing is desirable. Avoid rutting and compaction of the plowed area by traffic. If it rains after the plowing is completed, wait until the soil dries out before continuing construction.

8. Reset the corner stakes, if necessary, using the offset reference stakes and locate the bed or trench areas by staking their boundaries. Extend the transport pipe from the pump chamber (which had previously been cut off) to several feet above the ground surface.
9. Install one or more standpipes (basal area observation ports). Use 4-inch PVC, with the bottom 12 inches perforated, with rebar to stabilize the pipe, and with gravel around the perforations. Use at least one standpipe in the downslope portion of the mound, with the bottom at the original ground surface, and the top extending above final grade where it can be capped. The maintenance provider can use these standpipes to observe water levels.
10. Place the filter media that has been properly selected around the edge of the plowed area. Keep the wheels of trucks off plowed areas. Avoid traffic on the downslope side of the mound system. Work from the end and upslope sides. This will avoid compacting the soils on the downslope side, which, if compacted, would affect lateral movement away from the mound and could cause surface seepage at the toe of the mound.
11. Move the filter media into place using a small track-type tractor with a blade, an excavator or a slinger. Do not use a tractor/backhoe having rubber-tired wheels. Always keep a minimum of 6 inches of filter media beneath tracks to prevent compaction of the natural soil. Ensure placed sand is settled to a uniform density of approximately 1.3 to 1.4 g/cm3 (81.2 to 87.4 lb./ft3). Do not over compact the sand.
12. Place the filter media to the required depth, i.e., to the top of the bed. Shape sides to the desired slope.
13. With the blade of the tractor form the infiltration bed. Hand level the bottom of the bed to within ½ inch.
14. Place the pea gravel in the bed. Level the aggregate to the design depth. Ensure the side separation from bed to surface exposure will be obtained.
15. Place the distribution pipes, as determined from the pressure distribution guidelines, on the aggregate. Connect the manifold to the transport pipe. Slope the manifold to the transport pipe. Lay the laterals level, removing rises and dips.
16. Pressure test the distribution system for uniformity of flow.
17. Place 2 in. of aggregate (pea gravel) over the distribution pipe.
18. An approved geotextile material may be placed over the aggregate, however, increasing concerns of geotextile plugging with root mat have led to some practitioners discontinuing use of the fabric. If using no geotextile use a layer of Clean Coarse Sand between the bed and the soil cap material, or a layer of birds eye gravel then a layer of Clean Coarse Sand.

19. Place the soil for the cap and topsoil on the top of the bed. This may be a subsoil or a topsoil. A depth after settling of 12 inches in the center and 6 inches at the outer edge of the bed is desired. This creates a slope that assists the surface run-off of precipitation. Also, this layer provides some frost protection. Do not drive over the top of the bed as the distribution system may be damaged. Use sandy loam, loamy sand soil, ensure oxygen can get in. If landscaping requires shallow slopes, ensure positive drainage from mound surface. With infiltrators installed as a single lateral (e.g. 36″ wide) the soil cap may follow the upper curve of the infiltrator chamber, however, ensure the side vents are covered with Clean Coarse Sand and that the bed to surface separation is adhered to.
20. Seed or sod the mound system.
21. Protect the receiving area for a minimum of 7.5 m downslope from the toe of the mound against disturbance and compaction; vegetate to enhance evapotranspiration in the area.

III- 8.10 Sand lined trench/bed diagrams

In all cases the diagrams show schematic sections of trenches, sand lined beds are simply wider trenches. These diagrams are adapted from the Washington State RS&G for sand lined trenches and beds.

Figure III- 35. Sand lined trench

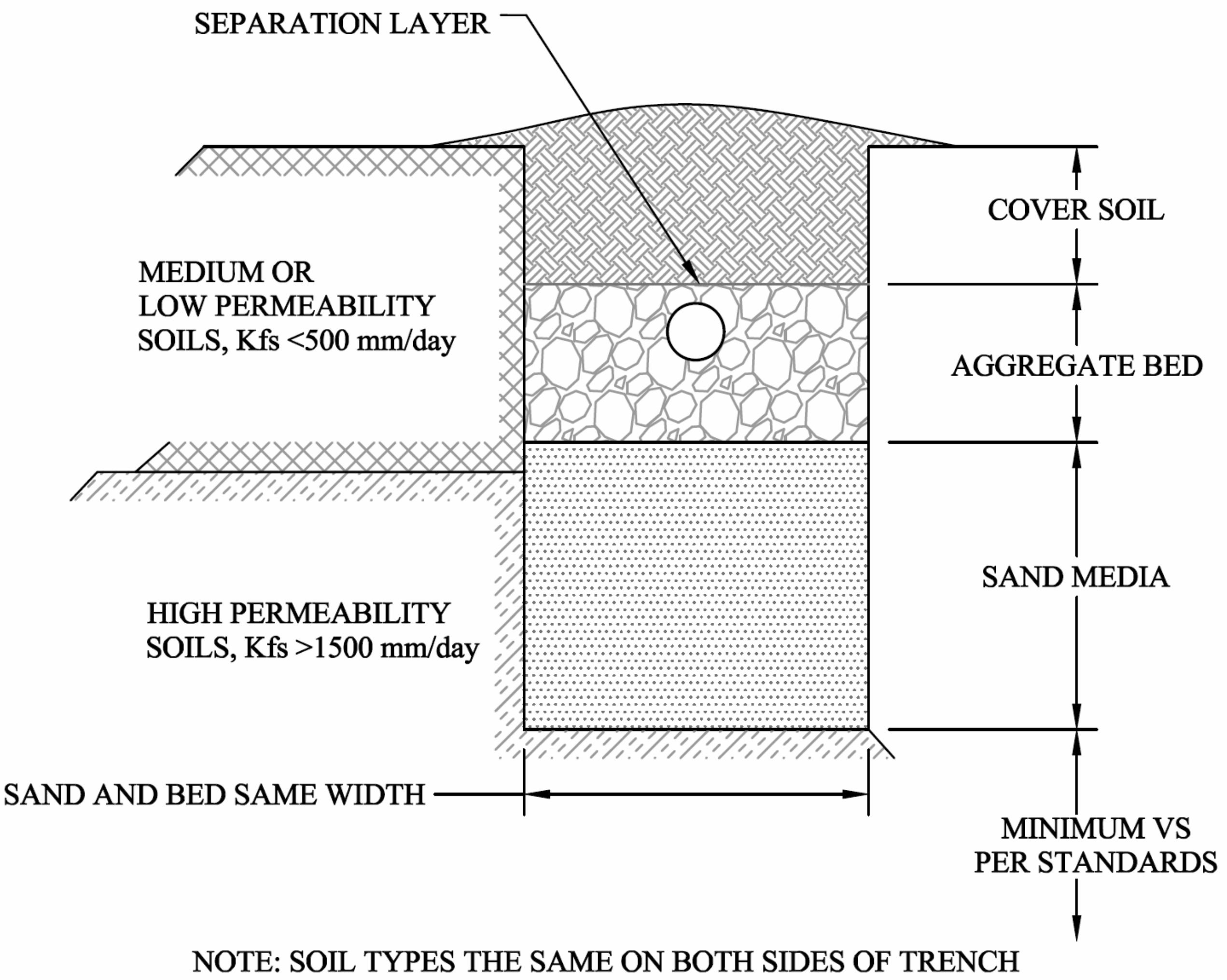


Figure III- 36. Sand lined trench reaching permeable soils at depth

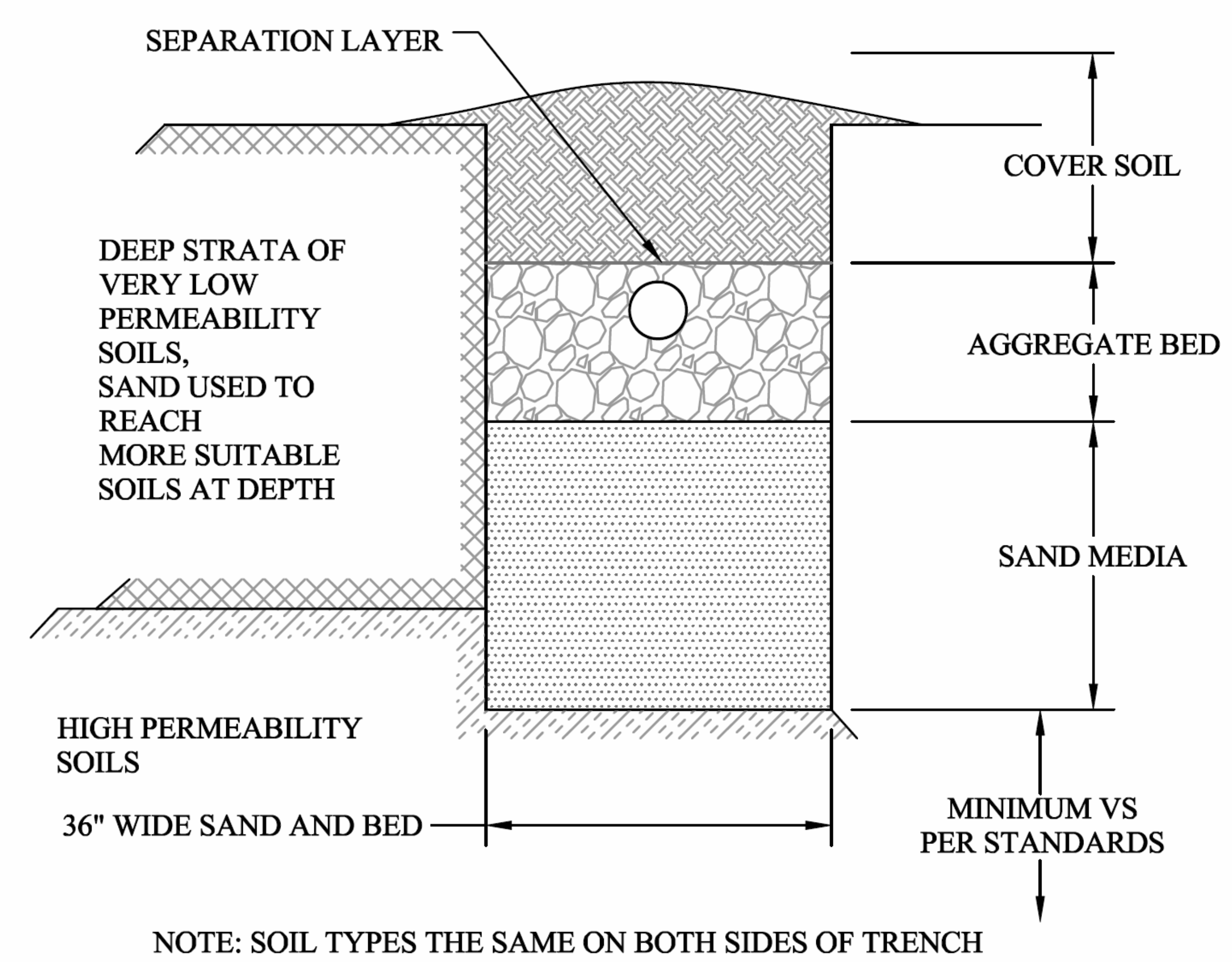


Figure III- 37. Sand lined trench on highly permeable soil, showing membrane to prevent short circuiting at bed edges

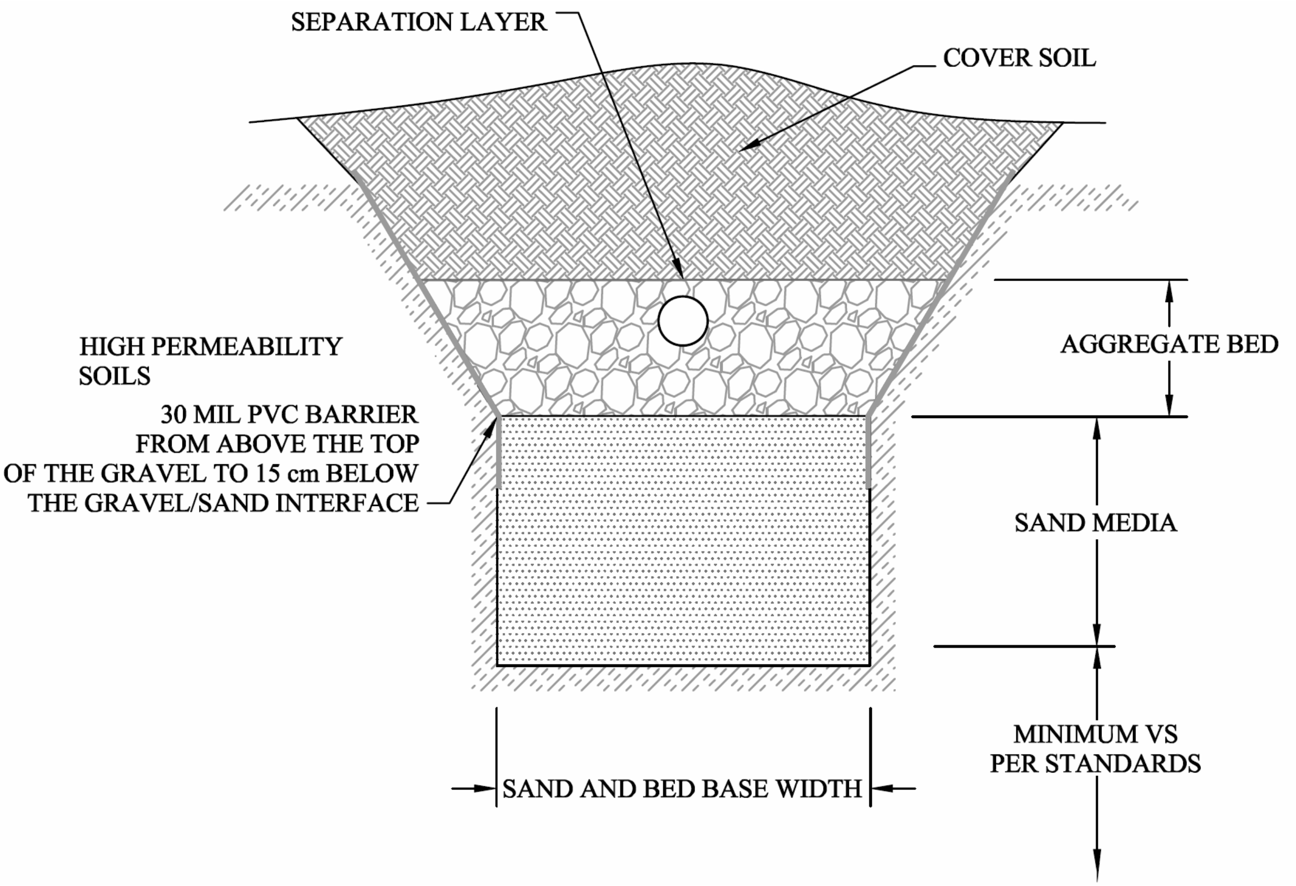


Figure III- 38. Sand lined trench on highly permeable soil, showing sand layer to prevent short circuiting at bed edges

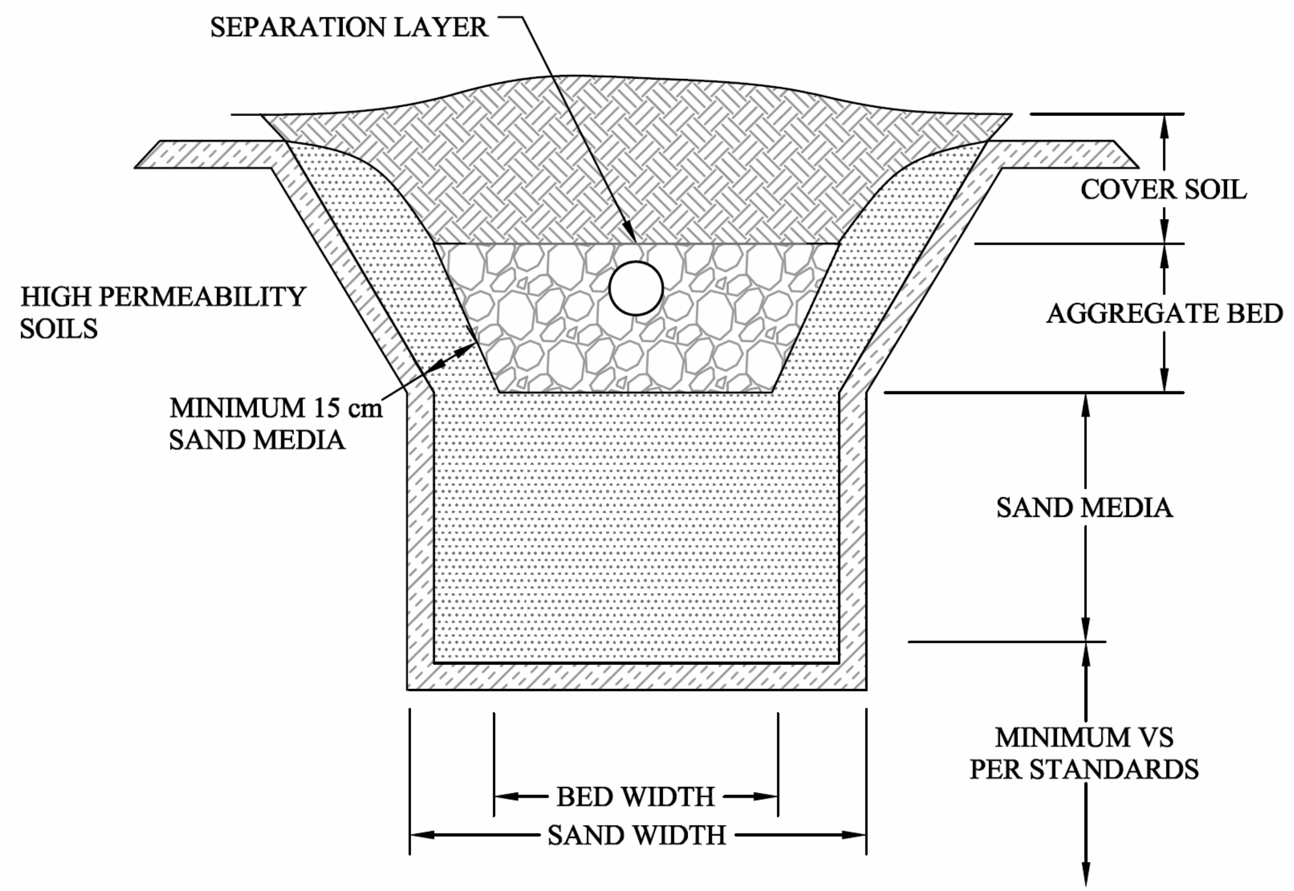
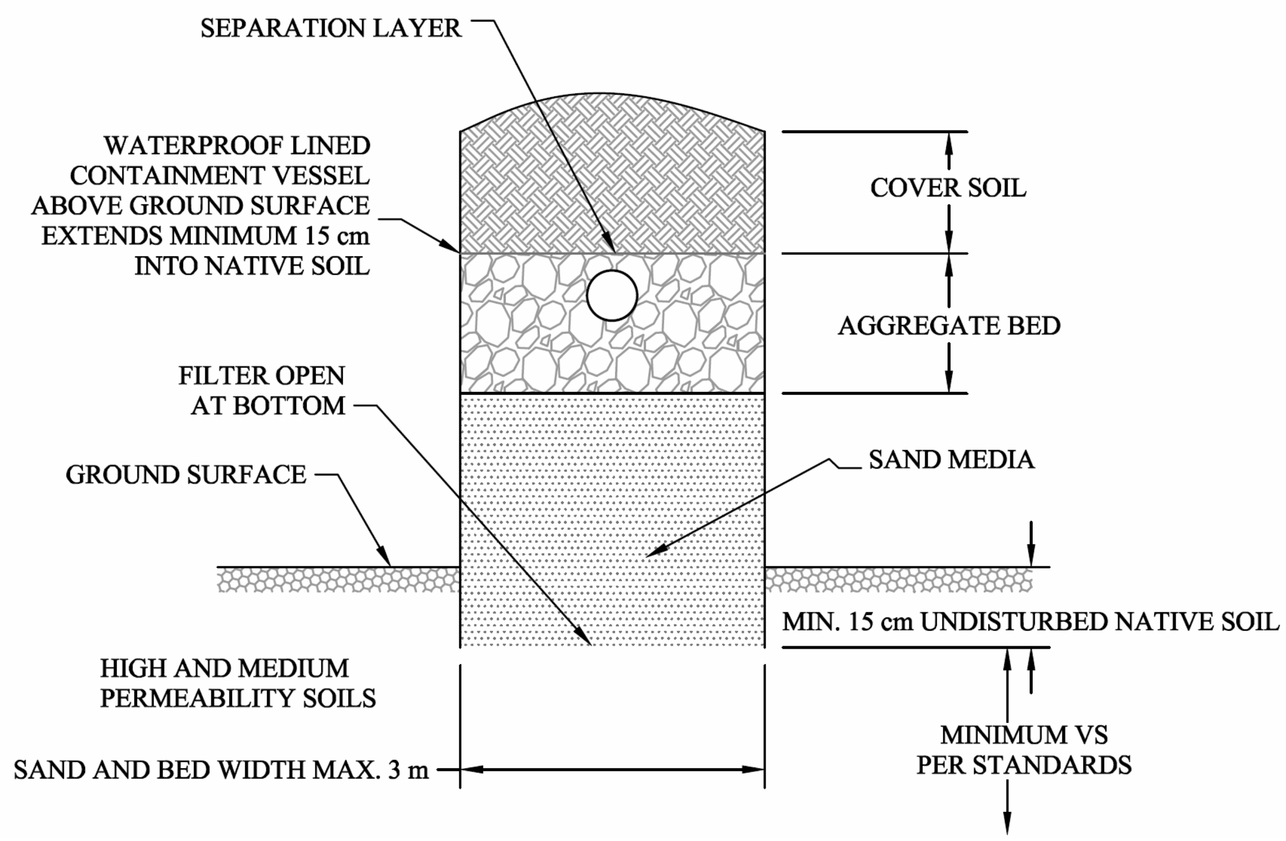


Figure III- 39. Bottomless sand filter



SEWERAGE SYSTEM
STANDARD PRACTICE MANUAL

VOLUME IV - RATIONALE

VERSION 3 SEPTEMBER 2014

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

Volume IV Table of Contents

Volume IV Rationale

IV- 1 INTRODUCTION

This volume is intended to be used for background information and reference, for information **only**. This volume does not contain standards or guidelines that APs are expected to follow or consider. It states the performance basis for the standards in Volume II, and summarizes the rationale for the design standards.

This volume includes rationale for some of the treatment and dispersal methods, in particular, those that are less common. It does not include rationale for commonly-used and well established methods or equipment such as septic tanks or infiltration trenches.

In this volume, technical terms are used and concepts mentioned which may not be familiar to the reader. For background reading refer to the USEPA manual (Otis et al. 2002); also see general references in Section IV- 8.

IV- 2 PERFORMANCE CONTEXT

IV- 2.1 Performance statements

The Sewerage System Regulation (SSR) provides a base performance statement, requiring that sewerage systems be constructed with the result of not causing or contributing to a health hazard.

A "health hazard" is defined as the discharge of domestic sewage or effluent into a source of drinking water, surface waters, tidal water, a sewerage system that is not capable of containing or treating domestic sewage, or onto land. A "health hazard" also includes the proposed construction or maintenance of a sewerage system which may, in the opinion of a Health Officer, cause a health hazard.

This Manual is intended to:

- Provide sewerage system standards and guidelines that support cost effective health protection.
- Establish actions and standards commensurate with risk.
- Provide simple standards that are readily applied.
- Provide sewerage system standards and guidelines that support environmental protection.
- Provide standards and guidelines supported by science, evidence or by evidence of best practice.

IV- 2.2 Performance requirements and objectives

IV- 2.2.1 PERFORMANCE REQUIREMENTS

The SSR provides treatment system performance requirements for effluent from Type 2 and 3 treatment methods. The SPM establishes typical performance for Type 1 effluent.

IV- 2.2.2 PERFORMANCE OBJECTIVES AND APPLICATION

Performance objectives were used to develop sewerage system standards and guidelines which, when applied, result in compliance with the performance statements.

This approach can be considered "semi-prescriptive" in that the approach is based on clear performance goals, but offers simplified prescriptive means of compliance which are appropriate for simple, low cost, small flow systems.

In development and review of standards, these objectives were considered together with system cost implications and the need for standards to be easily applied.

Water quality objectives were developed, based largely on BC Approved Water Quality Guidelines, and other water quality guidelines (see below), but without a formal quantitative risk analysis. The water quality objectives were also compared to reasonable expectations for soil-based treatment for a properly functioning onsite sewerage system, with reference to authoritative design manuals (Otis et al. 2002; R. Crites and Tchobanoglous 1998; R. W. Crites, Reed, and Middlebrooks 2006). Water quality references included:

- British Columbia Approved Water Quality Guidelines, BC Ministry of Environment, 2010 Edition.
    - http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html
- Guidelines for Canadian Recreational Water Quality. Health Canada, April 2012.
    - http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/guide_water-2012-guide_eau/index-eng.php
- Section 108 of the BC *Environmental Management Act* – Municipal Wastewater Regulation.
    - http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/87_2012

IV- 2.2.2.1 General objectives

Qualitative or semi-quantitative objectives used in development of the standards and guidelines include the following:

- Prevent or reduce the risk of untreated effluent discharging to the ground surface or a water body.
- Design and documentation standards to support full record of the system design and specification.
- Include features and equipment that facilitate maintenance and monitoring of systems.
- Expectation that systems should function properly for a minimum of 35 years.
- Develop standards that are generally consistent with standard practice in North America.
- Provide methods for addressing exceptions.

IV- 2.2.2.2 Objectives for pathogen removal performance in the soil treatment unit

For this Manual, the primary water quality objectives, at the limiting layer, were based on Fecal Coliform bacteria, as follows:

- Removal to a median fecal coliform bacteria density of less than 200 CFU/100mL, to meet the BC Approved Water Quality Guideline for recreation, primary contact.
- Removal to a median density of no less than 0.1 CFU/100mL, as a check to avoid specifying standards which would lead to overdesign of the dispersal system.
- Similar bacteria removal at the limiting layer for all dispersal techniques, loading rates and effluent types.

For the practical purpose of monitoring of groundwater quality, these water quality objectives can also be considered to apply to groundwater sampled at a distance of 4 metres down-gradient from the lowest edge of the dispersal system. This distance is established to represent a distance far enough from the dispersal field to avoid accidental damage (over 3 m), and close enough that water sampled will be reasonably representative of the water quality at the limiting layer below the dispersal area.

These fecal coliform bacteria (FCB) objectives are conservative when compared to the Health Canada objective (Health Canada 2012). For primary contact in fresh water, the BC Ministry of Environment specifies FCB < 200 CFU/100 mL, and Escherichia coli (E. coli) < 77 CFU/100 mL. In comparison, Health Canada specifies an E. coli criterion of < 200 CFU/100 mL.

Some water quality references (including Health Canada) conclude that E. coli is the preferred indicator of fecal contamination of recreational waters. However, in this Manual, the fecal coliform bacterium is used as an indicator, for consistency with the SSR definition of Type 3 effluent.

IV- 2.2.2.3 Secondary objective for nitrogen removal performance in the soil treatment unit

The ammonia and nitrate nitrogen concentrations, at the base of the design vertical separation, are used as secondary indicators of system performance. This Manual uses the following objectives for water quality measured at the limiting layer under the dispersal system or, for practical purposes of groundwater monitoring, at a location up to four metres down-gradient from the dispersal area.

- Median ammonia nitrogen, ≤ 3.5 mg/L
- Median nitrate nitrogen, ≤ 30 mg/L

These nitrogen objectives are based on what is realistically achievable for a properly planned, installed, and maintained onsite sewerage system, based on research and on monitoring of systems in BC (Otis et al. 2002).

These water quality objectives apply to soil-water or groundwater directly below, or immediately down-gradient from, the dispersal system. These objectives do not relate directly to ambient surface water quality objectives. A site-specific analysis of the effects on surface water quality would need to consider denitrification and dilution, within the saturated soil, and within the surface water body. There is no generally applicable dilution ratio, and denitrification rates vary widely from site to site (Harman et al. 1996; GWMAP 1999; Otis et al. 2002).

The water input from even a larger onsite sewerage system (example 22,000 L/day) is small in comparison to most aquifers or streams. The majority of situations would result in a dilution ratio of more than 3:1, a range observed from BC case studies (including dilution in the saturated soil zone plus in the water body receiving flow) is 4:1 to 40:1 (M Payne, pers. comm. 2013). As an illustrative example only, using a 3:1 dilution ratio, a nitrate concentration of 30 mg/L would be diluted to less than 10 mg/L. The most stringent comparable ambient water quality criterion is for a fresh water body or a water well that is used as a drinking water source, in which case the water quality criterion for nitrate-nitrogen is < 10 mg/L.

The nitrogen objectives do not consider potential cumulative impacts of a large number of onsite sewerage system located in a relatively small area, or situated over an unconfined aquifer.

IV- 2.2.2.4 System function and the maintenance of design vertical separation

The SSR and the standards of this Manual are based on performance considerations. An onsite system is considered to be functioning if it meets **all** of the following:

- Sewage is collected and treated in accordance with the system design.
- Untreated sewage is not discharged.
- Effluent is discharged to the dispersal system and distributed by that system in accordance with the system design.
- Effluent infiltrates and disperses, without surfacing and without breakout occurring within the defined minimum Horizontal Setback to breakout.

- Effluent is dispersed and treated in the soil (and sand media if used) to meet the performance standards of the SSR and this Manual prior to reaching the limiting layer, so that renovated water reaching the limiting layer or the surface meets the primary water quality objectives defined in this Manual.

An onsite system may be functioning in mechanical and hydraulic aspects, but not meeting the performance standards for the soil treatment and dispersal system—particularly, the effluent may not be being renovated to meet the established water quality objectives at the limiting layer. Such a system can be said to be "disposing" of sewage and effluent, but is still malfunctioning and may be causing a health hazard.

As testing soil treatment performance is difficult, vertical separation is used as a secondary indicator of adequate soil treatment performance for installed systems.

For this reason, assessment of system function should include, at minimum, a check on the unsaturated vertical separation below the infiltrative surface.

Additionally, the following objectives are established to guide standards development:

- The design vertical separation should be maintained for life of the system.
- The vertical separation should allow for less effective treatment in the near saturated zone.

IV- 3 FORMS OF RATIONALE

Three approaches were used to establishing rationale during development of the standards:

- Science based; based on published scientific research.
- Evidence based; based on field measurements of a large number of operating systems.
- Or, where these two approaches are difficult or impossible, evidence of best practices; based on:
  - Either a consensus of current regulations or standards in other jurisdictions, or
  - A consensus of assembled experts.

Where a range of research was considered, preference was given to the weight of evidence and to research widely accepted by the industry—so consensus was a factor in consideration of science and evidence basis for rationale.

When considering a consensus based rationale, the standards of Version 2 of the SPM and the CSA B65 standard (CSA Group 2012) were consulted, together with other North American and international standards and guidelines. In some cases, selected technical advisors helped evaluate and select appropriate standards.

The rationale for design standards is generally science or weight-of-evidence based. Consensus based standards are identified specifically in their rationale statements.

IV- 4 RATIONALE FOR SELECTION OF MINIMUM STANDARDS

For system planning and specification, the standards chosen were those which are considered to be the minimum for a properly planned and installed system that meets the performance statements.

Standards were also selected and expressed to encourage consideration of options and leave opportunities for innovation.

IV- 5 RATIONALE FOR DESIGN STANDARDS

IV- 5.1 Priority for soil treatment

In general, the soil treatment and dispersal system is considered to be the key risk management strategy and the principal method of renovating the treated effluent to meet the primary water quality objectives (R. Crites and Tchobanoglous 1998; Otis et al. 2002; R. W. Crites, Reed, and Middlebrooks 2006).

Review of studies of virus removal in the saturated zone and of aquifer contamination by viruses emphasizes the importance of adequate pathogen removal in the vadose zone prior to water reaching an aquifer or the water table, and the potential persistence of viruses in the water table (Azadpour-Keeley, Faulkner, and Chen 2003; Uejio et al. 2014; Bradbury et al. 2013; Hunt, Borchardt, and Bradbury 2014; J. Schijven et al. 2006; J. F. Schijven and Hassanizadeh 2000; Yates, Gerba, and Kelley 1985).

As a consequence, even where Type 3 treatment is used the standards in this Manual are intended to treat the effluent to meet the primary water quality objective within the unsaturated soil zone.

IV- 5.2 Soils and site evaluation

Refer to standards Section II-3.3 and guidelines Section III-3.3.

The more detailed and complete the soil description the better. However, the main object is to describe the soil to meet the purpose of practical sewerage system planning.

For this reason this Manual offers simplified soil evaluation and description options, and the standards tables for HLR and LLR selection use simplified soil categories. See Section IV- 5.10.8

Volume III provides an explanation in Section III- 3.3.2.3 linking the purpose of soil description to minimum investigation and description standards.

This approach is common, with some jurisdictions using as few as three soil type categories (New Brunswick) and others (including Washington State, Wisconsin, Missouri (R. J. Miles, L. T. West 2001) and Vermont) using simplified soils categories and grouping soils which have the same loading rates together.

A simplified soil colour description method is offered as an option, following procedure in other jurisdictions (D. Burns et al. 2005; State of Victoria 2011).

Seasonal High Water Table is defined based on a review of standard practice in North America. Literature review included standards from North Carolina, Wisconsin, Rhode Island and research related to water table indicators and appropriate assessment methods (D. L. Lindbo et al. 2013; J. P. Williams, D. L. Lindbo, and M. J. Vepraskas 2013; Humphrey J and O`Driscoll 2011; RI NEMO 2008).

IV- 5.2.1 SOIL STRUCTURE AND CONSISTENCE CATEGORIES

In order to simplify use of standards tables, including site capability tables and loading rate tables, a procedure was developed in which soils were pre-qualified based on their structure and consistence.

This procedure allows for early identification of soils that have unfavorable characteristics for infiltration and soil based treatment of effluent, and simplifies the selection of design parameters.

The table of categories was developed based on the following main considerations:

- Categories of soil structure were based on recommendations of Dr. E. jerry Tyler and others (Tyler 2001; Tyler, Drozd, and Peterson 1991; State of Wisconsin 1999; Otis et al. 2002) and on USDA procedure (Burt 2009). Selected categories included those with more favorable structure (higher vertical hydraulic conductivity, higher hydraulic loading rates), less favorable structure (lower vertical hydraulic conductivity, lower loading rates) and unfavorable structure (not recommended)
- Recommendations on soil morphology, including structure and consistence, in relation to effluent Long Term Acceptance Rate (D. L. Lindbo et al 2007)
- The use of stronger consistence to, generally represent higher soil density with resulting lower soil hydraulic conductivity and lower soil aeration (Saxton and Rawls 2006; Otis et al. 2002; Schoeneberger et al. 2012)
- The general correlation, for soils with expansive clay content, between soil consistence of very firm (moist) and stronger with horizons with higher expansive clay content. These horizons are generally considered unsuitable for effluent dispersal
- The significant reduction in open pore space in soils which are weakly cemented or stronger.

Selection of a soil hydraulic loading rate following the HLR tables (see Section IV- 5.10) and consideration soil constraints to site capability following the site capability tables include checks based on soil permeability. As a result, the soil structure and consistence table is not directly adjusted for soils with unusual soil hydraulic conductivity. This might include soils with large extra structural cracks or very coarse structure. This is because permeability testing will identify unusually permeable or impermeable soils. However, as an added precaution, this Manual provides additional guidance for prismatic and platy structured soils (see Sections IV- 5.3.5.4 & IV- 5.3.5.5).

IV- 5.3 System selection standards

Refer to standards Section II-4 and guidelines Section III-4.

This Manual stipulates selecting a system for a site based on:

- Site capability, considering soil and site constraints and opportunities.
- Vertical separation, which is identified as the key site and soil factor for system performance.
- Type of distribution, dosing method and dosing frequency (linked to hydraulic application rate (HAR)).

Site capability is emphasized as a logical way to select an appropriate system for a site (Beal, Gardner, and Menzies 2005; Dawes and Goonetilleke 2003; Wells 1987; Bouma and Ziebell 1972).

IV- 5.3.1 SIMPLER SOLUTIONS AND OPTIONS PRIORITIZED

The SPM standards are intended to be simple and easy to apply. In general, standards are focused on providing simplest, lower cost solutions first, which are considered to be:

- Gravity distribution systems using Type 1 effluent.
- Pressure distribution systems using Type 1 effluent.
- BC zero discharge lagoons, ET beds and ETA beds (limited to application in certain parts of the province).

Small flow, residential systems are considered the main priority of the SPM. The SPM standards are focused on the majority of systems and sites, and do not prioritize the “what if” or “one off” situations that may arise.

IV- 5.3.2 LIMITATION ON STANDARDS, PROFESSIONAL RELIANCE

This Manual provides standards for the treatment and discharge of normal residential sewage and effluent only. In order to keep the standards reasonably simple, situations where it is not possible to establish straightforward, reliable instruction based standards are outside the scope of the manual. These situations include:

- Complex sites.
- Very severely constrained soils.
- Challenging non-residential sewage flows.
- Larger flow systems (which require professional design under the SSR).

For these reasons the standards may state that a certain technique is “not allowed” due to a particular site constraint, or a particular soil type is a “limiting layer”.

For all sewerage systems and sites, site and project specific design by a professional is an option, but is outside the scope of this Manual.

IV- 5.3.3 TREATMENT SYSTEM SELECTION

The AP has ultimate responsibility for selecting a treatment system and ensuring that it meets the Regulation. For this reason, it was not considered appropriate to simply refer to an external testing standard for treatment system selection. Instead, this Manual recommends that practitioners refer to the two commonly used testing agencies (BNQ and NSF) as a part of a more comprehensive selection process.

IV- 5.3.4 SITE CAPABILITY AND DISPERSAL SYSTEM SUMMARY TABLES

For convenience, this Manual includes several tables in Section II- 4 and III-4 that summarize the constraints and opportunities for various systems. These tables highlight the availability of solutions, while attempting to keep the solutions simple.

These tables do not include all feasible solutions. The intent is to provide simple standards for the majority of conditions, as described above.

IV- 5.3.5 DISPERSAL SYSTEM LIMITATIONS

Refer to standards Section II-4.1 and guidelines Section III-4.1.

IV- 5.3.5.1 Gravity distribution flow splitting and dosing

Gravity distribution is suitable for many favorable sites and soils, but distribution by trickling gravity leads to poor flow splitting, and poor distribution, in larger distribution networks. As a result, there is some industry consensus that trickling gravity systems should be limited to infiltration surface areas of less than 100 m^2.

Flow splitting using trickling gravity with serial or sequential systems relies on ponding in the upper laterals of the system. Since sewerage systems rely on unsaturated soils for soil-base treatment (see Section IV- 5.6), this distribution method was not considered acceptable, except for ET beds or ETA beds, where ponding is normal. Further, serial systems do not allow for ready access for service. For these reasons this Manual specifies combining sequential distribution with gravity dosing but not with trickling gravity distribution.

References for splitting devices and gravity distribution include: (Coulter and Bendixen 1958; L. Gill, Patel, and O’Luanaigh 2007; Patel, O’Luanaigh, and Gill 2008; Otis et al. 1977).

IV- 5.3.5.2 High soil permeability

Very permeable soils (such as gravel or gravelly sand), and soils with high coarse fragment content, are considered too permeable for effective soil-based treatment, without special precautions or strategies (Washington State Department of Health 2002a; Washington State Department of Health 1990).

This manual provides strategies for highly permeable soils. These strategies or methods were based in a large part on published laboratory and field research and monitoring of sand filters and sand mounds. Sand filter research is considered relevant because the sand used in a typical intermittent sand filter is very permeable, with a typical measured and calculated Kfs in the range of 20,000 to 80,000 mm/day (NRCS 1984; Kenney, Lau, and Ofoegbu 1984). Sand mound research and monitoring data is also relevant, as permeability testing of mound sand indicates as typical measured and calculated mound sand Kfs of 8,000 to 30,000 mm/day.

For this manual, strategies were developed following the approach discussed in Section IV- 5.6 to result in soil treatment unit performance meeting the primary objective, and include the following:

- Increased vertical separation.
- Micro-dosing.
- Uniform distribution of effluent.
- Soil hydraulic loading rates which are well below the soil's hydraulic capacity (see Section IV- 5.10.4), including specific reduction for soils with high coarse fragment content. See Section IV- 5.7.1.2 for discussion of coarse fragment content impact on soil water holding capacity.
- Sand mounds, sand lined trenches and beds.

IV- 5.3.5.3 Low and very low soil permeability

Very low permeability soils also constrain the ability of the soil to absorb and treat effluent. This category includes clay loams and clay textured soils, and soils with unfavorable structure and consistence. These types of soils can accept limited flows of effluent and are poorly aerated.

This Manual offers or requires the following solutions or strategies for these soils:

- Soil hydraulic loading rates that are lower than the soil's hydraulic capacity, to allow for aeration of the soil (see Section IV- 5.10.4).
- Limitation to system width and type of effluent for bed systems (see Section IV- 5.11.3).
- Micro-dosing.
- Type 2 or 3 effluent.
- Uniform distribution of effluent.
- Sand mounds (J.C. Converse, Tyler, and (Wis.) 1990).
- ET beds, ETA beds and BC zero discharge lagoons.

For soils with significant amounts of expandable clay minerals there is a risk of soil permeability becoming very low as soils wet. This Manual offers guidance on identification and on risks associated with these soils.

IV- 5.3.5.4 Prismatic and columnar soils

Prismatic and columnar structure may be indicative of soils with high expandable clay content or low permeability, or, for columnar soils, high sodium content. However, this is not always the case and so prismatic structure, in particular, is typically permitted for effluent dispersal (Tyler 2001; Hart et al. 2008).

Prismatic soils, even if of suitable consistence and with permeability high enough to be used for effluent dispersal, require special consideration because of a high risk of bypass flow in macropores (Bouma et al. 1977).

This Manual provides guidance on these risks and on strategies for use of these soils.

IV- 5.3.5.5 Platy soils

Platy soils can be difficult to use for dispersal of effluent because:

- Hydraulic properties can vary considerably across a property or dispersal site.
- Horizontal hydraulic conductivity is often very much higher than vertical hydraulic conductivity.
- Layers of platy structure may be hard to characterize because the tested permeability or percolation rate can range from low to medium to high and can vary widely over a single dispersal site.
- There may be risk of piping, which may lead to structural failure.

Standards related to platy soils are based on published papers by Tyler (Tyler 2001), with some adjustments based on experience with BC sites. The Manual offers guidance on risks associated with these soils and on potential solutions for sites with platy soils, as well as recommending a larger number of soil test pits and permeability tests to more fully characterize the platy soils.

IV- 5.3.5.6 Slope

Steep slopes are a constraint to on-site systems because of a number of factors including:

- Risk of poor distribution, for gravity systems with D-Box or splitter tee flow splitting.
- Increased risk of breakout.
- Cover soil depth or installation depth limits affecting wider systems on slopes.
- Awkward installation.

The manual provides for the following limits for systems installed on steep slopes:

- A maximum allowable slope for D-Box and splitter tee flow splitting; this leads to a limit to slope for trickling gravity distribution systems.
- Increased trench or dripline spacing on steep slopes, and particularly slopes with shallow soils, to reduce breakout risk and to make installation more practical.
- A slope limit for dispersal system trenches, based on installation difficulties and the need for a minimum thickness of soil cover.
- A slope limit for Seepage Beds, at-grade beds and Alberta At Grade system.
- Slope limits for BC zero discharge lagoon systems, based on providing for stable berms and manageable construction.

IV- 5.3.5.7 Rainfall and evapotranspiration

For regions with high rainfall, the rationale for reducing loading rates (HLR and LLR) is based on considering that the standard loading rates apply for sewerage systems located in regions of the province with average precipitation in the 300 to 1200 mm/year range. The standard procedure is to lower loading rates where rainfall is very high (Rutledge et al. 1985).

Simplified reductions in the standards are based on consideration of average daily rainfall in the wettest month and proportioned to the base value. The proportions for three coastal region sites, Victoria Airport (883 mm/year) taken as the base value, Lake Cowichan (2022 mm/year) and Tofino (3305 mm/year) were used for comparison.

Evapotranspiration and ETA beds and BC zero discharge lagoons use evapotranspiration or evaporation as part of their dispersal method. For this reason, application is limited to certain climates.

IV- 5.4 Design flow

This discussion refers to standards in Section II-5.1 and guidelines in Section III-5.1.

IV- 5.4.1 RESIDENTIAL DAILY DESIGN FLOW (DDF)

In general, a selected Daily Design Flow should consider:

- Average sewage flow.
- Mass loading, particularly BOD mass loading in the sewage.
- Potential BOD mass loading to the dispersal system (in Type 1 effluent).
- Peak day flow.

In general, average flows are more suitable for sizing a dispersal system, because of the combined flow equalization in the various system components. However, in British Columbia and in several other jurisdictions and standards in North America, there is a history of using peak-day flows instead and, as a result; the residential sewage flow standards of this Manual are presented in the form of Daily Design Flow.

IV- 5.4.1.1 Hydraulic loading rates and DDF

The hydraulic loading rate tables of this Manual are based on mass loading, average sewage flow rates, and a typical residential peaking factor of 2 to 4.

Most of the references used (see Section IV- 5.10and IV- 5.11) assumed a peaking factor of 1.5 to 2 and use a Daily Design Flow of at least 150 USgal (570 L) per bedroom (Tyler 2001; C. Taylor and Jones 1997; Winneberger 1984; Otis et al. 2002)(Laak, pers. comm.).

Published soil hydraulic loading rates such as these are based on field measurements of long term acceptance rate (LTAR) for Type 1 effluent. These rates inherently consider typical residential sewage strength and septic tank performance. Type 2 and 3 HLR are based on the same flows.

IV- 5.4.1.2 Peaking factors

Measured peaking factors for onsite sewerage systems vary depending on the part of the system and the degree of flow equalization. The following is a brief summary of reported peaking factors (R. Crites and Tchobanoglous 1998; Laak 1986; Tchobanoglous, Burton, and Stensel 2002; Geyer and Lentz 1966):

- Residential sewage: 1.5 to 5
- Lagoons: 1
- Soil interface: 1.25 to 2.5
- Process tanks (including septic tanks): 1 To 3.5
- Pipes: 3 to 12
- Surge tanks (momentary peaks): 100 to 1000

For simplicity a peaking factor of 2 is used as the basis for SPM residential DDF, and a caveat is placed in the standards to instruct APs to consider different peaking factors when planning a system. This peaking factor of 2.0 is a compromise between the peaking factor applicable for soil interface sizing, and that for selecting septic tanks.

The Manual recommends that APs identify systems likely to have a different sewage flow pattern, including an unusual peaking factor.

The DDF standards instruct that average flow should not exceed 50% of DDF, and average daily flows should be monitored to confirm this.

For planning of BC zero discharge lagoons, the tables show the design flow (DDF) but the underlying rationale for lagoon sizing is based on average flows. Likewise, calculations of water balance, for ET and ETA beds, use average flows.

IV- 5.4.1.3 Average flows

The standard residential daily design flows were developed using average per capita flows; this approach is widely supported (R. Crites and Tchobanoglous 1998; CSA Group 2012; Otis et al. 2002; AS/NZS 2000). However, this Manual also offers a simplified approach based on the number of bedrooms in the house.

Several Canadian provinces and US states base the design sewage flows for residences on the number of bedrooms. This manual provides for calculations of sewage flows related to the floor area of a house. These calculated flows have been compared to actual measured flows in a number of houses. As a result, for medium to large size houses, this Manual specifies lower design flows than the current Version 2 SPM and the CSA B65 standard (CSA Group 2012).

Average per capita flows were based on research, with weighting toward the median average data provided by Lowe, 2009 for normal residences. (Otis et al. 2002; Lowe et al. 2009; Mayer and DeOreo 1999; Geyer and Lentz 1966; Linaweaver, Admin, and Resources 1966) as well as literature values (Otis et al. 2002; R. Crites and Tchobanoglous 1998; Laak 1986).

The check on per capita flows included application of two incremental flow relationships (which provides reduced per capita flows as occupancy increases) (Linaweaver, Admin, and Resources 1966; Mayer and DeOreo 1999).

IV- 5.4.1.4 Per bedroom occupancy and floor area

The US Census Bureau and US Housing Survey, the 2011 Canadian Census and analysis by the National Research Council of Canada were the primary sources of data for the following average values:

- Occupancy per bedroom.
- House size and number of bedrooms.
- Floor area per person.
- Residential occupancy (number of occupants per house).

IV- 5.4.1.5 Table values

Rounded table values were developed based on this analysis, using average flow estimates and a peaking factor of 2. The tables are developed to be internally consistent when used with per capita flows for normal single family residences. Floor areas for the base flows were selected to represent average house sizes, and so to avoid the need for addition of flows to the base values in the majority of cases.

The occupancy table includes less common residential uses, including seasonal cottages and luxury homes.

IV- 5.4.1.5.(a) Luxury homes

For a luxury home average sewage flow per occupant is often higher than for an average home. Luxury homes often include the following:

- Larger overall floor area with larger rooms than an average home.
- High quality, high cost materials than average.
- More water use appliances than an average home.
- Domestic service workers.
- Large parties and frequent guest use.

Average flow per occupant for luxury homes is reported to be approximately twice that for normal homes, and sewage flow typically increases with increasing cost of homes (Laak 1986; Geyer and Lentz 1966).

IV- 5.4.1.6 Comparison to other standards

Most of the residential Daily Design Flows in this Manual are lower than those in the current Version 2 SPM, due to floor area considerations in that manual. For smaller houses, the design flows in this manual are comparable to design flows in the Canadian Standards Association CSA-B65 standard. For larger houses flows are lower than in CSA-B65 as noted above.

IV- 5.4.1.7 Sewage and effluent strength

Analysis of BOD mass loading to the infiltrative surface based on these DDF values and standard HLR values indicates that variation of mass loading from those of other standards is small.

Final organic mass loadings to the dispersal area are in range for guidance on acceptable mass loading to the infiltrative surface, see Section IV- 5.10.1(Laak 1986; Otis et al. 2002; Washington State Department of Health 2002b; Washington State Department of Health 2002c; Eberhard Roeder, David Bloomquist, and Paul Booher 2007).

IV- 5.4.2 DAILY DESIGN FLOWS FOR NON-RESIDENTIAL BUILDINGS

This Manual includes a table with first estimates of average flows for non-residential buildings or facilities. This table is based on published research, manuals or guidelines as well as on monitoring data from facilities in BC. (Salvato, Nemerow, and Agardy 2003; British Water 2009; Dziegielewski 2000; Otis et al. 2002; Nova Scotia Environment 2009; Onsite Sewage Treatment Program 2009; CSA Group 2012; Corbitt 2004; QSG 2005; K. Snodgrass 2007; Gössling et al. 2012; Dakers et al. 2004).

APs are encouraged to develop project-specific design flows, using measured flow rates whenever available.

IV- 5.5 Sewage and Type 1 effluent parameters

For this Manual (see Section III- 5.1.3), the reported quality of typical (median) residential sewage and septic tank effluent is based on research by Water Environment Research Foundation (Lowe et al. 2009).

Typical sewage flow peaking factors are based on design manuals and research (Lowe 2007; R. Crites and Tchobanoglous 1998; Laak 1986).The USEPA provided information on how garburators influence sewage quality (Otis et al. 2002).

IV- 5.6 Soil treatment performance

For the purpose of this rationale, discussion is generally limited to pathogen removal related to the primary performance objective for soil based treatment. Pathogen removal primarily considered removal of fecal coliform indicator organisms, but consideration was also given to removal of pathogens, including viruses, in soil based treatment. Attenuation of many, but not all, other contaminants is improved by similar steps to those that improve pathogen attenuation.

Removal of BOD and TSS is not considered to be a limiting factor for soil treatment unit performance, except in terms of long term acceptance rate (LTAR). See Section IV- 5.10.

IV- 5.6.1 INTERLINKED FACTORS

The performance of the soil treatment system is affected by a number of interlinked factors. As a result, simple vertical separation tables are not adequate on their own. Key standards influencing soil-based treatment include the following:

- Hydraulic Loading Rate (HLR) (Section II-5.5).
- Hydraulic Application Rate (HAR) (specified in the standards for HLR, dose method and dose frequency) (Section II-5.2).
- Vertical Separation (VS) (specified directly and also indirectly via minimum system contour length standards) (Sections II-5.3 and II-5.6).
- Type of distribution and uniformity of distribution (Section II-5.2).
- Infiltrative surface architecture (Sections II-4.1 and II-6).

IV- 5.6.2 STANDARDS DEVELOPMENT

IV- 5.6.2.1 Type of distribution, dosing, effluent type and vertical separation (VS) principles

The principles summarized in Table IV- 1 (below) were developed based on extensive literature review.

Table IV- 1 summarizes rationale and provides one or more references for each principle as a starting point for further reading. The summary rationale and references are primarily related to pathogens, since the primary performance objective is for pathogen attenuation.

These principles were used to establish a conceptual approach as well as setting draft standards for site capability, vertical separation and dosing frequency tables.

Table IV- 1. Principles for soil component standards

PRINCIPLE	NOTES	SELECTED REFERENCE(S)
Maintain aerobic conditions	Improves pathogen attenuation, microbial and faunal activity, oxidation (including of Nitrogen and Phosphorous). Increases system lifespan. Linked to maintenance of unsaturated flow.	(Potts et al. 2004; Kreissl 1978; Bouma, J. 1977).
Maintain a low soil water content (unsaturated flow)	Increases travel time, soil treatment and pathogen attenuation. Reduces risk of bypass flow forcing. Improves aeration.	(Lance and Gerba 1984; S. S. Van Cuyk et al. 2004; Torkzaban et al. 2006; S. V. Cuyk et al. 2001; Huntzinger Beach and McCray 2003)
Avoid bypass flows	Reduces risk of breakthrough of untreated effluent. Critical for high and very low permeability soils.	(Motz et al. 2012; J. C Converse et al. 1991) (Flury et al. 1994; McDonnell 1990), see also sand filter research, below.
Adjust designs for reduced treatment in the near saturation zone	The upper capillary or near saturated zone is effective for pathogen attenuation and soil treatment, but the lower zone is less effective due to oxygen transport limitations.	(Abit et al. 2008; Amoozegar, Niewoehner, and Lindbo 2006; Wespetal and Frekot 2001; Berkowitz, Silliman, and Dunn 2004).
Establish minimum VS to avoid saturated flow paths from infiltrative surface to water table.	Risk of establishing saturated flow pathways above the water table if the near saturated zone meets the infiltrative surface. Higher risk with saturated infiltrative surfaces (e.g. gravity distribution).	(Reneau 1978; Gillham 1984)
Soil type limitations and larger VS for gravity distribution to certain soils	Pathogen attenuation and distribution relates to the thickness, permeability and continuity of biomat, and to matrix permeability. Favorable for mid-range soil permeabilities.	(Bouma and Ziebell 1972; Kreissl 1978; J. C Converse and Tyler 1998a; L. W. Gill et al. 2007)
Increased VS for gravity distribution	High and low range soil permeabilities present a risk of bypass flows. For these soils biomat may be less reliable for treatment and dispersal and so for all effluent types larger VS is needed. Gravity sand filter studies reviewed for calibration.	(Clark and Gage 1909; Mancl and Peeples 1991) and above.
Soil treatment performance improved by uniform distribution.	Uniform distribution improves pathogen attenuation due to reduced risk of saturated flow and improved aeration. Uniformity was considered for gravity, dosed gravity, pressure and SDD distribution methods.	(J. E. McCray et al. 2000; Robert L. Siegrist, Sheila Van Cuyk 2001; J. C. Converse 1974; J. C. Converse et al. 1974)
Soil treatment performance improved by low hydraulic application rate (HAR)—increased dose frequency.	For uniform distribution methods, HAR is a key factor for pathogen attenuation, and also a key factor in avoiding bypass flows and improving aeration.	((Stevik, Ausl, et al. 1999; J. Bouma, C. Belmans, L. W. Dekker and W. J. M. Jeurissen 1983) and see Section IV- 5.7.1.2

PRINCIPLE	NOTES	SELECTED REFERENCE(S)
Use micro-dosing for subsurface drip dispersal (SDD) to native soils to allow reduced VS	SDD supports improved pathogen removal, particularly with micro-dosing.	(Hassan, Reneau, and Hagedorn 2008; Bohrer and Converse)
Use micro-dosing for sand systems with high HLR	Sand filter studies indicate that pathogen removal is depends on HAR, and recommend parameters for micro-dosing.	(Emerick et al. 1997; Darby et al. 1996; Emerick et al. 1999; Stevik, Ausland, et al. 1999)
Provide for increased VS for Type 2 HLR with demand dosing or gravity distribution	The allowable or advisable VS is related to increased HLR, increased HAR, reduced biomat contribution to distribution and to reduced biomat treatment.	See Section IV- 5.6.2.2
Encourage shallow placement of dispersal systems	Improves aeration, see above. Increased biological and microorganism activity in shallow soils. Improved phosphorous removal and more favorable soil structure and consistence.	(Mokma, Loudon, and Miller 2001; Otis et al. 2002)
Encourage placement of dispersal systems in healthy ecosystems with high organic matter content	Organic matter improves soil water holding capacity and so reduces risk of bypass flows. Also important for contaminant attenuation and breakdown of contaminants. Improves conductivity and aeration.	(Saxton and Rawls 2006)
Establish HLR based on pathogen removal as well as LTAR	See Section IV- 5.10	(Washington State Department of Health 2002c; Emerick et al. 1997)

IV- 5.6.2.2 Type 2 effluent and soil treatment unit performance

Several studies identify the risk that application of wastewater with reduced BOD, TSS, and ammonium nitrogen (but not necessarily greatly reduced pathogen levels) to soil at high hydraulic loading rates may result in deeper penetration of pathogens into the soil profile (Otis et al. 2002; L. W. Gill et al. 2007; R. L. Siegrist, Tyler, and Jenssen 2000; L. W. Gill et al. 2009).

The USEPA recommends carefully considering the use of the higher loading rates which may be feasible with this type of wastewater (due to higher LTAR).

The soil treatment unit and HLR standards of this Manual consider the following points with respect to application of Type 2 effluent:

- Review of the literature on pathogen removal performance for a range of treatment systems that meet the Type 2 treatment method standard shows variable rates of pathogen removal and pathogen removal reliability (see Section IV- 5.6.2.2.(a)).
- Review of literature on soil-based pathogen removal in soils loaded at high HLR and HAR, and with aerobic treatment unit effluent, showed limited removal in some instances (Kreissl 1978; Bouma and Ziebell 1972; J. C Converse and Tyler 1998a; Blasing and Converse 2004; J. McCray and Et Al 2010). See Section IV- 5.7for discussion of HAR and pathogen removal.
- Low BOD effluent limits the development of a biomat. Reduced biomat reduces soil treatment and also reduces the uniformity of distribution for gravity dispersal systems (J. C. Converse and Tyler 1998b; L. W. Gill et al. 2007).

- The Minnesota Pollution Control Agency model compares rates of pathogen reduction based on pathogen density at the infiltrative surface, HLR, VS and HAR (see Sections IV- 5.6.2.3 & IV- 5.10). The model was used to check that standards result in adequate pathogen removal in soil above the limiting layer. The model was also used to compare removal for different loading rates, vertical separation distances and dosing frequencies, with the goal that removal in the soil above the limiting layer be similar for all cases.
- Development of Type 2 HLR standards also included consideration of pathogen removal performance using this model and other references. This led to a limit to maximum HLR, particularly for highly permeable soils. See Section IV- 5.10 for discussion of HLR standards.
- A key advantage of Type 2 effluent is that little or no biomat will form at the infiltrative surface, assuming relatively conservative hydraulic loading rates. This Manual assumes that APs will most often use a Type 2 treatment method to reduce the size of the dispersal system. For this reason, relatively high HLRs were maintained in the standard for Type 2 effluent. However, even at higher Type 2 HLR, organic mass loading is considerably lower than for Type 1 HLR and so biomat formation will be limited.
- Since this Manual is linked to the SSR, the treatment methods, and hence the treatment standards, are limited to Types 1, 2 and Type 3. Standards in Volume II of this Manual were developed to be applicable to one of these three methods. There is no regulatory opportunity to distinguish one secondary treatment system from another, if neither meets the Type 3 standard.
- This manual provides a range of vertical separation as well as distribution and dosing options for use with Type 2 effluent, providing solutions for a large range of soil depths and soil characteristics.

As a result of these considerations and modelling, vertical separation (VS) standards for dispersal systems loaded with Type 2 effluent at Type 2 effluent HLR were established. In general the dosing and VS standards reflect the following:

- To provide adequate pathogen removal in soil with Type 2 effluent applied at Type 2 HLR, the recommended approach is to either increase vertical separation, or specify improved distribution and a lower hydraulic application rate (HAR), or to use a combination of these strategies.
- The specified vertical separation (VS) for a Type 2 HLR gravity system is larger than for a Type 1 HLR gravity system. This considers the relatively poor effluent distribution performance with Type 2 effluent and gravity distribution, which results in concentration of effluent and a high effective soil HLR at the proximal end of the dispersal system.
- Demand dose and timed dose frequencies are specified at a higher rate (smaller doses) for Type 2 effluent HLR versus Type 1 effluent HLR. However, the resulting hydraulic application rate is higher for Type 2 HLR. In addition, with demand dosing the higher Type 2 HLR carries a higher risk of causing bypass flow where doses are applied in close sequence.
- The specified VS for Type 2 HLR demand dosed and timed dosed uniform distribution systems is slightly larger than for Type 1, for some more highly permeable soils,. This is intended to reduce the risk of bypass flows with these systems at a higher HLR and to result in adequate pathogen removal in the soil above the limiting layer.
- Micro-dosing is defined to result in the same hydraulic application rate for Type 1 and Type 2 HLR.
- The specified VS for Type 2 effluent applied at Type 2 HLR using uniform distribution and micro-dosing is the same as for Type 1 HLR systems.
- For application of Type 2 HLRs to sand media micro-dosing is specified to improve pathogen removal in the sand media (see discussion of hydraulic application rate in Section IV- 5.7).

- The standards and guidelines emphasize that the Type 2 HLR dosing and vertical separation standards are related to loading rate. For situations where Type 2 effluent is applied at a Type 1 HLR, the specified VS is the same as for Type 1 HLR systems.

For certain problematic soil types, timed dosing or micro-dosing is specified for all types of effluent. This includes very highly permeable soils, for these soils Type 2 HLR was also capped to improve pathogen attenuation, see Section IV- 5.10.

IV- 5.6.2.2.(a) Secondary effluent pathogen removal performance

Primary and secondary treatment systems are not necessarily designed with pathogen removal as a priority. The Type 2 treatment method standard is directed primarily at removal of BOD, and may not provide any significant degree of pathogen attenuation (Arthur and Mundial 1983). A wide range of treatment techniques will meet Type 2 BOD and TSS standards.

Literature review of primary and secondary treatment performance indicates a wide range of pathogen removal in different secondary treatment systems (Lowe et al. 2009; Feachem et al. 1983) (J.M. Mauskar 20008; Mara and Horan 2003; Helmer et al. 1997; Tchobanoglous, Burton, and Stensel 2002; George, Crop, and Servais 2002; Feachem et al. 1983; James C. Converse and Converse 1998; McCarthy et al. 2001; Lesikar and Pillai 2003; Williamson 2009; Pundsack et al. 2001; Williamson 2010; Maxfield et al. 2003; Tchobanoglous, Burton, and Stensel 2002).

Counter-intuitively, some secondary treatment techniques may result in an increase in pathogen levels (Feachem et al. 1983). Other secondary treatment systems result in reliable pathogen and indicator organism removal by 2 log or better. Overall, research also shows high variability in rates of removal of pathogens in individual systems—both during testing and in operation.

For the purposes of developing standards for this Manual, comparisons were based on the majority of operating Type 2 treatment systems removing at least 0.5 log of pathogenic microorganisms. This is typically measured and reported and Fecal Coliform or E. coli indicator organisms.

Since most treatment systems use a septic tank with effluent filter preceding the secondary treatment unit, this removal rate was applied to Type 1 effluent pathogen levels, resulting in a value of 1.5E+5 CFU/100mL median Fecal Coliform indicator organisms in Type 2 effluent for standards development. This level falls in range for tested Fecal Coliform indicator levels in aerobic treatment plant effluent (James C. Converse and Converse 1998).

As a secondary outcome of this review, the guidelines of this Manual encourage specification of an adequately sized septic tank and effluent filter prior to secondary treatment.

IV- 5.6.2.3 Checks on performance, HLR, VS and HAR

This Manual relies on the following models and approaches used to develop and check the standards for loading rates, vertical separation and dosing frequency to the performance objectives (Section IV- 2.2.2):

- The models and research studies used to develop soil hydraulic loading rates, as discussed in Section IV-5.10.4.
- Each combination of effluent quality and soil hydraulic loading rate implies an oxygen loading rate or BOD loading rate. Implied BOD loading rates were compared to rates recommended in authoritative manuals, and the soil hydraulic loading rates were adjusted where appropriate. (See Sections IV- 5.4.1& IV- 5.10.1. Refer also to a discussion of oxygen transport in Section IV- 5.11.3
- The pathogen attenuation model of the MPCA was used to review, compare and adjust soil HLR, HAR (dosing frequency), and vertical separation, to meet the primary water quality objective at the limiting layer (Minnesota Pollution Control Agency 2010; Wespetal and Frekot 2001). Further consideration of pathogen removal performance was based on literature review, including studies on pathogen removal in intermittent sand filter systems and sand mounds and specific studies of virus removal (example (Emerick et al. 1997; Emerick et al. 1999; Standridge, Olstadt, and Sonzogni 2001; S. Van Cuyk et al. 2004)).
- The Colorado School of Mines nitrogen attenuation model (J. McCray and Et Al 2010) was used to check nitrate-nitrogen concentrations at the limiting layer, for common soil textures and system types.
- Soils data and pedotransfer relationships were used to roughly correlate soil texture and structure categories with soil permeability for the purpose of comparing soil HLR established using soil characteristics to HLR established using permeability (Saxton and Rawls 2006; Boulding 1994; Van Genuchten and Nielsen 1985; Schaap, Leij, and van Genuchten 2001).
- Consideration of soil and site capability included review of work in Carolina on a logical relationship between HLR and soil and site characteristics (D. L. Lindbo et al 2007).

IV- 5.7 Dosing

This discussion refers to standards in Section II-5.2 and guidelines in Section III-5.2.

Dosing standards were developed as part of development of the overall standards for the soil treatment and dispersal system, as discussed above.

IV- 5.7.1.1 Micro-dosing

For shallow vertical separations or for very high or low permeability soils micro-dosing (low hydraulic application rate (HAR) timed dosing) is recommended in order to meet performance objectives for the soil treatment unit.

Hydraulic application rate (HAR) may be defined based on discharge per dose per orifice or emitter, or on a depth per application basis. For simplicity in presentation of the standards HAR was related to doses per day by the following formula:

$$\boxed{\text{HAR} = \text{HLR} \div \text{Dose Frequency}}$$

IV- 5.7.1.2 Water holding capacity and HAR implications for maximized pathogen attenuation

The upper limit of the water-holding capacity for a soil is when it is said to be at "field capacity." This can also be termed the "drained upper limit."

The lower limit of water holding capacity is the "permanent wilting point" (PWP), at which point crops wilt and will not recover. Soils under a dispersal area are unlikely to be drier than this.

The "water holding capacity" of a soil is taken to be the difference between the field capacity and PWP.

The water holding capacity of sands tends to approach the field capacity as the sands become cleaner and coarser.

To encourage slow flow in aerated, unsaturated soil (and avoid bypass flows), doses of effluent should result in water content as far below field capacity as practical. Since water is applied to the top of the soil column, there is a limit to the depth of soil that should be considered when calculating dose volumes, assuming that one wishes the whole column to be effective. This depth is related to the matrix permeability of the soil.

For effluent filtration through sand, researchers recommend a maximum per dose HAR of 10% of the sand or soil water holding capacity (Emerick et al. 1997). This dose HAR is related to up to 60 cm sand depth, which is conceptually reasonable given the high matrix permeability of sands.

For structured soils of lower permeability it is important to avoid preferential flow in macropores and planar voids. These soils have a limited ability to rapidly absorb a dose of effluent into the soil matrix (due to low matrix hydraulic conductivity). Therefore, dose volume needs to consider the water holding capacity over a relatively shallow soil depth.

Typical values for soil water holding capacity used for standards development are based largely on the pedotransfer model developed by Saxton and Rawls (Saxton and Rawls 2006) for average soils with average organic matter content, average density and low coarse fragment content.

Water holding capacity is affected by gravel or other coarse fragments. For a general estimate of the effect of coarse fragment on soil water capacity a factor of (1 – coarse fragment proportion) may be used to adjust the water holding capacity (Kai Lipsius 2002; Sinowski, Scheinost, and Auerswald 1997). This calculation is provided in the guidelines and is also used to support adjustment of HLR for soils with high proportion of coarse fragments (Simon and Reneau 1987).

Water holding capacity is also impacted by soil density; guidelines provide a factor for adjustment based on research data (Saxton and Rawls 2006).

IV- 5.7.1.3 Design values for micro-dosing

In this Manual, the hydraulic application rate (HAR) for micro-dosing is limited to 10% of the soil water holding capacity. The "effective" soil depth used for calculation of dose frequency is as follows:

- 60 cm depth for sands, loamy sands, mound sand, fine sands and loamy fine sands.
- 30 cm depth for loamy very fine sands and sandy loams.
- 15 cm depth for loam, silt loams, silts, clay loams and clays.

Dosing frequency is based on HAR for the soil depth to provide the simplified dosing rate table in the standards. HAR and soil depth was calibrated using the MPCA predictions of dosing frequency needed to meet performance objectives for the soil treatment unit (Minnesota Pollution Control Agency 2010; Wespetal and Frekot 2001).

The guideline provides a version of the simplified micro-dosing table adjusted for the lower HLR used with subsurface drip dispersal systems.

To allow for flexibility a calculation method is provided in the guideline.

IV- 5.8 Vertical separation

Refer to standards Section II-5.3 and guidelines Section III-5.3.

Unsaturated vertical separation is considered critical to system performance. Section IV- 2.2.2 establishes specific objectives for performance at the base of the specified VS.

This Manual provides four different tables for selecting a vertical separation, to recognize the fundamental differences in how different systems infiltrate and treat effluent in the soil.

This Manual mandates that the allowable vertical separation is related to the method of distribution and dosing, allowing for smaller vertical separation with a uniform distribution system dosed at a low HAR (Emerick et al. 1997; Wespetal and Frekot 2001; Otis et al. 2002).

For gravity distribution to highly permeable soils, modern standards generally either prohibit or discourage this approach (Washington State Department of Health 2002a). Standards for gravity distribution to sandy gravelly soils is based on soil water holding capacity, and also on reports of gravity sand filter performance (Clark and Gage 1909; Peeples 1991; Mancl and Peeples 1991).

In this Manual, the allowable vertical separation was adjusted based on the principles in Section IV- 5.6.2, and then checked against other SPM standards using the procedure described in Section IV- 5.6.2.3. Nitrogen attenuation performance was modeled only for an "average" soil type, Sandy Loam with a favorable structure and consistence.

Sand mound vertical separation initial values were based on Wisconsin and Washington State standards as well as sand mound and filter research (Emerick et al. 1997; Darby et al. 1996; Emerick et al. 1999; Stevik, Ausland, et al. 1999; J. C. Converse 2004; M. M. Converse, Converse, and Tyler 1999; J. C Converse and Tyler 1998a; Kristiansen 1981). Performance was checked using the same approach as for other systems (see Section IV- 5.6.2.3). Estimates of pathogen removal in sand mounds also included studies of sand mounds in seasonally saturated conditions and with Type 2 effluent (Blasing and Converse 2004).

For ease of use, vertical separation tables were simplified as follows:

- Vertical separation distances are increased in increments of 5 cm or more.
- Each table has only two or three soils categories, rather than every soil type.
- The sand mound vertical separation is simplified.
- Special considerations needing increased vertical separation are included with site capability tables. (Refer to Section II-4.1), and with the guidelines.

IV- 5.8.1 LONG TERM MAINTENANCE OF VERTICAL SEPARATION

The standard vertical separation tables are based on systems that are constructed following minimum system contour length and LLR standards. For larger systems (design flow > 9100 L/day), professional design is required by the SSR. Professional design includes estimating water table mounding and confirming vertical separation.

As a result, the design vertical separation would normally be maintained for the life of the system.

IV- 5.9 Horizontal separation

This discussion refers to standards in Section II-5.4 and guidelines in Section III-5.4.

This Manual bases horizontal separation (HS) distances on a consensus of regulations and codes used elsewhere in North America, and those used historically in BC. For the horizontal setback distance to a drinking water well, the SSR mandates a horizontal separation, and specifies a process for site-specific assessment of that separation.

This Manual uses the approach that the unsaturated sand and soil (the vadose zone), beneath the dispersal area, is the main zone of soil-based treatment. This approach does not rely on lateral saturated groundwater flow as a significant part of the soil-based treatment system, since pathogen removal in this zone is not reliable.

To reduce risks from leaking tanks, this Manual specifies testing to confirm watertight tanks, and ongoing maintenance standards for tanks, see Section IV- 5.9.3.

The specified horizontal setback distances are based on the following objectives:

- Provide consistence with the SSR.
- Reduce direct human exposure to pathogenic microorganisms.
- For BC zero discharge lagoons, reduce the risk of indirect human exposure to pathogens via insects or other vectors based on common practices.
- Reduce odours from BC zero discharge lagoons
- As a secondary consideration, reduce nitrate-nitrogen concentrations at drinking water wells, as resulting from the density or spacing of onsite sewerage systems in areas where water wells are common.
- Consider environmental protection on a qualitative or semi-quantitative basis, as described below
- Provide a logistical separation distance, so that one structure can be altered or repaired without harming a nearby structure. For example, a septic tank should not be located too close to a building foundation, even without a foundation perimeter drain, to avoid damage to one structure while working on the other structure.

The consensus based standards were checked against a qualitative risk assessment for human health and environment, on the basis that where the receptor boundary is high risk, then a larger setback is specified. This approach was also checked against historical information.

The horizontal separation standards are not intended to guarantee potability of water at the receptor, but rather to reduce risk.

IV- 5.9.1 SYSTEM TYPE AND HORIZONTAL SEPARATION

The system standards of this Manual have been calibrated to provide similar water quality at the limiting layer that forms the base of the soil-based treatment system, see Section IV- 2.2.2.2. As a result, there is no supporting rationale for varying horizontal separation according to pre-treatment or dosing system. This Manual provides a simplified HS table independent of treatment type.

This Manual provides special setback distances for BC zero discharge lagoons, to reduce problems arising from vectors, insects and odours, and also to address the practical issue of berm width.

IV- 5.9.2 PHOSPHOROUS ATTENUATION

Whereas pathogens and nitrogen are not reliably attenuated in the water table over short distances, phosphorous is generally significantly attenuated with increasing distance from the point of discharge. Phosphorous is also reliably attenuated in the vadose (unsaturated) zone, particularly with shallow placed dispersal systems using conservative HLR.

Due to the BC's wide variation of soil types and potential phosphorous adsorption capacities and attenuation or retardation factors, it is not considered practical to establish HS to fresh water based solely on phosphorous attenuation or retardation.

Attenuation and retardation of movement of phosphorous in soil was reviewed, based on a range of literature values for average soil types and common system types as well as to available monitoring data (Robertson, Schiff, and Ptacek 1998; Flaten et al. 2003; Siegrist et al. 2011; Robertson 2003). For phosphorous, the water quality objectives were based on BC Approved Water Quality Guidelines.

This review indicated that the standard setback distance to fresh water is expected to avoid negative impacts due to phosphorous in the majority of cases for, at least, the expected lifespan of a typical sewage system.

IV- 5.9.3 RISK MANAGEMENT FOR TANKS

Leaking tanks and poorly sealed enclosures may be a risk to health and the environment. Older tanks and enclosures were often unreliably sealed. Some standards require large horizontal setback distances, as a way to manage risks. Given that a leaking tank may have little or no primary attenuation of pathogens; these strategies are not likely to be reliable as a primary method for risk mitigation.

To reduce risks of leaking tanks, it is considered preferable to combine a requirement for reliably sealed tanks and enclosures (Ball et al. 2004) with maintenance requirements. Key risk management strategies in this Manual include the following:

- Select and install tanks to meet CSA structural standards (CSA B66).
- Seal tank lids (for tanks with separate lids), enclosures, penetrations and risers. Screen vents.
- Requirements for the following:
  - Proper tank installation.
  - Proper support of inlet and outlet piping.
  - Watertight testing of tanks, with performance standard.
- Check tanks and enclosures at every maintenance visit.

IV- 5.10 Hydraulic Loading Rate

This discussion refers to standards in Section II-5.5 and guidelines in Section III-5.5.

IV- 5.10.1 HLR TABLES

Long Term Acceptance Rates (LTAR) which can support sustainable systems (with a system life of 35 years or more) were used as the initial basis for HLR selection. LTAR is the stable equilibrium rate at which an effluent of particular strength can be applied to a particular soil using a particular system configuration and process.

IV- 5.10.2 CONSIDERATION OF LTAR AND CONTAMINANT ATTENUATION

HLR standards need to consider contamination attenuation (particularly pathogen attenuation) as well as simple disposal of effluent. See Section IV- 5.6for discussion of contamination attenuation and Sections IV-5.6.2 & IV- 5.6.2.2 for principles and approaches used when considering HLR.

This dualistic approach will increase system life and improve performance and is considered to be the standard approach for modern onsite sewerage system design (Rule Development Committee 2002).

IV- 5.10.3 AEROBIC INFILTRATIVE SURFACE

Modern HLR standards are based on maintenance of generally unsaturated and aerobic conditions rather than a "deeply ponded infiltration surface" approach. The rationale for this choice is to increase system life and to improve pathogen and contaminant removal reliability.

This approach results in somewhat lower "aerobic" Long Term Acceptance Rates (LTAR) than for ponded conditions and also has implications for distribution and dosing.

Dosing to the infiltrative surface promotes increased aerobic LTAR, as long as the HLR is low enough. If the HLR is raised to the point where the infiltrative surface will be ponded, for at least part of the time, then the dosing will have a limited effect on LTAR (Hargett, Tyler, and Siegrist 1981).

IV- 5.10.4 DEVELOPMENT OF HYDRAULIC LOADING RATE (HLR) VALUES

IV- 5.10.4.1 Conceptual approach

Development of HLR standards in this manual was based on five main concepts:

- Long term acceptance rate (LTAR) based on soil hydraulic properties.
- LTAR based on effluent strength.
- Pathogen removal performance to meet the stated performance objective, related to standards for VS, dosing and distribution.
- BOD mass loading and oxygen transport needed to maintain aerobic conditions at and near the infiltrative surface.
- Equilibrium unsaturated flow from the infiltrative surface, based on very low or no ponding.

IV- 5.10.4.2 Development of values

IV- 5.10.4.2.(a) First estimates of values

First estimates of HLR based on soil texture and structure were based on:

- The values developed by Tyler (Tyler and Converse 1994; Tyler 2001).

- Values summarized by Kreissl (Kreissl 1978).
- An approach developed for low permeability soils (Simon and Reneau 1987).

The Tyler table is widely used in other jurisdictions (including Alberta, the SPM V2, the CSA B65 and the USEPA manual). See Section IV- 5.2.1for discussion of development of the table of soil structure and consistence categories, which extends the consideration of soil texture and structure in the Tyler table with consistence to provide further check on soil suitability (D. L. Lindbo et al 2007).

First estimates of sand media HLR were based on the HLR used in Washington State, Wisconsin and Oregon standards. Sand media gradation specifications were based on the sand media specified by those states and on test protocols established by ASTM.

First estimates of HLR based on soil permeability used semi empirical relationships between LTAR and permeability and percolation rates developed by Taylor, Laak, Ryon, Winneberger and others, which are also widely used (Catherine Taylor, Yahner, and Jones 1997; Laak 1986; Laak, Healy, and Hardisty 1974; Winneberger 1984; Ryon 1927).

IV- 5.10.4.2.(b) Further analysis and development of final values

For comparison between LTARs for effluent of different strengths (e.g. Type 1 to Type 2), empirical relationships from the literature were used (Laak 1986; Tyler 2001; Tyler and Converse 1994; Jenssen and Siegrist 1991; Catherine Taylor, Yahner, and Jones 1997). Comparison included consideration of a limit to HLR related to a percentage of the saturated hydraulic conductivity, for the maintenance of unsaturated and aerobic conditions (Robert L. Siegrist 1987) (see also the use of the modified Bouma model, below for consideration of maintenance of primarily unsaturated flow conditions).

Pathogen removal performance was considered as part of overall consideration of soil treatment unit standards (see Section IV- 5.6), including model comparisons as discussed in Section IV- 5.6.2.2. In general small system area was prioritized over the need to increase VS, since it was considered that VS can be provided using imported material, but the land area cannot be increased. However, to provide better soil-based treatment, and to maintain consistent vertical separation standards, the standard HLR for high permeability soils was limited (capped to a maximum value) for Type 1 and 2 effluents, see Section IV- 5.3.5.2 for discussion of other strategies for the soil treatment unit related to high permeability soils.

BOD mass loading was considered for LTAR (particularly for Type 1 systems with high HLR, such as sand mounds), with a target of a maximum 5 g/m^2/Day BOD for sand media and a range of 1 to 7 g/m^2/Day for soils (Otis et al. 2002; Peeples 1991; Rule Development Committee 2002; Washington State Department of Health 2002b; Matejcek 2000; Eberhard Roeder, David Bloomquist, and Paul Booher 2007). As noted in Section IV- 5.4.1the relationship of the HLR tables to the residential DDF standards was checked with respect to mass loading of BOD to the infiltrative surface, with a view to avoiding ponding at the infiltrative surface. BOD loading rates and oxygen transport considerations were also used to adjust HLR values for lower permeability soils, resulting in a limiting "cap" for HLR to these soils. See Section IV- 5.11.3for discussion of oxygen transport modelling. See Section IV- 5.3.5.3 for discussion of other strategies for the soil treatment unit related to high permeability soils.

Equilibrium unsaturated flow was considered using a model with a modified form of Bouma's equation and considering an aerobic biomat with very low ponding levels, with biomat hydraulic conductivity properties varied to reflect the type of effluent applied (D. E. Radcliffe and West 2009; Bouma, J. 1977; S.D. Finch et al. 2007).

IV- 5.10.4.3 Correlation between soil characteristics, permeability and percolation rate

As noted in Section IV- 5.6.2.3, pedotransfer relationships and measured values were used to establish approximate correlations between soil characteristics and permeability or percolation rate.

To consider the correlation between permeability and percolation rates several approaches were used, with the primary approach being application of the Glover formula (Amoozegar 1997; Zangar 1953; Adam Olivieri and Roche 1979).

IV- 5.10.4.4 Simplified tables

For ease of use, the hydraulic loading rate tables were simplified as follows:

- The standard hydraulic loading rates were generally rounded.
- Soil types with similar or identical HLRs were grouped together into soil texture "groups" representing a number of soil texture classes and sub classes. A table is provided in the guideline to allow fitting of soil texture into the appropriate group.
- A simplified method of displaying soil structure and consistence characteristics was developed (see Section IV- 5.2.1).
- The HLRs based on permeability and percolation rate were combined in a single table, since the rates are roughly comparable (as noted above).

IV- 5.10.5 DEPTH RANGE FOR APPLICATION OF HLR

The standard recommends determining HLR based on the lowest permeability soil within 30 cm below the infiltrative surface. Rationale includes:

- This depth is representative of a mid-range for consideration of water holding capacity for dosing design.
- This depth is the minimum depth for sand media in a sand mound system (so avoiding confusion in this case).
- A similar depth is recommended in literature (D. L. Lindbo et al 2007).

A similar approach was taken in establishing procedure for soil type selection for other standards, including vertical separation and site capability.

IV- 5.10.6 SUBSURFACE DRIP DISPERSAL HLR

Subsurface Drip Dispersal (SDD) systems are typically sized using an areal loading calculation, with an allowance of "width per line" (EPRI and TVA 2004). In most design guidelines, a width of 60 cm per line is allowed. Due to the relationship of small surface contact around the dripline to the wide area, a lower HLR is recommended than that for standard trench or bed systems.

Dripline manufacturers have recommended HLRs for drip systems, and several jurisdictions rely on these recommendations. The state of Wisconsin provides a manual for SDD (State of Wisconsin 1999) which includes a HLR table suited to cold climate SDD systems.

Dripline manufacturer recommendations and the Wisconsin HLR table were compared to the SPM standard HLR for soil types and an approximate relationship was established to allow use of a factor for Type 1 and Type 2 effluent which. When this factor is applied to HLR table values in Volume II, this results in rates similar to the manufacturer recommendations and the Wisconsin table. Adjustment for effluent strength was made where necessary, following the same approach used to adjust LTAR for different strength effluents described above.

Adjusted HLRs were used in checking the VS and dosing standards for SDD to the primary performance objective, following the process outlined in Section IV- 5.6.2.2 . An AP may use the SPM loading rates, or use loading rates recommended by the manufacturer.

In this Manual, SDD standards (Section II-6.11) include a requirement to increase the number of emitters where Type 1 effluent is used. This considers the need to limit mass loading per emitter, and increase total line length for higher BOD effluent, in order to maintain aerobic conditions near the emitters.

SDD systems rely on shallow burial for oxygen transport and for improved system performance; the standard burial depth for residential systems is 15 to 30 cm.

IV- 5.10.7 HLR AFFECTED BY SODIUM AND SALINITY

In situations where a dispersal system is constructed in clayey soils, sodium in the sewage can accumulate in the soil and reduce the soil permeability. With Type 1 effluent, the LTAR is often limited by the permeability of the biomat, rather than the soil. However, with Type 2 or 3 effluent, accumulating sodium may be more significant in terms of reduction of soil permeability in the long term due to higher mass loading and less risk of biomat accumulation (Amoozegar 1998).

As precautions, this Manual includes a warning in Volume III guidelines, and specifies reserve areas for ETA systems.

IV- 5.10.8 RISK MANAGEMENT AND METHODS FOR HLR SELECTION

Studies (Hart et al. 2008; Winneberger 1984) have highlighted the risk of relying exclusively on soil morphology to establish HLR. Other studies highlight the need for a high level of soil science training to successfully classify soils based on morphology (R. J. Miles, L. T. West 2001).

The study by Hart et al. found that field soil permeability testing was a valuable tool to correct excessively high HLR values which were originally selected for study sites based on soil texture and structure following local code.

Other researchers highlight the risk of relying only on permeability, and particularly on percolation rate (Winneberger 1984).

Based on these considerations, this Manual specifies use of both soil morphology and soil hydraulic conductivity conjunctively, allowing each approach to be used as a check on the other approach. The standard method is to use the lower, or more conservative, loading rate. In addition to this check, this Manual uses soil consistence (rupture resistance) to help identify unsuitable or marginal soils.

IV- 5.11 System minimum contour length and Linear Loading Rates

This discussion refers to standards in Section II-5.6 and guidelines in Section III-5.6.

To meet the performance objective for maintenance of VS, while keeping simplicity, the standards take two approaches:

- A minimum system contour length for all systems.

- LLR tables for some systems.

IV- 5.11.1 MINIMUM SYSTEM CONTOUR LENGTH

A minimum contour length was established, with allowance for use on relatively deep soils or vertical flow conditions for small systems. This allows for simplicity with these small systems on deeper soils.

The minimum length and required soil depth was established to result in safe linear loading rate (maintenance of minimum VS standards) when combined with standards for trench or bed width and spacing and standard HLR for more permeable soils. Calculations were based on the controlling condition of a flat or low slope site, using Darcy's Law and models for water table mounding and drainage, including (Khan, Kirkham, and Handy 1976; Kaplan 1991).

IV- 5.11.2 LLR TABLE VALUES

In this Manual, the standard linear loading rates are based on a consensus between rates calculated using Darcy's Law and the published values from Tyler & Kuns (Tyler 2001). The Darcy's Law approach is the same method used by the Canadian Standards Association in CSA-B65 (CSA Group 2012).

The Tyler tabular approach has been used widely in North America with no known reports of the linear loading values being excessive for small systems. In general, this Manual uses Darcy's Law as the basis for LLRs for more permeable soils, and the Tyler tables for less permeable soils. Depth ranges for LLR selection are chosen to reflect the range of vertical separations offered in the standards.

The target for the LLR standard is to maintain vertical separation below the dispersal area and in the receiving area over the life of the system. The simplified LLR approach is used to avoid the need for practitioners to estimate water table mounding for small systems.

For each soil texture group, typical hydraulic conductivity (Ksat) was based on a consensus of:

- Saxton and Rawls (Saxton and Rawls 2006).
- Tyler and Converse (Tyler and Converse 1994).
- With checks to a number of field permeameter tests on native soils and sand fill in BC.

Standard linear loading rates were limited to a maximum of 4 times higher than the rates recommended by Tyler, and the higher rate of the calculated rate and that from Tyler's table was used in each case.

Tyler's tabular values are based on DDF rather than average flows, with a minimum of 150 USgal/day/bedroom (570 L/day/bedroom). Average daily flow rates were used for calculation of values for the standard, but for ease of use the standards tables are presented based on DDF, with DDF = 2 x average daily flow to match the DDF standards. This means that allowable LLR values were doubled to allow use with DDF.

The new standard linear loading rates were compared to field measurements of water table mounding at operating dispersal systems in BC to confirm that the specified rates are reasonable (M Payne, pers. comm. 2013).

IV- 5.11.3 SYSTEM WIDTH, SOIL TYPE AND OXYGEN TRANSPORT

The SPM standards consider oxygen transport to the infiltrative surface and receiving soil treatment system in several ways:

- Bed width limitation (Section II-6).
- Bed and trench spacing standards (Section II-6).

- Limiting Type 1 Seepage Bed and bottomless sand filter systems to permeable soil types (Section II-4.1).
- Encouraging shallow infiltration surfaces, restricting the depth of cover soil, and specifying the quality of cover soils (Section II-6 and guidelines Section III-6).
- Specifying or recommending highly treated effluent for certain soils (Section II-4.1 and Section III-6).

In some cases these standards essentially specify a minimum allowable system contour length, through the need to maintain maximum bed width.

The seed values for these standards were based on other standards, including the SPM Version 2, Washington State and Wisconsin standards, Tyler (Tyler 2001) and the USEPA manual (Otis et al. 2002).

To examine the relationship of bed width and spacing to soil type and effluent type a model was used. The model is based on a heat transfer approach proposed by Janna and supported by oxygen transfer models and pedotransfer relationships (Janna 2007; Mahuta and Boyle; Saxton and Rawls 2006; Moldrup et al. 2000). Analysis was based on maintaining aerobic conditions in and below the bed with soil at field capacity.

IV- 6 SPECIFICATION AND INSTALLATION STANDARDS

This discussion refers to standards in Section II-6 and guidelines in Section III-6.

In general, the selected standards for specification and installation are intended to reflect BC industry consensus. The selected standards were intended to:

- Support the water quality objectives.
- Ensure that choices offered were consistent with the design standards.
- Provide for simple and cost-effective use of the standards by most practitioners in BC.
- Establish consistent performance standards for competitive or alternative systems.
- Provide generic standards that are not specific to, or prejudiced toward, any particular manufacturer or supplier.
- Allow for future introduction of new equipment or methods to BC.
- Within reason, provide standards that are comparable to other North American jurisdictions.
- Include systems commonly used in BC, or particularly well-suited to the BC environment.

Many of the standards for specification and installation are considered important or necessary to ensure the soil treatment and dispersal systems meet water quality objectives.

IV- 7 MAINTENANCE AND MONITORING

Refer to standards Section II-7 and guidelines Section III-7. Studies identifying watershed level pathogen contamination from onsite sewerage systems indicate that maintenance and monitoring of systems is of critical importance (Graves et al. 2002), (Feng Jiang and Amanda Worthington 2005; D. Radcliffe et al. 2006)).

In general, improved monitoring and maintenance will have a stronger effect upon overall performance than will improvement in design.

The maintenance of sewerage systems includes monitoring of the system operation and performance. In the case of a treatment system, this includes monitoring of effluent quality for conformance with the Regulation.

Following this conclusion and the need for monitoring to confirm performance, the standards include requirements for maintenance plans, maintenance procedures and for minimum frequency of maintenance and monitoring.

Studies of the performance of secondary and tertiary treatment systems (see Section IV- 5.6.2.2.(a)) indicate that systems must be maintained and monitored to meet effluent standards (USEPA 2003). Although grab sample monitoring is not always reliable, this Manual stipulates periodic sampling and testing of effluent from all Type 2 and 3 treatment systems, as a means to demonstrate compliance with the Regulation and recommends sampling from or after the dispersal system pump chamber to provide a degree of aggregation of effluent in the sample. Guidance is provided for sampling in the vadose zone for Combined Treatment and Dispersal Systems (CTDS).

The SPM cannot guide actions by owners, and so cannot provide standards for their implementation of maintenance.

However, the SSR mandates maintenance, and the standards and Volume III guidelines provides procedure guidance in the form of checklists to guide work by maintenance providers.

IV- 8 DESIGN MANUALS AND OTHER REFERENCES

A number of useful design manuals provide information relating to the planning, construction, operation and maintenance of onsite sewerage systems. Should conflicts arise between the prescribed requirements of the Sewerage System Regulation (SSR) or the standards of the SPM and the information presented in these manuals, it is recommended that the AP follow the SPM standards and the AP must meet the requirements of the SSR.

IV- 8.1.1 DESIGN MANUALS

The following is a short list of widely used design manuals:

- US EPA Onsite Wastewater Treatment Systems Manual, 2002 (Otis et al. 2002). Available online at http://www.epa.gov/owm/septic/pubs/septic_2002_osdm_all.pdf
- CSA B65-12,(CSA Group 2012) Installation Code for Decentralized Wastewater Systems, available from the CSA http://shop.csa.ca/en/canada/page/home/
- University of Minnesota, Onsite Sewage Treatment Program, 2009. Manual for Septic System Professionals. Published online by U. of Minnesota (Onsite Sewage Treatment Program 2009). Available online at http://septic.umn.edu/sstsmanual/index.htm
- Washington State RS&G and supporting documentation. Available online at http://www.doh.wa.gov/CommunityandEnvironment/WastewaterManagement/FormsPublications#RS&G
- Wisconsin State standards Available online at http://dsps.wi.gov/php/sb-ppalopp/prodcode_result.php/POWTSM/POWTS_COMPONENT_MANUAL
- Small and Decentralized Wastewater Management Systems 1998 (R. Crites and Tchobanoglous 1998).

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