Instructions for 2009 SSTS Design Forms

The 2009 Design forms included in this file are intended to meet the new 2008 Chapter 7080 Rules. Due to the many changes there will be updates over the next months and year. Please check back to the website frequently and download the most current version. There are 19 worksheets in the 2009 SSTS Design Form Workbook, they are:

1. Preliminary Evaluation
2. Field Evaluation
3. Boring Log
4. Site Evaluation Map
5. Percolation Test
6. Flow & Soil
7. Trench & Bed
8. Mound
9. At-Grade
10. Pressure Distribution
11. Non-Level Pressure Distribution
12. Pump Selection
13. Pump Tank
14. Flow Estimate for Existing Subdivision
15. Flow Estimate for New Subdivision
16. Measured Flow-Other Establishment
17. Final Flow Total
18. Flow & System Summary
19. Single-Pass & Recirculating Filter

These worksheets were created in Microsoft Excel. You must have a software program that can open .xls documents to use these forms. If you do not have Microsoft Excel, you can download a similar program named OpenOffice online: http://www.openoffice.org/

There are two ways you can utilize this workbook:

1. You can use the Excel worksheet on a computer and fill in the values on a computer & print out the results or email them. Using this function you must be sure to enable macros if asked this by Excel, or
2. You can print blank copies of the worksheets and fill them out by hand.

SECURITY LEVEL & MACROS

This file contains macros which are imbedded formulas to do some of the calculations. In order for these to work:

1. Your security level must be medium or low (not the default of high). This can be changed under Tools, Macro, Security
2. If prompted enable the macros.

INPUTS

In each worksheet, you will notice each cell is colored either green (or grey depending on your system settings) or yellow.

Yellow cells are user input cells, that is, these are the cells where you as the designer must manually enter the value that the worksheet is requesting.

Green cells are cells that will fill in automatically as you enter values into the yellow cells.

CHECK BOXES

Many of the worksheets have check boxes that one may check on the computer. If these are not working, you are most likely is in "design mode" in excel. To fix this, from the menu, select View, Toolbars, and then select "Control Toolbox". Now a new toolbar will appear in your menu bar. There is a button that looks like a ruler and a speed square. Click it to get out of design mode. Now the check boxes should work.

DROP DOWN MENUS

Some of the yellow cells have a drop-down menu function. A small arrow pointing downwards will appear in the lower right corner of the cells with a drop-down menu. You MUST choose one of the values in the drop-down menu. To erase the value, simply highlight the cell and press the Delete key on your keyboard.

NOTE: Most of the cells in this workbook have a great deal of complex formatting and formulas in the background. If you alter the formulas, the workbook will not function properly. It would be a good idea to copy this workbook and always work with the the copy, so the original can be utilized for back-up purposes only.

PRINTING

The worksheets should display and print at 100%. This makes the worksheets readable and able to be filled in by hand. The worksheets can be printed in either color or black and white. You may need to set your computer/printer to grayscale option or you may wish to change the colored portions of the worksheets. Each sheet that is part of your design must be printed separately as there is not a way to print them all at one time.

SAVING
Each time a design is done the file should be saved with a unique file name. Keep an original version of the workbook with no data entered. To have a version which can not be altered you can create at PDF. Creating a PDF requires the full version of Adobe Acrobat which is software you may not have. The other option is to go to "Tools"..."Protection"..."Protect Worksheet" and save the file for that particular job which it what the overall plan for how to do this.
CREDITS
Developed by the University of Minnesota: Sara Christopherson, Dave Gustafson and Dan Wheeler; Tim Haeg, Watab Inc.; Chris LeClair, Washington County; and the Minnesota Pollution Control Agency. Thanks to the many that provided comments and feedback during the development process.

Preliminary Evaluation Form

University of Minnesota Onsite Sewage Treatment Program

1. Contact Information

Property Owner/Client: Client Phone Number:

Address

Parcel I.D. Township # Range # W Section

Date Township name Latitude/Longitude

Evaluation for system type New Construction ☐ ☐ Existing Dwelling Parcel dimensions

2. Flow Information

Client-Provided Information

Type(s) of use (*all that apply*) ☐ Residential ☐ Commercial ☐ Other Use (Specify)

No. of bedrooms* (*if applicable*) Unfinished space (ft^2)

No. of residents in home ☐ Adults ☐ Children ☐ Teenagers

Existing flow measurements ☐ Yes (If Yes, attach readings) ☐ No

Water-using devices (*check all that apply*)
☐ Garbage Disposal ☐ Water Softener ☐ Iron Filter
☐ Dishwasher ☐ Sump Pump Other (*specify*)
☐ Large Bathtub/Jacuzzi ☐ High Efficiency Furnace
☐ Laundry/Large Tub on 2nd Floor ☐ Hot Tub

Water use concerns (*check all that apply*)
☐ Faucet/Toilet ☐ Multiple Loads of Laundry/Day ☐ Long-Term Prescription Meds
☐ In-Home Business ☐ No Lint Screen ☐ Use of Anti-Bacterial Soap ☐ Frequent Entertaining of Out-of-Town Guests

Any additional current or future uses on this parcel (*specify*)

Any non-sewage discharges to system (*specify*)

Sewage ejector or grinder pump in home ☐ Yes ☐ No

I acknowledge the above is complete and accurate (*Client(s) signature and date*)

Designer-determined Flow Information

A. Estimated Design Flow (gallons per day)

Anticipated waste strength ☐ Domestic ☐ High Strength Reasoning

3. Preliminary Site Information

B(1). Water supply well(s) within 100 ft of absorption area ☐ Yes ☐ No

Well(s) were located ☐ Direct Observation ☐ County Well Index Maps ☐ Personal Communication

Depth of well(s) ft Well casing depth(s) ft Source

B(2). Site within 200 ft of noncommunity transient supply well ☐ Yes ☐ No Source

B(3). Site within a drinking water supply management area ☐ Yes ☐ No Source

B(4). Location of all existing and proposed buildings and improvements on lot (*see Site Evaluation map*)

B(5). Buried water supply pipes within 50 ft of proposed system ☐ Yes ☐ No

C. Location of all easements on lot (*see Site Evaluation map*) Source

D. Elevation of ordinary high water level (OWHL) - MN DNR (***if adjacent to parcel***)

E. Floodplain designation and flood elevation Source

F. Determine property lines (*see Site Evaluation map*) ☐ Survey ☐ Plat Map ☐ Other

Site located in a shoreland district/area ☐ Yes ☐ No

G. Distance of setbacks ☐ Property Lines ☐ OHWL ☐ Easements ☐ Water Supply Pipes ☐ Well(s)
☐ Other Buildings

H. Soil Survey Information (***from web soil survey***) ☐ Map Map Units on Parcel

List landforms Slope Range

Parent materials (*circle all that apply*) Till Outwash Loess Bedrock Alluvium Colluvium Lacustrine Organic Cut/Fill

Landscape Position (*circle all that apply*) Summit Shoulder Backslope Footslope Toeslope Depression Stream Terrace Man-made Plain

___ Minimum bedrock depth ☐ Maximum Bedrock Depth ☐ Minimum Redox Depth ☐ Maximum Redox Depth

Map Unit Ratings
Septic Tank Absoprtion Field - Trench (MN)
Septic Tank Absorption Field - At-grade (MN)
Septic Tank Absorption Field - Mound (MN)

Preliminary Evaluation Form

University of Minnesota Onsite Sewage Treatment Program

4. Preliminary Soil Profile Information (*from web soil survey - map unit description & official series descriptions*)

Map Unit

	Depth	Texture(s)	Structure(s)	Consistence	Other (flooding, ponding, etc.)
Horizon 1					
Horizon 2					
Horizon 3					
Horizon 4					
Horizon 5					

Map Unit

	Depth	Texture(s)	Structure(s)	Consistence	Other (flooding, ponding, etc.)
Horizon 1					
Horizon 2					
Horizon 3					
Horizon 4					
Horizon 5					

Map Unit

	Depth	Texture(s)	Structure(s)	Consistence	Other (flooding, ponding, etc.)
Horizon 1					
Horizon 2					
Horizon 3					
Horizon 4					
Horizon 5					

Map Unit

	Depth	Texture(s)	Structure(s)	Consistence	Other (flooding, ponding, etc.)
Horizon 1					
Horizon 2					
Horizon 3					
Horizon 4					
Horizon 5					

5. Local Government Unit Information

Name of LGU		LGU Contact	
LGU-specific setbacks			
LGU-specific design requirements			
LGU-specific installation requirements			

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer)	(Signature)	(License #)	(Date)

Field Evaluation Form

University of Minnesota
Onsite Sewage Treatment Program

1. Contact Information

Property Owner/Client _____ Client Phone Number: _____

Address _____

Date _____ Weather Conditions _____

2. Utility and Structure Information

Utility Locations Identified ☐ Gopher State One Call ☐ Any Private Utilities

Property Lines ☐ Determined and Approved By Client _____ *Client's Approval (initial)*

☐ Determined But Not Approved

☐ Approximate

☐ Property Lines Surveyed

Locate and Verify (*see Site Evaluation map*)

☐ Existing Buildings ☐ Improvements ☐ Easements ☐ Setbacks

3. Site Information

Percent Slope _____ Slope Direction _____

Landscape Position _____ Geomorphic Description _____

Vegetation type(s) _____

Evidence of cut, fill, compacted or disturbed areas ☐ Yes ☐ No ☐ Locate Areas on Site Evaluation Map

Discuss the flooding or run-on potential of site _____

Identify benchmarks and elevations (*Site Evalulation Map*) _____

Proposed soil treatment area adequately protected ☐ Yes ☐ No

4. General Soils Information

Original soils ☐ Yes ☐ No

Type of observation ☐ Soil Probe ☐ Soil Boring ☐ Soil Pit* **Soil pit required if determining loading rate without perc test*

Number of soil observations _____

Soil observations were conducted in the proposed system location ☐ Yes ☐ No

A soil observation was made within the most limiting area of the proposed system ☐ Yes ☐ No

Soil boring log forms completed and attached ☐ Yes ☐ No

Percolation tests performed, forms completed and attached ☐ Yes ☐ No

5. Phase I. Reporting Information

Depth to standing water		inches
Flood elevation		feet
Depth to bedrock		inches
Depth to periodically saturated soil		inches
Maximum depth of system		inches
Elevation at system bottom		feet
Percolation rate		min/inch
Loading rate		gpd/ft^2
Contour loading rate		gpd/ft

Anticipated construction issues

Differences between soil survey and field evaluation

Site evaluation issues / comments

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Soil Boring Log

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Onsite Sewage Treatment Program

Date

Time

Client/ Address:

Legal Description/ GPS

Landscape position

Vegetation

Soil parent materials (Check all that apply)

☐ Outwash ☐ Lacustrine ☐ Loess

☐ Till ☐ Alluvium ☐ Bedrock ☐ Organic

Soil survery map units

Slope%

Slope shape

I-------- Structure----------I

Depth (in)	Texture	Matrix Color(s)	Mottle Color(s)	Redox Kind(s)	Indicator(s)	Shape	Grade	Consistence

Comments

Textures:
c-clay
sic-silty clay
sc-sandy clay
cl-clay loam
sicl-silty clay loam
scl-sandy clay loam
si-silt
sil-silt loam
l-loam
sl-sandy loam
ls-loamy sand
s-sand

Subsoil Indicator(s) of Saturation:

S1. Distinct gray or red redox features
S2. Depleted matrix (value >/=4 and chroma </=2)
S3. 5Y chroma </= 3
S4. 7.5 YR or redder faint redox concentrations or redox depletions

If yes to one of the above indicators then:

Topsoil Indicator(s) of Saturation:

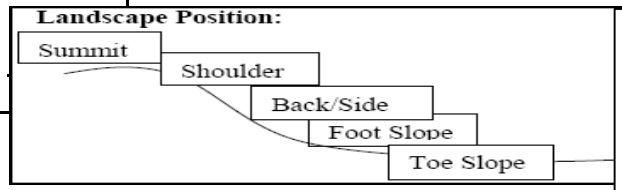
T1. Wetland Vegetation
T2. Depressional Landscape
T3. Organic texture or organic modifiers
T4. N 2.5/ 0 color
T5. Redox features in topsoil
T6. Hydrolic indicators

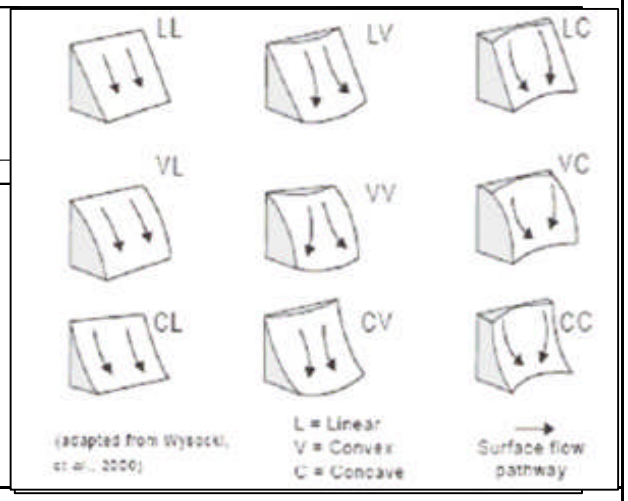
Consistence:

Loose-	Intact specimen not available
Friable-	Slight force between fingers
Firm-	Moderate force between fingers
Extremely firm-	Moderate force between hands or slight foot pressure
Rigid-	Foot pressure

Slope Shape:

Slope shape is described in two directions: up and down slope (perpendicular to the contour), and across slope (along the horizontal contour); e.g. Linear, Convex or LV'.





Soil Structure Grade:

Massive-	No observable aggregates, or no orderly arrangement of natural lines of weakness
Weak-	Poorly formed, indistinct peds, barely observable in place
Moderate-	Well formed, distinct peds, moderately durable and evident, but not distinct in undisturbed soil
Strong-	Durable peds that are quite evident in un-displaced soil, adhere weakly to one another, withstand displacement, and become separated when soil is disturbed
Loose-	No peds, sandy soil

Soil Structure Shape:

Granular-	The peds are approximately spherical or polyhedral and are commonly found in topsoil. These are the small, rounded peds that hang onto roots when soil is turned over.
Platy-	The peds are flat and plate like. They are oriented horizontally and are usually overlapping. Platy structure is commonly found in forested areas just below the leaf litter or shallow topsoil.
Blocky-	The peds are block-like or polyhedral, and are bounded by flat or slightly rounded surface that are casting of the faces of surrounding peds. Blocky structure is commonly found in the lower topsoil and subsoil.
Prismatic-	Flat or slightly rounded vertical faces bound the individual peds. Peds are distinctly longer vertically, and faces are typically cast or molds of adjoining peds. Prismatic structure is commonly found in the lower subsoil.
Single Grain-	The structure found in a sandy soil. The individual particles are not held together.

Site Evaluation Map

University of Minnesota
Onsite Sewage Treatment Program

Contact Information

Property Owner/Client: _____

Address: _____

List any construction issues:

Mapping Checklist

Map scale: _____ ___indicate north ___show slope _____% direction ___

Locate

- ☐ Lot Dimensions/Property Lines
- ☐ Dwellings and other improvements
- ☐ Existing or proposed system(s)
- ☐ Replacement area
- ☐ Unsuitable area(s)
- ☐ Public water supply wells
- ☐ Pumping access
- ☐ Inner wellhead zone

Easements

- ☐ Phone
- ☐ Electric
- ☐ Gas

Elevations

- ☐ Borings
- ☐ Benchmark
- ☐ Perc Tests
- ☐ Horizontal & Vertical Reference Points

Setbacks

- ☐ Building
- ☐ All water wells within 100 feet
- ☐ Pressure Pipe
- ☐ Water Suction
- ☐ Streams, Lakes,
- ☐ Floodway and

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_____	_____	_____	_____
(Designer)	(Signature)	(License #)	(Date)

Percolation Test Worksheet

University of Minnesota
Onsite Sewage Treatment Program

1. Contact Information

Property Owner/Client:

Address:

2. General Percolation Information

Diameter in

Date prepared and/or soaked:

Method of scratching sidewall:

Is pre-soak requiried*? * *Not required in sandy soils*

Soak* start time:

Soak* end time:

Method to maintain 12 in of water during soak

3. Percolation Test Data

Test hole: #1

Location:

Date reading taken:

Elevation:

Starting time:

Depth**: inches

Soil texture description:

Depth (in)	Soil Texture

*** 12 inches for mounds & at-grades, depth of absorption area for trenches & beds*

Reading	Start Time	End Time	Start Reading	End Reading	Perc rate	% Difference	Pass
1						NA	NA
2						NA	NA
3							

Chosen Percolation Rate for Test Hole #1 mpi

Additional percolation test data may be included on attached pages
Design Percolation Rate (maximum of all tests) = mpi

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Additional Percolation Data

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Test hole: #2 Location:

Starting time: Depth**: inches

** 12 in. for mounds & at-grades, depth of absorption area for trenches and beds

Soil texture description:

Depth (in)	Soil Texture

Reading	Start Time	End Time	Start Reading (in)	End Reading (in)	Perc rate (mpi)	% Difference Last 3 Rates	Pass
1					NA	NA	
2					NA	NA	
3							

Chosen Percolation Rate for Test Hole #2 mpi

Test hole: #3 Location:

Date reading taken: Elevation:

Starting time: Depth**: inches

** 12 in. for mounds & at-grades, depth of absorption area for trenches and beds

Soil texture description:

Depth (in)	Soil Texture

Reading	Start Time	End Time	Start	End Reading	Perc rate	% Difference	Pass
1					NA	NA	
2					NA	NA	
3							

Chosen Percolation Rate for Test Hole #3 mpi

Additional Percolation Data

University of Minnesota
Onsite Sewage Treatment Program

Test hole: #4 Location:

Date reading taken: Elevation:

Starting time: Depth**: inches

** 12 in. for mounds & at-grades, depth of absorption area for trenches and beds

Soil texture description:

Depth (in)	Soil Texture

Reading	Start Time	End Time	Start Reading (in)	End Reading (in)	Perc rate (mpi)	% Difference Last 3 Rates	Pass
1					NA	NA	
2					NA	NA	
3							

Chosen Percolation Rate for Test Hole #4 mpi

Test hole: #5 Location:

Date reading taken: Elevation:

Starting time: Depth**: inches

** 12 in. for mounds & at-grades, depth of absorption area for trenches and beds

Soil texture description:

Depth (in)	Soil Texture

Reading	Start Time	End Time	Start	End Reading	Perc rate	% Difference	Pass
1					NA	NA	
2					NA	NA	
3							

Chosen Percolation Rate for Test Hole #5 mpi

Minnesota Pollution Control Agency

Design Flow and Soil Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. AVERAGE DESIGN FLOW:

A. Estimated Design Flow *(GPD)*: _____ gpd

Note: The estimated design flow is considered a peak flow rate including a safety factor. For long term performance, the average daily flow is *recommended* to be < 60% of this value.

or *Measured Flow (GPD)* : flow times safety factor

_____ gpd X _____ = _____ gpd

Design Flow: _____ Gallons Per Day (GPD)

B. *Septic Tank* capacity: _____ Gallons

System Type

☐ Type I ☐ Type II ☐ Type III ☐ Type IV ☐ Type V

Number of *Septic Tanks* or *Compartments* : _____

Effluent Screen & Alarm ? _____

Table I - Design Flow (Gallons Per Day)

Number of Bedrooms	Classification of Dwelling			
	I	II	III	IV
2 or less	300	225	180	*
3	450	300	218	*
4	600	375	256	*
5	750	450	294	*
6	900	525	332	*

Table II - Septic Tank Capacity

Number of Bedrooms	Septic Tank Liquid Minimum Capacities (Gallons)	Capacity with Garbage Disposal and/or Sewage Pumped to Tank*
3 or less	1,000	1,500
4 or 5	1,500	2,250
6 or 7	2,000	3,000
8 or 9	2,500	3,750

* Flows for Classification IV dwellings are 60 percent of the values as determined for Classification I, II or III systems.

2. SITE EVALUATION:

A. *Depth to Limiting Layer* : _____ inches _____ ft

B. Type of Soil Treatment and Dispersal Area

○ Trenches ○ Bed ○ At-Grade ○ Mound

C. Type of Distribution

○ Gravity Distribution ○ Pressure Distribution-Level ○ Pressure Distribution-Unlevel

D. *Landscape Position* : _____

E. *Soil Texture Group Number* : _____

F. *Estimated Percent Land Slope* : _____ %

or

G. *Calculated Slope* = _____ (*Rise*) ÷ _____ (*Run*) x 100 = _____

Texture Group

Soil Texture	Group #
Coarse Sand	1
Medium Sand	2
Fine Sand	3
Coarse Loamy Sand	4
Medium Loamy Sand	4
Fine Loamy Sand	5
Very Fine Loamy Sand	5
Coarse Sandy Loam	6
Medium Sandy Loam	6
Fine Sandy Loam	7
Very Fine Sandy Loam	7
Loam	8
Silt Loam	9
Clay Loam	10
Silty Clay Loam	10
Sandy Clay Loam	10
Silty Clay	11
Sandy Clay	11
Clay	11

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Design Flow and Soil Worksheet

University of Minnesota Onsite Sewage Treatment Program

3. SOIL LOADING RATES: Use either A. or B. below

A.

7080 Table IX	
DETAILED SOIL DESCRIPTIONS (SOIL PIT REQUIRED)	
Texture	
Texture Group	
Structure	
Grade	
Consistence	
Select Soil Loading Rate:	

B.

7080 Table IXa	
PERCOLATION TEST SIZING	LOADING RATE (GPD/ft^2)
Faster than 0.1*	0.00
0.1 to 5*	1.20
0.1 to 5 (soil texture groups 3 & 5)	0.60
6 to 15	0.78
16 to 30	0.60
31 to 45	0.50
46 to 60	0.45
61-120	0.24
Slower than 120	0.00

*Rapidly permeable soils: see 7080.2260

Slowest measured percolation rate:

Select Soil Loading Rate:

C. Design Loading Rate: GPD/ft^2

4. ORGANIC LOADING (if pretreatment is being used)

Organic Loading = *Design Flow* X *Estimated CBOD* in mg/L in th ÷ 1,000,000 = lbs CBOD/day

gpd X mg/L X 8.35

Table III (7083.4030)	
Treatment	CBOD (mg/L)
Level A	15
Level B	25
Level C	125

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(Designer) (Signature) (License #) (Date)

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Trench & Bed Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. SYSTEM SIZING:

A. *Design Flow* : _____ GPD **B.** *Maximum Depth* : _____ inches

C. *Soil Loading Rate:* _____ GPD/ft^2

D. *Required Bottom Area: Design Flow (1.A) ÷ Loading Rate (1.C) = Initial Required Bottom Area*

_____ ÷ _____ = _____ ft^2

E. Select *Dispersal Media* :
- ☐ Rock
- ☐ Other Approved Media _____

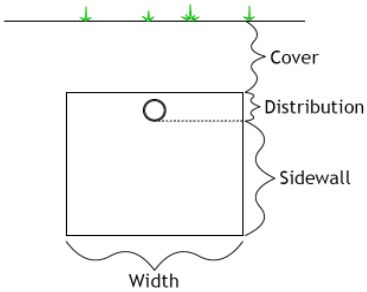
F. Select *Distribution Method* :
- ☐ Pressure (required for rapidly permeable soils)
- ☐ Gravity-Drop Box
- ☐ Gravity-Other _____

G. Select *Dispersal Type* :
- ☐ Trench - Rock or equivalent (section 2 below)
- ☐ Trench - Registered Products (section 3 below)
- ☐ Bed (section 4 below)

2. TRENCH CONFIGURATION: (Rock or equivalent media)

A.

Initial required trench bottom area (ft^2): (from 1.D)	Sidewall Absorption (inches)	Bottom Area Reduction	Bottom Area Multiplier	Design trench bottom area
	6 to 11	0%	1	
	12 to 17	20%	0.8	
	18 to 23	34%	0.66	
	24	40%	0.6	



B. Select *Sidewall Height* : _____ inches = _____ ft

C. *Design Bottom Area* (2.A): _____ ft^2

D. Select *Trench Width* : _____ inches = _____ ft

E. *Total Designed Trench Length: Bottom Area* (2.C) ÷ *Trench Width* (2.D) = *Total Required Trench Length*

_____ ft^2 ÷ _____ = _____ ft

F. Select *Trench Spacing* : _____ ft *(typically 5 - 12 ft from center to center)*

G. Calculate Lawn Area: *Trench Length* (2.E) X *Trench Spacing* (2.F) = ft^2 lawn area

_____ X _____ = _____ ft^2 lawn area

H. If using rock or similar substitute media, select *Depth Required to Cover Distribution Pipe* :

_____ ft (0.33 for pressure, 0.5 for gravity)

I. Calculate *Media Volume* : (*Sidewall Height* (2.B) + Depth to Cover Pipe (2.H)) X *Bottom Area (2.C)* = cubic ft.

(_____ + _____) X _____ = _____ ft^3

Divide ft^3 by 27 ft^3/yd^3 to calculate cubic yards:

_____ ft^3 ÷ 27 = _____ yd^3

3. TRENCH CONFIGURATION: (Registered Products)

A. Registered Product: _____ (from MPCA list)

B. Product Absorption Area: _____ ft^2 / linear ft
(from MPCA Registered Product List)

C. Req'd *Bottom Area* (1.D): _____ ft^2

D. Total *Required Trench Length: Bottom Area* (4.C) ÷ Sizing Value (4.B) = *Total Required Trench Length*

_____ ft^2 ÷ _____ ft^2 / lin. ft = _____ ft

E. Select *Trench Spacing* : _____ ft *(typically 5 - 12 ft from center to center)*

F. Calculate Lawn Area: *Trench Length* (3.D) X *Trench Spacing* (3.E) = ft^2 lawn area

_____ X _____ = _____ ft^2 lawn area

4. BED CONFIGURATION: (for sites with less than 6% slope)

A. Req'd *Bottom Area* (1.D): _____ ft^2

B. Select size *Multiplier* : _____ 1.0 = pressurized
1.5 = gravity (not allowed in rapidly permeable soils)

Designed Bottom Area : _____ ft^2

C. Select *Bed Width* : _____ ft
Maximum width = 25 ft. (pressurized)
Maximum width = 12 ft. (gravity)

D. Calculate *Bed Length: Designed Bottom Area* (4.B) ÷ *Bed Width* (4.C) = *Bed Length*

_____ ft^2 ÷ _____ ft = _____ ft

E. Select *Sidewall Absorption* : _____ inches below the pipe = _____ ft

F. Calculate *Media Volume* : (*Media Depth (4.E)* + depth to cover pipe) X *Designed Bottom Area (4.B)* = ft^3

(_____ ft + _____ ft X _____ = _____ ft^3

Calculate *Volume in cubic yards* : Media volume in cubic feet (4.F) ÷ 27 = cubic yards

_____ ÷ 27 = _____ yd^3

5. ORGANIC LOADING: (Optional)

A. *Organic Loading* = *Design Flow* X *Estimated cBOD* in mg/L in the effluent X 8.35 ÷ 1,000,000 (See Table III)

_____ X _____ mg/L X 8.35 ÷ 1,000,000 = _____ lbs cBOD/day

B. Calculate *System Organic Loading: lbs. cBOD/day* (5.A) ÷ *Bottom Area* (2.C) , (3.C) or (4.A) = lbs/day/ft^2

_____ lbs/day ÷ _____ ft^2 = _____ lbs/day/ft^2

Table III (7083.4030)	
Treatment	cBOD (mg/L)
Level A	15
Level B	25
Level C	125

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer)	(Signature)	(License #)	(Date)

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Mound Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. SYSTEM SIZING:

A. *Design Flow (Flow & Soil - 1.A) :* _____ GPD

B. *Soil Loading Rate (Flow & Soil-3.C):* _____ GPD/ft^2

C. *Depth to Limiting Condition:* _____ ft

D. *Percent Land Slope:* _____ %

E. *Design Media Loading Rate:* _____

F. *Mound Absorption Ratio* (1.E÷1.B): _____

G. *Design Contour Loading Rate:* _____ GPD/ft

(From Table I - same as Linear Loading Rate)

Table I
MOUND CONTOUR LOADING RATES:

Measured Perc Rate	← OR →	Texture - derived mound absorption ratio		Contour Loading Rate:
≤ 60mpi		1.0, 1.3, 2.0, 2.4, 2.6	→	≤12
61-120 mpi	← OR →	5.0	→	≤6
≥ 120 mpi		-	→	-

2. DISPERSAL MEDIA SIZING

A. Calculate *Required Dispersal Bed Area: Design Flow* (1.A) ÷ *Design Media Loading Rate* (1.E) = ft^2

_____ GPD ÷ _____ GPD/ft^2 = _____ ft^2

If a larger dispersal media area is desired, enter size: _____ ft^2

B. Calculate *Dispersal Bed Width: Contour Loading Rate* (1.G) ÷ *Design Media Loading Rate* (1.E) = *Bed Width*

_____ ft ÷ _____ gpd/ft^2 = _____ ft

C. Calculate *Dispersal Bed Length: Dispersal Bed Area* (2.A) ÷ *Bed Width* (2.B) = *Bed Length*

_____ ft^2 ÷ _____ ft = _____ ft

D. Select *Dispersal Media* :

☐ Rock

☐ Other Approved Media _____

3. ABSORPTION AREA SIZING

Note: Mound setbacks are measured from the Absorption Area.

A. Calculate *Absorption Width: Bed Width* (2.B) X *Mound Absorption Ratio* (1.F) = *Absorption Width*

_____ ft X _____ = _____ ft

B. For slopes from 0 to 1%, the *Absorption Width* is measured from the bed equally in both directions.
Calculate *Absorption Width Beyond the Bed* : *Absorption Width* (3.A) - *Bed Width* (2.B) ÷ 2 = *Width beyond Bed*

(_____ ft - _____ ft) ÷ _____ = _____ ft

C. For slopes >1%, the *Absorption Width* is measured downhill from the upslope edge of the *Bed* .
Calculate *Downslope Absorption Width* : *Absorption Width* (3.A) - *Bed Width* (2.B) = ft

_____ ft - _____ ft = _____ ft

Comments:

4. MOUND SIZING

A. Calculate *Clean Sand Lift:* 3 feet minus *Depth to Limiting Condition* (1.C) = *Clean Sand Lift* (1 ft minimum)

3.0 ft - [ ] ft = [ ] ft

B. Calculate *Upslope Height: Clean Sand Lift* (4.A) + *media depth* (1 ft.) + *cover* (1 ft.) = *Upslope Height*

[ ] ft + [ ] ft + [ ] ft = [ ] ft

C. Select *Upslope Berm Multiplier* (based on land slope): [ ] (figure D-34)

D. Calculate *Upslope Berm Width* : *Multiplier* (4.C) X *Upslope Mound Height* (4.B) = *Upslope Berm Width*

[ ] x [ ] ft = [ ] ft

E. Calculate *Drop in Elevation Under Bed: Bed Width* (2.B) X *Land Slope* (1.D) ÷ 100 = *Drop* (ft)

[ ] x [ ] % ÷ 100 = [ ] ft

F. Calculate *Downslope Mound Height: Upslope Height* (4.B) + *Drop in Elevation* (4.E) = *Downslope Height*

[ ] ft + [ ] ft = [ ] ft

G. Select *Downslope Berm Multiplier* (based on land slope): [ ] (figure D-34)

H. Calculate *Downslope Berm Width: Multiplier* (4.G) X *Downslope Height* (4.F) = *Downslope Berm Width*

[ ] x [ ] ft = [ ] ft

I. Calculate *Minimum Berm to Cover Absorption Area: Downslope Absorption Width* (3.B or 3.C) + 4 ft. = ft

[ ] ft + [ ] ft = [ ] ft

J. *Design Downslope Berm* = greater of 4H and 4I: [ ] ft

K. Select *Endslope Berm Multiplier* : [ ] (usually 3.0 or 4.0)

L. Calculate *Endslope Berm* (4.K) X *Downslope Mound Height* (4.F) = *Endslope Berm Width*

[ ] x [ ] ft = [ ] ft

M. Calculate Mound Width: *Upslope Berm Width* (4.D) + *Bed Width* (2.B) + *Downslope Berm Width* (4.J) = ft

[ ] ft + [ ] ft + [ ] ft = [ ] ft

N. Calculate Mound Length: *Endslope Berm Width* (4.L) + *Bed Length* (2.C) + *Endslope Berm Width* (4.L) = ft

[ ] ft + [ ] ft + [ ] ft = [ ] ft

D-34: Slope Multiplier Table

Land Slope %		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Upslope	3:1	3.00	2.91	2.83	2.75	2.68	2.61	2.54	2.48	2.42	2.36	2.31	2.26	2.21	2.17	2.13	2.09	2.06	2.03	2.00	1.97	1.95	1.93	1.91	1.89	1.87	1.85
Berm Ratio	4:1	4.00	3.85	3.70	3.57	3.45	3.33	3.23	3.12	3.03	2.94	2.86	2.78	2.70	2.62	2.55	2.48	2.41	2.35	2.29	2.23	2.18	2.13	2.08	2.03	1.98	1.93

Land Slope %		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Downslope	3:1	3.00	3.09	3.19	3.30	3.41	3.53	3.66	3.80	3.95	4.11	4.29	4.48	4.69	4.95	5.24	5.55	5.88	6.24	6.63	7.04	7.47	7.93	8.42	8.93	9.46	10.02
Berm Ratio	4:1	4.00	4.17	4.35	4.54	4.76	5.00	5.26	5.56	5.88	6.25	6.67	7.14	7.69	8.29	8.92	9.57	10.24	10.94	11.67	12.42	13.19	13.99	14.82	15.67	16.54	17.44

5. ORGANIC LOADING: (Optional)

A. *Organic Loading* = *Design Flow* X *Estimated CBOD* in mg/L in the effluent X 8.35 ÷ 1,000,000 (See Table III)

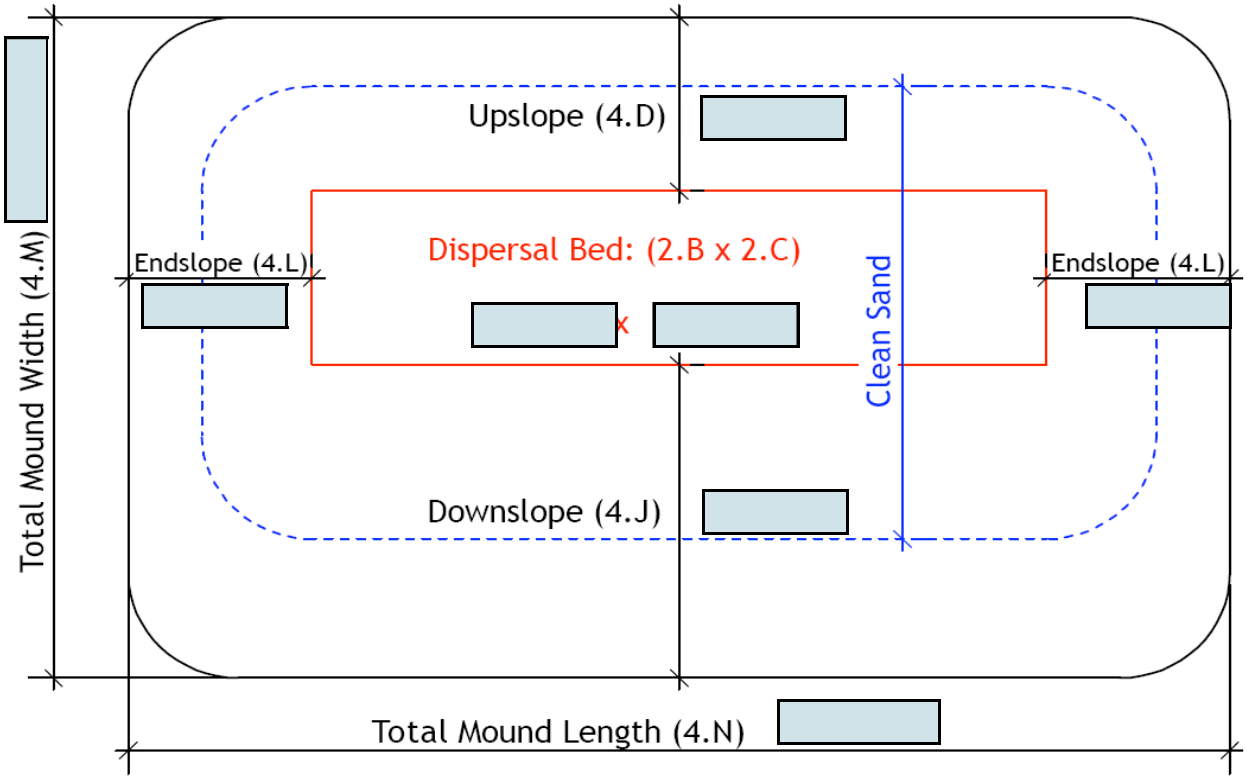
[ ] gpd X [ ] mg/L X 8.35 ÷ 1,000,000 = [ ] lbs CBOD/day

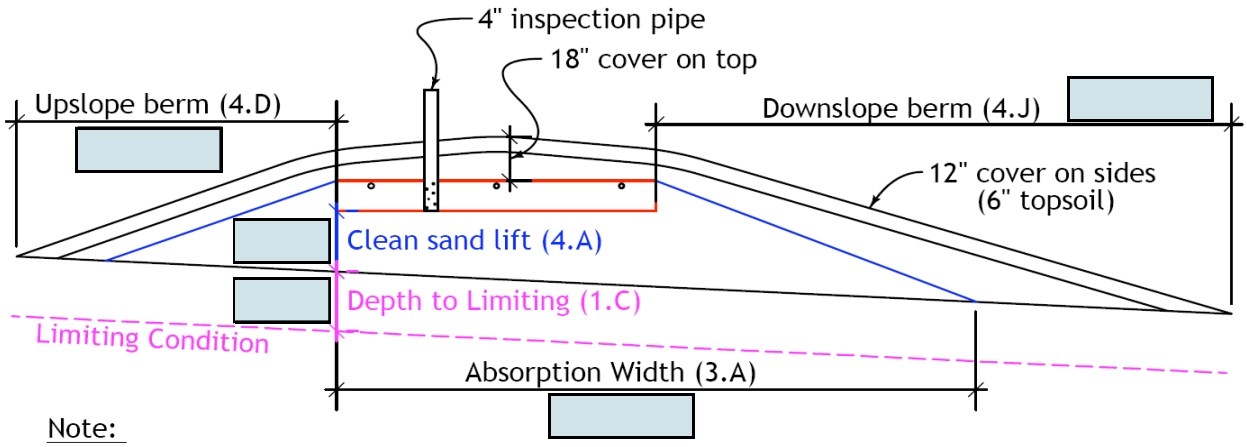
B. Calculate *System Organic Loading: lbs. CBOD* (5.A) ÷ *Bed Area* (2.A) = lbs/day/ft^2

[ ] lbs/day ÷ [ ] ft^2 = [ ] lbs/day/ft^2

Table III (7083.4030)	
Treatment	CBOD (mg/L)
Level A	15
Level B	25
Level C	125

6. MOUND DIMENSIONS





Note:
For 0 to 1% slopes, *Absorption Width* is measured from the *Bed* equally in both directions.
For slopes >1%, *Absorption Width* is measured downhill from the upslope edge of the *Bed*.

Comments:

Divert surface water away from mound.

7. APPROXIMATE MOUND MATERIAL CALCULATIONS:

A. Calculate *Bed* (rock) *Volume* : *Bed Length* (2.C) X *Bed Width* (2.B) X *Depth* = *Volume* (ft^3)

[ ] ft X [ ] ft X 1.0 = [ ] ft^3

Divide ft^3 by 27 ft^3/yd^3 to calculate cubic yards:

[ ] ft^3 ÷ 27 = [ ] yd^3

Add 20% for constructability: [ ] yd^3 X 1.2 = [ ] yd^3

B. Calculate *Clean Sand Volume:*

Upslope Volume : ((*Upslope Mound Height - 1*) x 3 x *Bed Length*) ÷ 2 = cubic feet

(([ ] ft - 1) X [ ] ft X [ ]) ÷ 2 = [ ] ft^3

Downslope Volume : ((*Downslope Height - 1)* x Downslope Absorption Width x *Media Length*) ÷ 2 = cubic feet

(([ ] ft - 1) X [ ] ft X [ ]) ÷ 2 = [ ] ft^3

Endslope Volume : (*Downslope Mound Height - 1)* x 3 x *Media Width* = cubic feet

([ ] ft - 1) X [ ] ft X [ ] ft = [ ] ft^3

Volume Under Rockbed : *Average Sand Depth* x *Media Width* x *Media Length* = cubic feet

[ ] ft X [ ] ft X [ ] ft = [ ] ft^3

Total Clean Sand Volume : *Upslope Volume* + *Downslope Volume* + *Endslope Volume* + *Volume Under Media*

[ ] ft^3 + [ ] ft^3 + [ ] ft^3 + [ ] ft^3 = [ ] ft^3

Divide ft^3 by 27 ft^3/yd^3 to calculate cubic yards: [ ] ft^3 ÷ 27 = [ ] yd^3

Add 20% for constructability: [ ] yd^3 X 1.2 = [ ] yd^3

C. Calculate *Sandy Berm Volume:*

Total Berm Volume (approx) : ((Avg. Mound Height - .5 ft topsoil) x Mound Width x Mound Length) ÷ 2 = cu. ft.

([ ] - 0.5)ft X [ ] ft X [ ]) ÷ 2 = [ ] ft^3

Total Mound Volume - Clean Sand volume -Rock Volume = cubic feet

[ ] ft^3 - [ ] ft^3 - [ ] ft^3 = [ ] ft^3

Divide ft^3 by 27 ft^3/yd^3 to calculate cubic yards: [ ] ft^3 ÷ 27 = [ ] yd^3

Add 20% for constructability: [ ] yd^3 x 1.2 = [ ] yd^3

D. Calculate *Topsoil Material Volume: Total Mound Width X Total Mound Length X .5 ft*

[ ] ft X [ ] ft X 0.5 ft = [ ] ft^3

Divide ft^3 by 27 ft^3/yd^3 to calculate cubic yards: [ ] ft^3 ÷ 27 = [ ] yd^3

Add 20% for constructability: [ ] yd^3 x 1.2 = [ ] yd^3

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer)	(Signature)	(License #)	(Date)

Minnesota Pollution Control Agency

At-Grade Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. DISPERSAL MEDIA SIZING:

A. *Design Flow* *(Flow & Soil 1.A)* [ ] GPD

B. *Soil Loading Rate* *(Flow & Soil 3.C)* [ ] GPD/ft^2

C. *Land Slope* [ ] %

D. *Contour Loading Rate* [ ] GPD/ft
(From Table I - Same as Linear Loading Rate)

E. *Absorption Bed Width* = *Contour Loading Rate* (1.D) ÷ *Soil Loading Rate* (1.B)
(round up to nearest whole number) *Cannot exceed 15 feet*
[ ] GPD/ft^2 ÷ [ ] GPD/ft = [ ] ft

F. *Absorption Bed Length* = *Design Flow* (1.A) ÷ *Contour Loading Rate* (1.D)
[ ] GPD ÷ [ ] GPD/ft = [ ] ft

G. Required Absorption Bed Area = Design Flow (1.A) ÷ Soil Loading Rate (1.B)
[ ] ÷ [ ] = [ ] ft^2

2. BERM SIZING:

A. Determine *System Height* = (media height + 12" cover, usually 24" total, divide by 12 to convert to feet)
[ ] inches ÷ 12 = [ ] ft

B. *Upslope Mulitiplier* based on percent slope (see Table II)
[ ]

C. *Upslope Width* = *Upslope Multiplier* (2.B) X *System Height* (2.A)
[ ] X [ ] ft = [ ] ft

D. *Downslope Mulitiplier* based on percent slope (see Table II)
[ ]

E. 4 to 1 Downslope Berm Width = *Downslope Multiplier* (2.D) X *System Height* (2.A)
[ ] X [ ] ft = [ ] ft

F. *Minimum Downslope Berm to cover media by 5 ft* = *Absorption Bed Width* (1.E) + 5 ft
[ ] ft + 5 ft = [ ] ft

G. Design Downslope Berm: Use the greater of the 4 to 1 berm (2.E) and the Minimum Downslope berm (2.F)
[ ] ft

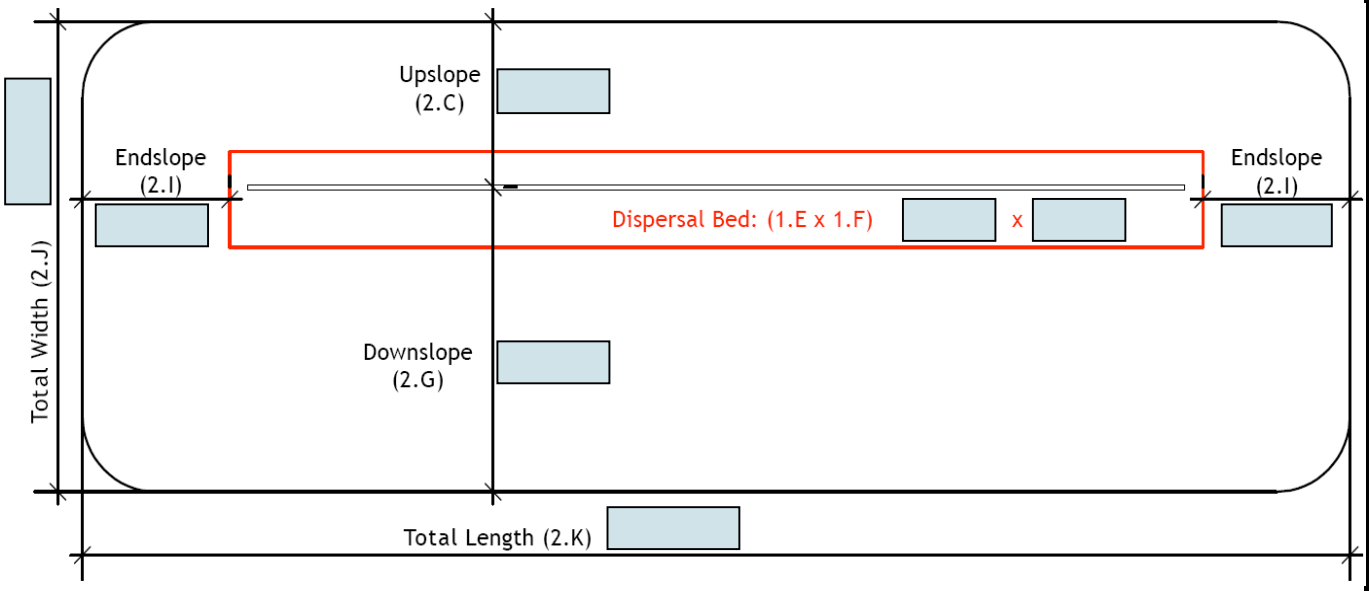
H. *Endslope Mulitiplier* (usually 4.0)
[ ]

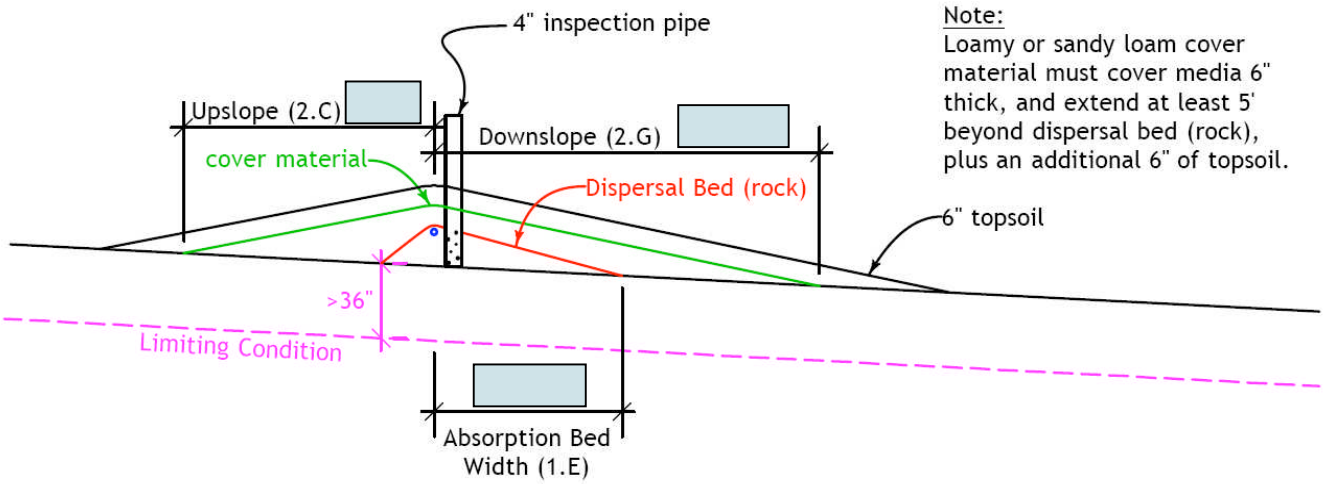
I. *Endslope Width* = *Endslope Multiplier* (2.H) X *System Height* (2.A)
[ ] X [ ] ft = [ ] ft

J. *System Width* = The sum of the *Upslope Width* (2.C) + *Downslope Width* (2.G) (Minimum of 6 feet)
[ ] ft + [ ] ft = [ ] ft

K. *System Length* = Sum of the *Endslope Width* (2.H) + *Absorption Bed Length* (1.F) + Endslope *Width* (2.H)
[ ] ft + [ ] ft + [ ] ft = [ ] ft

3. AT-GRADE DIMENSIONS:





Note:
Loamy or sandy loam cover material must cover media 6" thick, and extend at least 5' beyond dispersal bed (rock), plus an additional 6" of topsoil.

Note:
For 0 to 1% slopes, *Absorption Width* is measured from the *Pipe* and divided equally in both directions.
For slopes >1%, *Absorption Width* is measured downhill from the *Pipe*.

4. APPROXIMATE VOLUME CALCULATIONS:

A. *Rock Area* = Absorption Bed Length (1.F) X *Absorption Bed Width* (1.E)

[ ] ft X [ ] ft = [ ] ft^2

B. *Rock Volume in Cubic Feet* = *Rock Area* (4.A) by *Depth of Media (Rock)* (1 foot) and divide by 2.

[ ] ft^2 X 1 ft ÷ 2 = [ ] ft^3

C. *Rock Volume in Cubic Yards* = *Volume in Cubic Feet* (4.B) divided by 27

[ ] ft^3 ÷ 27 = [ ] yd^3

D. *Loamy or Sandy Loam Cover Material Volume:*
Volume in Cubic Feet = System Width (2.J) X System Length (2.K) X 1.5 ÷ 2, minus rock volume (4.B)

([ ] ft X [ ] ft X 1.5 ÷ 2) - [ ] = [ ] ft^3

E. *Loamy or Sandy Loam Cover Volume in Cubic Yards* = *Volume in Cubic Feet* (4.D) divided by 27

[ ] ft^3 ÷ 27 = [ ] yd^3

F. Add 20% for constructability: [ ] yd^3 x 1.2 = [ ] yd^3

G. Topsoil Volume in Cubic Feet = System width (2.J) X System Length (2.K) x 0.5

[ ] X [ ] X 0.5 = [ ] ft^3

H. *Topsoil Volume in Cubic Yards* = *Volume in Cubic Feet* (4.G) divided by 27

[ ] ft^3 ÷ 27 = [ ] yd^3

I. Add 20% for constructability: [ ] yd^3 x 1.2 = [ ] yd^3

5. Organic Loading: (optional)

A. *Organic Loading* = *Design Flow (1.A)* X *Estimated BOD* in mg/L in the effluent X 8.35 ÷ 1,000,000 (Table III)

[ ] gpd X [ ] mg/L X 8.35 ÷ 1,000,000 = [ ] lbs BOD/day

B. Calculate *System Organic Loading: lbs. BOD* (5.A) ÷ *Absorption Bed Area* (1.G) = lbs/day/ft^2

[ ] lbs/day ÷ [ ] ft^2 = [ ] lbs/day/ft^2

Table III (7083.4030)	
BOD Treatment	BOD (mg/L)
Level A	15
Level B	25
Level C	125

5. Comments:

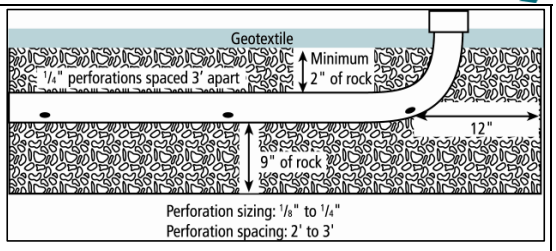
I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer) (Signature) (License #) (Date)

Minnesota Pollution Control Agency

Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program



1. Select *Number of Perforated Laterals (2-3 foot spacing)* : [ ]

2. Select *Perforation Spacing (< 9 ft² /perforation)* : [ ] ft

   Note: Must use 2 feet for media filters

3. Select *Perforation Diameter* [ ] inch

4 *Length of Laterals* = Media Bed Length - 2 Feet. *Perforation can not be closer then 1 foot from edge.*

[ ] - 2ft = [ ] ft

5. Determine the *Number of Perforation Spaces* . Divide the *Length of Laterals* (Line 4) by the *Perforation Spacing* (Line 2) and round down to the nearest whole number.

   Number of Perforation Spaces = [ ] ft ÷ [ ] ft = [ ] Spaces

6. *Number of Perforations per Lateral* is equal to 1.0 plus the *Number of Perforation Spaces* (Line 5).

   Perforations Per Lateral = [ ] Spaces + 1 = [ ]

   Check Table I to ensure that the number of perforations per lateral guarantees less than a 10% discharge variation.

Table I Maximum Number of Perforations Per Lateral to Guarantee <10% Discharge Variation

1/4 Inch Holes						7/32 Inch Holes					
Perforation Spacing (Feet)	Pipe Diameter (Inches)					Perforation Spacing (Feet)	Pipe Diameter (Inches)				
	1	1¼	1½	2	3		1	1¼	1½	2	3
2	10	13	18	30	60	2	11	16	21	34	68
2½	8	12	16	28	54	2½	10	14	20	32	64
3	8	12	16	25	52	3	9	14	19	30	60
3/16 Inch Holes						**1/8 Inch Holes**					
Perforation Spacing (Feet)	Pipe Diameter (Inches)					Perforation Spacing (Feet)	Pipe Diameter (Inches)				
	1	1¼	1½	2	3		1	1¼	1½	2	3
2	12	18	26	46	87	2	21	33	44	74	149
2½	12	17	24	40	80	2½	20	30	41	69	135
3	12	16	22	37	75	3	20	29	38	64	128

7. *Total Number of Perforations* equals the *Number of Perforations per Lateral* (Line 6) multiplied by the *Number of Perforated Laterals* (Line 1).

   [ ] Perf. Per Lateral X [ ] Number of Perf. Laterals = [ ] Total Number of Perf.

   Calculate the *Square Feet per Perforation*

8. *Bed Area* = Bed Width (ft) X Bed Length (ft)

   [ ] ft X [ ] ft = [ ] ft²

9. *Square Foot per Perforation* = *Bed Area* (Line 8) divided by the *Total Number of Perforations* (Line 7).

   [ ] ft² ÷ [ ] perforations = [ ] ft²/perforations

   Recommended value is 4-10 ft² per perforation. Does not apply to At-Grades

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Minnesota Pollution Control Agency

Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

10. Select *Minimum Average Head* : _____ ft

11. Select *Perforation Discharge* (GPM) based on Table III: _____ GPM per Perforation

12. Determine required *Flow Rate* by multiplying the *Total Number of Perforations* (Line 7) by the *Perforation Discharge* (Line 11).

_____ Perforations X _____ GPM per Perforation = _____ GPM

13. Select *Type of Manifold Connection* (End or Center): _____

14. Select ***Minimum Diameter*** of laterals based on Table I: _____ in

Determine *Volume of Distribution Piping*

15. *Pipe Diameter* of Distribution Pipe _____ in

16. *Volume of Liquid Per Foot of Distribution Piping* : _____ Gallons

17. *Volume of Distribution Piping* =

= [*Number of Perforated Laterals* (Line 1) X *Length of Laterals* (Line 4) X (Volume of Liquid Per Foot of Distribution Piping (Line 16)]

_____ X _____ X _____ = _____ Gallons

Table II
Volume of Liquid in Pipe

Pipe Diameter (inches)	Liquid Per Foot (Gallons)
1	0.045
1.25	0.078
1.5	0.110
2	0.170
3	0.380
4	0.661

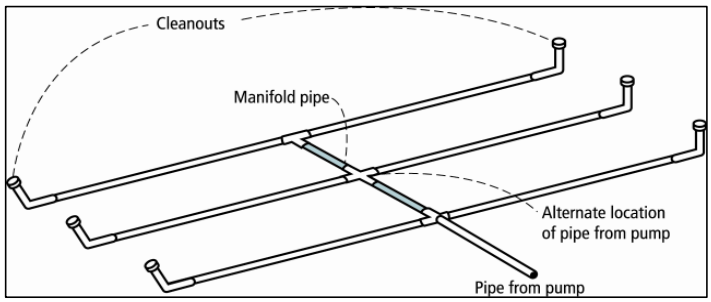
Table III
Perforation Discharge (GPM)

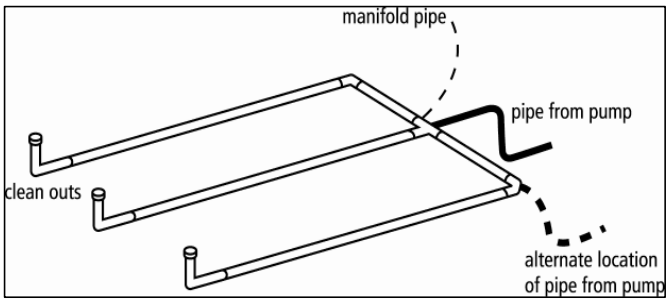
Head (ft)	Perforation Diameter			
	1/8	3/16	7/32	1/4
1.0[a]	0.18	0.41	0.56	0.74
2.0[b]	0.26	0.59	0.80	1.04
5.0[c]	0.41	0.93	1.26	1.65

a: Use 1.0 for dwellings using 1/4 inch or 3/16 inch holes.

b: Use 2.0 for dwellings using 1/8 inch holes; or, for other establishments using 1/4 inch or 3/16 inch holes.

c: Use 5.0 for other establishments using 1/8 inch perforations and media filters.





I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer)	(Signature)	(License #)	(Date)

Minnesota Pollution Control Agency

Non-Level Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. Enter soil treatment area (STA) length in order of the Highest Elevation to the Lowest Elevation:

Lateral 1	Pipe Elevation	ft	Length of STA	ft	Highest	
Lateral 2	Pipe Elevation	ft	Length of STA	ft	↓	
Lateral 3	Pipe Elevation	ft	Length of STA	ft		
Lateral 4	Pipe Elevation	ft	Length of STA	ft		
Lateral 5	Pipe Elevation	ft	Length of STA	ft	Lowest	

2. Calculate *Change in Elevation* over the laterals

   = Highest Elevation (Lateral 1) - Lowest Elevation (Last Lateral above) _____ - _____ = _____ ft

3. Select *Minimum Average Head*: _____ ft

   Use 1.0 ft for dwellings using 1/4 inch or 3/16 inch holes.

   Use 2.0 ft for dwellings using 1/8 inch holes; or, for MSTS or other establishments using 1/4 inch or 3/16 inch holes.

   This worksheet cannot be used for a Minimum Average Head of 5.0 feet. Design must be modified or valving must be used to equalize flow.

4. Calculate the *Total Head* = *Minimum Average Head* (Line 3) + *Change in Elevation* (Line 2)

   _____ ft + _____ = _____ ft

5. Calculate *Pressure Head for Each Lateral*

   A. Highest trench elevation (Pipe Elevation 1): *Pressure Head* equals *Minimum Average Head* (Line 3)

   B. All other trenches: *Pressure Head* equals *Minimum Average Head* (Line 3) plus the *Change in Elevation* from Lateral 1.

	Minimum Average Head		Elevation of Lateral 1		Elevation of Lateral		Pressure Head
Lat 1		+ [		-		] =	ft
Lat 2		+ [		-		] =	ft
Lat 3		+ [		-		] =	ft
Lat 4		+ [		-		] =	ft
Lat 5		+ [		-		] =	ft

Minnesota Pollution Control Agency

Non-Level Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

6. Determine the *Flow Rate per Hole*

Select a Perforation Diameter and the corresponding gallons per minute from Table I, interpolating as needed.

or Calculate Perforation Discharge (Q) in GPM:

$$Q = 19.65cd^2\sqrt{h}$$

c=0.60; d=perforation diameter; h=pressure head

Lat 1 Pressure Head		Perforation Diameter		=		GPM	Highest
Lat 2 Pressure Head		Perforation Diameter		=		GPM	↓
Lat 3 Pressure Head		Perforation Diameter		=		GPM	
Lat 4 Pressure Head		Perforation Diameter		=		GPM	
Lat 5 Pressure Head		Perforation Diameter		=		GPM	Lowest

7. Calculate Flow in Gallons Per Minute for Lateral 1

A. Select *Perforation Spacing*: _____ feet

B. *Length of Laterals* = Length of STA (Line 1) - 2 Feet

_____ - 2 ft = _____

C. *Number of Perforation Spaces* = Divide the Length of Lateral 1 (7.B) by the Perforation Spacing (Line 10) and round down to the nearest whole number. Check Table II to ensure the maximum number of perforations is not exceeded.

_____ ft/ _____ ft = _____ Spaces

D. *Number of Perforations =Number of Perforation Spaces (Line 11) + 1.*

_____ Spaces +1 = _____

E. *Flow Rate for Lateral 1 = Number of Perforations X Flow Rate Per Hole for Lateral 1*

_____ X _____ = _____ GPM for Lateral 1

Perforation Discharge (GPM)				
Head (ft)	Perforation Diameter			
	1/8	3/16	7/32	1/4
1.0[a]	0.18	0.41	0.56	0.74
1.5	0.22	0.51	0.69	0.9
2.0[b]	0.26	0.59	0.80	1.04
2.5	0.29	0.65	0.89	1.17
3.0	0.32	0.72	0.98	1.28
4.0	0.37	0.83	1.13	1.47
5.0[c]	0.41	0.93	1.26	1.65

a: Use 1.0 for dwellings using 1/4 inch or 3/16 inch holes.

b: Use 2.0 for dwellings using 1/8 inch holes; or, for other establishments using 1/4 inch or 3/16 inch holes.

c: Use 5.0 for other establishments using 1/8 inch perforations and media filters.

8. Calculate the Gallons Per Minute Per Foot for Lateral 1. This value will then be used to make sure that the gallons per minute per foot is equivalent in each lateral

Gallons Per Length = Flow Rate for Lateral 1 divided by Length of Lateral 1

_____ ÷ _____ = _____ GPM/Foot

Maximum Number of Perforations Per Lateral to Guarantee <10% Discharge Variation											
1/4 Inch Holes						7/32 Inch Holes					
Perforation Spacing (Feet)	Pipe Diameter (Inches)					Perforation Spacing (Feet)	Pipe Diameter (Inches)				
	1	1¼	1½	2	3		1	1¼	1½	2	3
2	10	13	18	30	60	2	11	16	21	34	68
2½	8	12	16	28	54	2½	10	14	20	32	64
3	8	12	16	25	52	3	9	14	19	30	60
3/16 Inch Holes						1/8 Inch Holes					
Perforation Spacing (Feet)	Pipe Diameter (Inches)					Perforation Spacing (Feet)	Pipe Diameter (Inches)				
	1	1¼	1½	2	3		1	1¼	1½	2	3
2	12	18	26	46	87	2	21	33	44	74	149
2½	12	17	24	40	80	2½	20	30	41	69	135
3	12	16	22	37	75	3	20	29	38	64	128

Minnesota Pollution Control Agency

Non-Level Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

9. Balance flows for other lateral lengths, spacing, and size.
If you end up with large perforation spacing (3' is max) lower the initial spacing for Lateral 1 (Line 7.A) or the perforation size (Line 6)

Lateral 2 GPM = Length of Lateral X Gallons Per Minute Per Foot (Line 8)

[ ] ft X [ ] GPM/ft= [ ] GPM

Number of Perforations = GPM/Flow Rate for Lateral 2 (Line 6.2)

[ ] ÷ [ ] = [ ] Perforations

Check Table to ensure the maximum number of perforations is not exceeded.

Spacing = (Length of Lateral)/(Number of Perforations -1)

([ ]) ÷ ([ ] Perforations-1) = [ ] ft

Lateral 3 GPM = Length of Lateral X Gallons Per Minute Per Foot (Line 8)

[ ] ft X [ ] GPM/Ft= [ ] GPM

Number of Perforations = GPM/Flow Rate for Lateral 2 (Line 6.3)

[ ] ÷ [ ] = [ ] Perforations

Check Table to ensure the maximum number of perforations is not exceeded.

Spacing = (Length of Lateral)/(Number of Perforations -1)

([ ]) ÷ ([ ] Perforations-1) = [ ] ft

Lateral 4 GPM = Length of Lateral X Gallons Per Minute Per Foot (Line 8)

[ ] ft X [ ] GPM/Ft= [ ] GPM

Number of Perforations = GPM/Flow Rate for Lateral 2 (Line 6.4)

[ ] ÷ [ ] = [ ] Perforations

Check Table to ensure the maximum number of perforations is not exceeded.

Spacing = (Length of Lateral)/(Number of Perforations -1)

([ ]) ÷ ([ ] Perforations-1) = [ ] ft

Lateral 5 GPM = Length of Lateral X Gallons Per Minute Per Foot (Line 8)

[ ] ft X [ ] GPM/Ft= [ ] GPM

Number of Perforations = GPM/Flow Rate for Lateral 2 (Line 6.5)

[ ] ÷ [ ] = [ ] Perforations

Check Table to ensure the maximum number of perforations is not exceeded.

Spacing = (Length of Lateral)/(Number of Perforations -1)

([ ]) ÷ ([ ] Perforations-1) = [ ] ft

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Non-Level Pressure Distribution Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

10. Calculate Total GPM for system - the total GPM need from the pump.

Lateral 1 Flow =		GPM
Lateral 2 Flow =		GPM
Lateral 3 Flow =		GPM
Lateral 4 Flow =		GPM
Lateral 5 Flow =		GPM
Total Flow		GPM

Volume of Liquid in Pipe	
Pipe Diameter (inches)	Liquid Per Foot (Gallons)
1	0.045
1.25	0.078
1.5	0.110
2	0.170
3	0.380
4	0.661

11. Summary

ter the minimum pipe size that allows for even distribution and the volume of liquid in the pipe from the table on page

	Pipe Size (in)	Pipe Volume (gal/ft)	Pipe Length (ft)	Total Volume to Fill Pipe (gal)	Perforation Size (in)	Spacing (ft)
Lateral 1						
Lateral 2						
Lateral 3						
Lateral 4						
Lateral 5						
		Total Volume of Distribution Piping =				

Highest

Lowest

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Pump Selection Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. PUMP CAPACITY

1. Pumping to Gravity Distribution

A. Minimum discharge is 10 GPM (15 GPM recommended) _____ GPM

B. Maximum discharge is 45 GPM.

2. Pressure Distribution - See Pressure Distribution Worksheet

○ Individual SSTS ○ Collection System

Required *Flow Rate* (Line 12 of Pressure Distribution Worksheet) _____ GPM

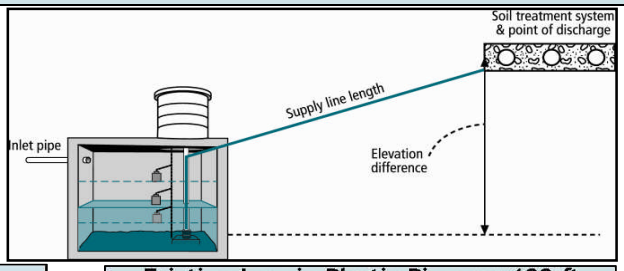
C. Distribution to: ☐ Soil Treatment Unit ☐ Media Filter ☐ ATU ☐ Other

2. HEAD REQUIREMENTS

3. Elevation Difference _____ ft
between pump and point of discharge:

4. Distribution Head Loss: _____ ft

Additional Head Loss: _____ ft
(due to special equipment, etc.)



Distribution Head Loss	
Gravity Distribution = 0ft	
Pressure Distribution based on Minimum Average Head Value on Pressure Distribution Worksheet:	
Minimum Average Head	**Distribution Head Loss**
1ft	5ft
2ft	6ft
5ft	10ft

Friction Loss

5. A. Supply Pipe Diameter: _____ Inches

B. Supply Pipe Length: _____ Feet

Friction Loss in Plastic Pipe per 100 ft (C=130)					
	Nominal Pipe Diameter				
Flow Rate (GPM)	1	1¼	1½	2	3
10	9.11	3.08	1.27	0.31	---
12	12.77	4.31	1.78	0.44	---
14	16.99	5.74	2.36	0.58	---
16	---	7.35	3.03	0.75	0.10
18	---	9.14	3.76	0.93	0.13
20	---	11.11	4.58	1.13	0.16
25	---	16.79	6.92	1.71	0.24
30	---	---	9.69	2.39	0.33
35	---	---	12.90	3.18	0.44
40	---	---	16.52	4.07	0.57
45	---	---	---	5.07	0.70
50	---	---	---	6.16	0.86
55	---	---	---	7.35	1.02
60	---	---	---	8.63	1.20
65	---	---	---	10.01	1.39
70	---	---	---	11.48	1.60

NOTE : IF system is an individual subsurface sewage treatment system, complete steps 6, 7 and 8. If system is a Collection System, skip steps 6, 7 and 8 and go to Step 9.

6. Based on **Friction Loss in Plastic Pipe per 100ft** from Table I:

Friction Loss = _____ ft per 100ft of pipe

7. Determine *Equivalent Pipe Length* from pump discharge to soil dispersal area discharge point. Estimate by adding 25% to supply pipe length for fitting loss. *Supply Pipe Length (5.B)* X 1.25 = *Equivalent Pipe Length*

_____ ft X 1.25 = _____ ft

8. Calculate *Supply Friction Loss* by multiplying *Friction Loss Per 100ft* (Line 6) by the *Equivalent Pipe Length* (Line 7) and divide by 100.

Supply Friction Loss =

_____ ft per 100ft X _____ ft ÷ 100 = _____ ft

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Pump Selection Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

9. Equivalent length of pipe fittings.

Section 9 is for Collection Systems ONLY and does NOT need to be completed for individual subsurface sewage treatment systems.

Quanity X Equivalent Length Factor = Equivalent Length

Fitting Type	Quantity		Equivalent Length Factor		Equivalent Length (ft)
Gate Valve		X		=	
90 Deg Elbow		X		=	
45 Deg Elbow		X		=	
Tee - Flow Thru		X		=	
Tee - Branch Flow		X		=	
Swing Check Valve		X		=	
Angle Valve		X		=	
Globe Valve		X		=	
Butterfly Valve		X		=	
Valve 10		X		=	
Valve 11		X		=	

Equivalent Length Factors (ft.) for PVC Pipe Fittings			
Fitting Type	Pipe Diameter (in.)		
	1½	2	3
Gate Valve	1.07	1.38	2.04
90 Deg Elbow	4.03	5.17	7.67
45 Deg Elbow	2.15	2.76	4.09
Tee - Flow Thru	2.68	3.45	5.11
Tee - Branch Flow	8.05	10.30	15.30
Swing Check Valve	13.40	17.20	25.50
Angle Valve	20.10	25.80	38.40
Globe Valve	45.60	58.60	86.90
Butterfly Valve	-	7.75	11.50

NOTE: Equivalent length values for PVC pipe fittings on based calculations using the Hazen-Williams Equation. See Advanced Designs for SSTS for equation. Other pipe material may require different equivalent length factors. Verify other equivalent length factors with pipe material manufacturer.

NOTE: System installer should contact system designer if the number of fittings varies from the design to the actual installation.

A. Sum of Equivalent Length due to pipe fittings: _____ ft

B. *Total Pipe Length* = Supply Pipe Length (5.B) + Equivalent Pipe Length (9.A.)

_____ + _____ = _____ feet

$$h = \frac{0.128 * L * Q^{1.852}}{100 * D^{4.8655}}$$

C. Friction loss due to pipe fittings and supply pipe (h):

(0.128 X Total Pipe Length (9.B) X Flow Rate$^{1.852}$) ÷ (100 X Pipe Diameter$^{4.8655}$)

(0.128 X _____ X _____$^{1.852}$) ÷ (100 X _____$^{4.8655}$) = _____ ft

10. *Total Head* requirement is the sum of the *Elevation Difference* (Line 3), the Distribution Head Loss (Line 4), Supply Friction Loss (Line 8), and Friction Loss from the Supply Pipe and Pipe Fittings-if collection system (Line 9.C)

NOTE: Supply Friction Loss (Line 8) need ONLY be used if NOT a collection system.

NOTE: Friction Loss from the Supply Pipe and Pipe Fittings (Line 9.C) need ONLY be used if system is a collection system.

_____ ft + _____ ft + _____ ft + _____ = _____ ft

3. PUMP SELECTION

A pump must be selected to deliver at least _____ GPM (Line 1 or Line 2) with at least _____ feet of total head.

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(Designer)	(Signature)	(License #)	(Date)

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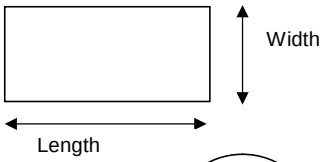
Pump Tank Sizing, Dosing and Float and Timer Setting Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

DETERMINE AREA AND GALLONS PER INCH

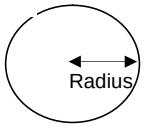
1. A. Rectangle area = Length (L) X Width (W)

[ ] ft X [ ] ft = [ ] ft2



B. Circle area = $3.14r^2$ (3.141593 X radius X radius)

3.14 X [ ]^2 ft = [ ] ft2



C. Get area from manufacturer [ ] ft2

2. Calculate *Gallons Per Inch* :

There are 7.48 gallons per cubic foot. Therefore, multiply the area from 1.A, 1.B, or 1.C by 7.48 to determine the gallons per foot the tank holds. Then divide that number by 12 to calculate the gallons per inch.

(Area X 7.48 gallons/ft3)/(12 in/ft) =

[ ] ft2 X 7.48 ÷ 12 in/ft = [ ] Gallons Per Inch

TANK CAPACITY

3. Select the required *Minimum Tank Capacity* based on the table below [ ] Gallons

4. Calculate *Total Tank Volume*

A. *Depth from bottom of inlet pipe to tank bottom* : [ ] in

B. *Total Tank Volume* = *Depth from bottom of inlet pipe* (Line 4.A) X *Gallons/Inch* (Line 2)

[ ] in X [ ] Gallons Per Inch = [ ] Gallons

5. Calculate *Volume to Cover Pump* (The inlet of the pump must be at least 4-inches from the bottom of the pump tank & 2-3 inches of water covering the pump is recommended)

(Pump and block height + 2 inches) X *Gallons Per Inch* (Line 2)

([ ] + 2 inches) [ ] Gallons Per Inch = [ ] Gallons

Design Flow (Gallons Per Day)	Minimum Pump Tank Capacity (Gallons)	
0-600	500	or Altnernating Dual Pumps
601-4,999	100% of the Design Flow	or Altnernating Dual Pumps
5,000-9,999	50% of the Design Flow	and Altnernating Dual Pumps

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Pump Tank Sizing, Dosing and Float and Timer Setting Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

DOSING VOLUME

7. Calculate *Minimum Pumpout Volume*

Volume of Distribution Piping - Line 17 of the Pressure Distribution Worksheet _____ Gallons

Minimum Pumpout Volume = Volume of Distribution Piping X 5 _____ X 5 = _____ Gallons

8. Calculate *Maximum Pumpout Volume* (25% of Design Flow)

Design Flow: _____ GPD X 0.25 = _____ Gallons

9. *Dosing Volume = Select a volume for 4-5 doses per day and is between the minimum (Line 7) and maximum (Line 8) pumpout volume:* _____ Gallons

10. Calculate *Doses Per Day* = Design Flow / *Dosing Volume*

_____ ÷ _____ = _____ *Doses Per Day*

11. Calculate Drainback:

A. *Diameter of Supply Pipe* = _____ inches

B. Length of Supply Pipe = _____ feet

C. *Volume of Liquid Per Lineal Foot of Pipe* = _____ Gallons

D. *Drainback = Length of Supply Pipe X Volume of Liquid Per Lineal Foot of Pipe*

_____ X _____ = _____ Gallons

12. *Total Dosing Volume = Dosing Volume* (Line 9) minus *Drainback* (Line 11.D)

_____ + _____ = _____ Gallons

Volume of Liquid in Pipe	
Pipe Diameter (inches)	Liquid Per Foot (Gallons)
1	0.045
1.25	0.078
1.5	0.110
2	0.170
3	0.380
4	0.661

FLOAT AND TIMER SETTINGS

A. TIME/DOSING SETTINGS

13. Required *Flow Rate*:

A. From Design (Line 12 of Pressure Distribution Worksheet): _____ GPM

B. Or calculated: GPM = Change in Depth (in) x Gallons Per Inch (Line 2) / Time Interval in Minutes

_____ X _____ ÷ _____ = _____ GPM

14. Choose a Flow Rate from Line 13.A or 13.B above. _____ **GPM**

15. Calculate **TIMER ON** setting:

Total Dosing Volume (Line 12)/GPM(Line 14)

_____ ÷ _____ = _____ Minutes ON

16. Calculate **TIMER OFF** setting:

Minutes Per Day (1440)/*Doses Per Day (Line 10)* - Minutes On (Line 15)

1440 ÷ _____ - _____ = _____ Minutes OFF

17. Measuring from bottom of tank:

Distance to set Pump Off Float=Gallons to Cover Pump (Line 5) / Gallons Per Inch (Line 2):

_____ ÷ _____ = _____ Inches

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Pump Tank Sizing, Dosing and Float and Timer Setting Design Worksheet

University of Minnesota Onsite Sewage Treatment Program

B. DEMAND DOSE FLOAT SETTINGS

18. Calculate *Float Separation Distance* using *Dosing Volume* .

Total Dosing Volume (Line 12)/Gallons Per Inch (Line 2)

[ ] ÷ [ ] = [ ] Inches

19. Calculate *Gallons for Alarm* (typically 2-3 inches)

Alarm Depth (inch) x *Gallons Per Inch* (Line 2)

[ ] X [ ] = [ ] Gallons

20. Calculate *Total Gallons* = *Gallons Over Pump* (Line 5) + *Total Dosing Volume* (Line 12) + *Gallons for Alarm* (Line 19)

[ ] + [ ] + [ ] = [ ] Gallons

21. *Minimum Tank Depth* = *Total Gallons* (Line 20)/*Gallons Per Inch* (Line 2)

[ ] ÷ [ ] = [ ] Inches

22. Measuring from bottom of tank:

A. *Distance to set Pump Off Float* = *Pump Height* + *Block Height* (Line 5) + *Alarm Depth* (Line 19)

[ ] + [ ] = [ ] Inches

B. *Distance to set Pump On Float=Distance to Set Pump-Off Float (Line 22.A) + Float Separation Distance (Line 18)*

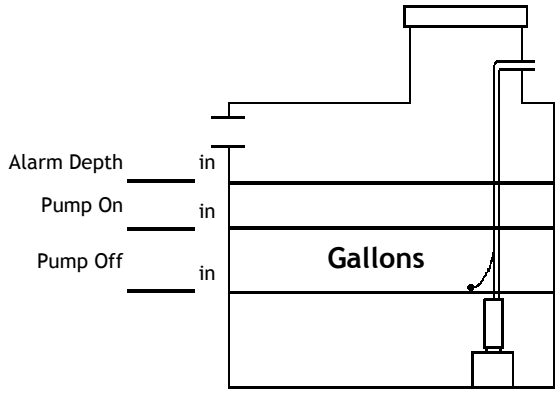
[ ] + [ ] = [ ] Inches

C. *Distance to set Alarm Float* = *Distance to set Pump-On Float* (22.B) + *Alarm Depth* (Line 19)

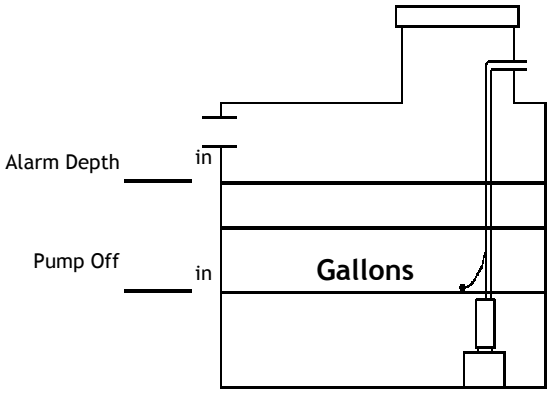
[ ] + [ ] = [ ] Inches

FLOAT SETTINGS

DEMAND DOSING



TIMED DOSING



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Flow Estimation: Existing Dwellings

University of Minnesota Onsite Sewage Treatment Program

Dwelling #	# of Bedrooms (minimum = 2)	Dwelling Classification (see Table IV)	7080.1860 Design Flow (gpd) (See Table 1)	Reduction Factor - 0.45 (if applicable*)	LISTS Flow per Dwelling (gpd)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
				Total Dwelling Flow Estimate	

* Use 1.0 for the flow from the ten hightest flow dwellings and 0.45 for remaining dwellings

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Flow Estimation: New Developments

University of Minnesota Onsite Sewage Treatment Program

Dwelling #	# of Bedrooms (minimum = 2)	Average Daily Flow (# of bedrooms x 110 gallons)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
Total Dwelling Flow		

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Measured Flow: Other Establishments

University of Minnesota Onsite Sewage Treatment Program

Day (1-30)	Meter Reading* (gal)	% Capacity (if exists)	GPD	Day (31-60)	Meter Reading* (gal)	% Capacity (if exists)	GPD	Day (61-90)	Meter Reading* (gal)	% Capacity (if exists)	GPD
1			NA	31				61			
2				32				62			
3				33				63			
4				34				64			
5				35				65			
6				36				66			
7				37				67			
8				38				68			
9				39				69			
10				40				70			
11				41				71			
12				42				72			
13				43				73			
14				44				74			
15				45				75			
16				46				76			
17				47				77			
18				48				78			
19				49				79			
20				50				80			
21				51				81			
22				52				82			
23				53				83			
24				54				84			
25				55				85			
26				56				86			
27				57				87			
28				58				88			
29				59				89			
30				60				90			

* Daily flow data collected during peak season of usuage. Meter calibrated monthly. Data could also be gathered from event counter or running time clock and converted to gallons.

Flow Calculations		
Minimum Flow		gpd
Peak Flow		gpd
Full capacity flow from 7 busiest consectutive days (if available):		gpd
Average Flow of Days in Operation (without capacity information) Do not include days with no flow		gpd
Average Flow X 1.5 Safety Factor		gpd
Average Flow X 2.0 Safety Factor		gpd

Use if system currently failing to surface, daily flow data not available or data not collected during peak usage.

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Flow Estimation:Other Establishments

University of Minnesota Onsite Sewage Treatment Program

Establishment	Type of Establishment	Unit	# of Units	Design Flow per Unit (See Table I)	Total Avg Daily Flow
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
				Total Flow (gpd)	

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Final Permitting Flow Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. Flow from Dwellings	Flow from Dwellings		gpd	From either existing and new development worksheet
2. Flow from Other Establishments	Permitting Flow from Other Establishments		gpd	From either Measured or Estimated-OE worksheet
3. Flow from Collection System	a) Total Length of Collection Pipe:		feet	Design flow must include 200 gallons of infiltration and inflow per inch of collection pipe diameter per mile per day with a minimum pipe diameter of two inches. Flow values can be further increased if the system employs treatment devices that will infiltrate precipitation.
	b) Diameter of Pipe (Minimum of 2 in):		inches	
	c) Flow From Collection System:		gpd	
4. Final Permitting Flow			gpd	Sum of 1, 2 and 3c.

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LISTS Design Flow and System Summary Worksheet

University of Minnesota Onsite Sewage Treatment Program

1. PERMITTING FLOW

Permitting Flow *(from Final Flow worksheet):* _____ GPD

2. ORGANIC LOADING

A. Facility with potential elevated levels of BOD_5, TSS or FOG? ☐ Yes ☐ No

See Assessment and Waste Strength Table

B. If Yes, Estimated or Measured Values ☐ Estimated ☐ Measured

i. BOD_5 _____ mg/l

ii. TSS _____ mg/l

iii. FOG _____ mg/l

If concentrations of BOD, TSS, and O&G are expected to be higher than 175 mg/1, 65 mg/1, or 25 mg/1 respectively, an estimated or measured average concentration must be determined.

3. GREASE TRAP

Grease trap required for facilities with high levels of O&G. A minimum of 24 hours (1 day) of hydraulic retention time is required, but can be up 4 days or more.The outlet baffle must extended to 50 - 70% of liquid depth.

A. Design Flow - Grease Trap (kitchen waste only): _____ GPD

Use 70% of permited flow to size the grease trap if using estimated design flows are being used.

B. Minimum capacity is equal to the Design Flow for Grease Traps (3A) multiplied by 1.

_____ X _____ day(s) = _____ Gallons

4. SEPTIC TANKS

A. Individual septic tanks at each dwelling (7080.1930 minimum)*:

Septic Tank capacity: _____ Gallons

Number of Septic Tanks/Compartments: _____

*Effluent Screen Minimum Size Slots*** _____ (1/8 or 1/16 inch)

** When septic tanks are installed at each dwelling an effluent screen and alarm must either be located at each dwelling or a the common treatment area.*

Minnesota Pollution Control Agency

LISTS Design Flow and System Summary Worksheet

University of Minnesota Onsite Sewage Treatment Program

B. Gravity collection to common septic tanks:

Minimum capacity is the design flow (1) multiplied by 3 days.

[ ] X 3 days = [ ] Gallons

Number of *Septic Tanks/ Compartments* : [ ]

*Effluent Screen Minimum Size Slots*** [ ] (1/8 or 1/16 inch)

*** 1/16 inch screen slots must be used when downstream distribution components utulize 1/8 inch diameter orifices.*

C. Pressure collection to common septic tanks:

Minimum septic tank capacity is the design flow multiplied by 4 days.

[ ] X 4 days = [ ] Gallons

Number of *Septic Tanks/Compartments* : [ ]

*Effluent Screen Minimum Size Slots*** [ ] (1/8 or 1/16 inch)

D. Septic tank liquid capacity prior to other treatment devices:

Capacity set by manufacturer's requirements, accepted engineering principles, or as identified in the product registration recommended standards and criteria.

[ ] Gallons

Number of *Septic Tanks/Compartments* : [ ]

Effluent Screen & Alarm ? ☐ Yes ☐ No

5. SITE EVALUATION OVERVIEW:

A. *Depth to Limiting Layer* : [ ] inches [ ] feet

B. *Landscape Position* : [ ]

C. *Soil Texture Group Number* : [ ]

D. *Percent Land Slope* : [ ] %

Minnesota Pollution Control Agency

LISTS Design Flow and System Summary Worksheet

University of Minnesota Onsite Sewage Treatment Program

6. SOIL LOADING RATES: Select method A. or B. below

A.

7080 Table IX DETAILED SOIL DESCRIPTIONS (SOIL PIT REQUIRED)	
Texture	
Texture Group	
Structure	
Grade	
Consistence	
Select Soil Loading Rate:	

B.

7080 Table IXa	
PERCOLATION TEST SIZING	LOADING RATE (GPD/ft^2)
Faster than 0.1*	0.00
0.1 to 5*	1.20
0.1 to 5 (soil texture groups 3 & 5)	0.60
6 to 15	0.78
16 to 30	0.60
31 to 45	0.50
46 to 60	0.45
61-120	0.24
Slower than 120	0.00

*Rapidly permeable soils: see 7080.2260

Slowest measured percolation rate: _____ mpi

Select Soil Loading Rate: _____

C. Design Loading Rate: _____ GPD/ft^2

7. SYSTEM OVERVIEW

A. *Type of Collection System* ☐ Gravity ☐ Pressure

B. *Kind of Soil Treatment and Dispersal Area* : _____

C. *Type of System:* ☐ Type I ☐ Type II ☐ Type III ☐ Type IV ☐ Type V

D. *Registered Product/pretreatment unit:* ☐ No ☐ Yes-Type: _____

E. *Distribution Method* : _____

Note: Pressure distribution must be used for soil treatment systems with flows greater than 2,500 gallons per day.

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules & laws.

_____	_____	_____	_____
(Designer)	(Signature)	(License #)	(Date)

Minnesota Pollution Control Agency

Single-Pass & Recirculating Sand Filter Worksheet

University of Minnesota Onsite Sewage Treatment Program

A. GENERAL SPECIFICATIONS

1. **Design flow** - *from Flow & Soil or LISTS Flow worksheet:* [ ]

2. **Type of filter** *(check)*: ☐ Single-Pass ☐ Recirculating

B. MINIMUM RECIRCULATION/DOSING TANK CAPACITY *(if applicable)*

A minimum of 24 hours (1 day) of hydraulic retention time is required, but can be greater.

Minimum capacity is equal to the Design Flow (1) multiplied by 1.

[ ] gpd X [ ] day(s) = [ ] Gallons

C. FILTER DIMENSIONS

1. Select loading rate: [ ] ft^2/gpd

Maximum hydraulic loading rate for single-pass is 1.0ft^2/gpd and 0.2 ft^2/gpd for recirculating.

2. Filter area = flow rate (A1) x loading rate (C1):

[ ] gpd X [ ] ft^2/gpd = [ ] ft^2

3. Verifty organic loading rate is accectable (can not exceed 0.005 lbs BOD/ft^2/day)

a. Take design flow (A1) multipled by estimated BOD_5 (from Flow and System - 2Bi) multipled by conversion factor (0.0000835).

[ ] gpd X [ ] mg/l X 0.00000835 [ ] lbs BOD

b. Divide lbs of BOD by square feet of filter (C2).

[ ] lbs BOD ÷ [ ] ft^2 = [ ] lbs BOD/ft^2

If greater then 0.005 lbs BOD/ft^2 hyraulic loading rate must be reduced.

4. Select width of filter: [ ] ft

5. Length of filter = filter area (C2) divided by filter width (C3) =

[ ] ft^2 ÷ [ ] ft = [ ] ft

Number of Zones: [ ]

1 zone minimum for single family dwelling, minimum of two zones for anything else.

Minnesota Pollution Control Agency

Single-Pass & Recirculating Sand Filter Worksheet

University of Minnesota Onsite Sewage Treatment Program

D. DRAINAGE SYSTEM

1. Type(s) of Drainage Media: _____

To protect the liner, 6 in. of 3/8- media must be installed under the liner and 2 in. of pea gravel on top of the liner. Drainfield rock must surround the collection pipe. The upper 2 in. must be pea gravel to limit migration of treatment media into drai

2. (a) Total Depth of Drainage Media: _____ ft

Minimum depth is 1 foot with bottom sloped 1% to drainage pipe unless pump is part of filter drainage.

(b) Depth of Pea Gravel: _____ in. ÷ 12 = _____ ft

c) Depth of Drainfield Rock: _____ in. ÷ 12 = _____ ft

3. Pea Gravel Volume: Multiply filter area (C2) by drainage depth (2b):

_____ ft^2 X _____ ft = _____ ft^3

Divide cubic feet by 27 ft^3/yd^3 to get cubic yards:

_____ ft^3 ÷ 27 = _____ yd^3

4. Drainfield Rock Volume: Multiply filter area (C2) by drainage depth (2c):

_____ ft^2 X _____ ft = _____ ft^3

Divide cubic feet by 27 ft^3/yd^3 to get cubic yards (for sand and gravel only):

_____ ft^3 ÷ 27 = _____ yd^3

5. Number of Drainage Pipes: _____

One drainage pipe per zone or twenty feet is minimum, more are recommended to facilitate system recovery.

6. Number of Inspection Ports: _____ *One inspection port per zone is minimum.*

Minnesota Pollution Control Agency

Single-Pass & Recirculating Sand Filter Worksheet

University of Minnesota Onsite Sewage Treatment Program

E. TREATMENT MEDIA

1. Type (sand, gravel, etc): _____

2. Depth of Treatment Media: _____ ft *2 feet is required*

3. Treatment Media Volume: Multiply filter area(C2) by treatment depth (E2):

_____ ft^2 X _____ ft = _____ ft^3

Divide cubic feet by 27 ft^3/yd^3 to get cubic yards

_____ ft^3 ÷ 27 = _____ yd^3

F. DISTRIBUTION MEDIA

1. Type of Distribution Media: _____

2. Depth of Distribution Media: _____ ft

Minimum depth is 0.67 feet (8 inches = 6 inches below the lateral and 2 inches above).

3. If using rock or gravel, media volume: Multiply filter area (C2) by distribution depth (F2):

_____ ft^2 X _____ ft = _____ ft^3

Divide cubic feet by 27 ft^3/yd^3 to get cubic yards

_____ ft^3 ÷ 27 = _____ yd^3

Treatment Media Specifications

	Single-Pass Sand	Recirculating Sand
Effective Size (mm)	0.4 - 0.9	1.5 - 2.5
Uniformity Coefficient	2.5	2
Sieve Size/Number	% Passing	
3/8	100	100
No. 4	77 -100	70 - 100
No. 8	53 - 100	5 - 78
No. 16	15 - 80	0 - 4
No. 30	3 - 50	
No. 50	0 - 3	
No. 100	0 - 3	
No. 200	0 - 3	0 - 3

G. COVER MATERIAL (if applicable)

Is the system covered with geotextile & soil *(check box)*?

☐ No ☐ Yes-Depth: _____ ft

Single-pass sand filters may be covered with soil while recirculating sand filter must have distribution media to the surface. If soil cover installed, maximum depth of 12 inches of loamy or sandy material with upper six inches of topsoil borrow is required along with appropriate vegetation.

Minnesota Pollution Control Agency

Single-Pass & Recirculating Sand Filter Worksheet

University of Minnesota Onsite Sewage Treatment Program

H. LINER

1. Total system height is sum of depth of drainage(D2), treatment(E2), distribution(F2) & cover(G):

[ ] ft + [ ] ft + [ ] ft +

[ ] ft = [ ] ft

Assumes verticle walls. If sloped additional liner will be needed.

2. Width of liner is equal to the design width (C4) plus the two times the total system height (H1) plus two additional feet for constructability:

[ ] ft + ([ ] ft x 2) + 2 = [ ] ft

3. Length of liner equals the design length (C5) plus two times the total system height (H1) of the filter plus two additional feet for constructability:

[ ] ft + ([ ] ft x 2) + 2 = [ ] ft

4. Liner size/area is then determined by multiplying the width(H2) and length (H3):

[ ] ft^2 X [ ] ft = [ ] ft^2

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer)	(Signature)	(License #)	(Date)

Estimate of Waste Strengths from Other Establishments

Type of Facility	BOD (mg/L)	BOD (lbs/unit/day)
Airports		
Per passenger	400 - 500	0.2
Per employee	400 - 500	0.5
Apartment houses	240 - 400	0.175/multiple family
Assembly hall (no kitchen)	240 - 400	0.01/seat
Boarding school	240 - 400	0.15/student
Bowling alley (no kitchen)	240 - 400	0.15/lane
Camps		
Construction (Semi-permantent)	400 - 500	0.140
Counntry club (member)	400 - 500	0.052/member
Country club (resident)	240 - 400	0.208/resident
Day (no meals)	400 - 500	0.031
Luxury	400 - 500	0.208
Church (no kitchen)	240 - 400	0.01/seat
Country club	400 - 800	0.17/member
Personnel addition	240 - 400	0.04/employee
Day school	240 - 400	0.03/student
Add for showers	240 - 400	0.01/student
Add for cafeteria	500 - 700	0.03/meal
Add for employees	240 - 400	0.03/employee
Factory		
No showers	240 - 400	0.04/employee
With showers	240 - 400	0.07/employee
Food service		
Ordinary restaurant	600 - 1500	0.35/seat
24-Hour restaurant	600 - 1500	0.50/seat
Freeway restaurant	600 - 1500	0.70/seat
Tavern (limited food)	400 - 800	0.10/seat
Carry-out (single service)	600 - 800	0.70/100 sqft
Carry-out	200 - 600	0.04/employee
Fast food chain	1000 - 2000	0.80/seat
Hospital (not including personnel)	400 - 600	0.70/bed
Personnel addition	240 - 400	0.04/employee
Laundromat	600 - 800	2.0/machine
Mobile home park	240 - 400	0.40/space
Motel, Hotel	240 - 400	0.30/room
Nursing home (not including kitchen or laundry)	400 - 600	0.30/bed
Personnel addition	240 - 400	0.04/employee

Estimate of Waste Strengths from Other Establishments

Type of Facility	BOD (mg/L)	BOD (lbs/unit/day)
Office building (per 8 hour shift)	240 - 400	0.04/employee
Resort hotel, cottage	240 - 400	0.15/room
Add for self-service laundry	600 - 800	2.0/machine
Service station	240 - 400	0.50/toilet or urinal
Swimming pool	300 - 500	0.21
Shopping center (no food service or laundry)	400 - 600	0.30/1000 sqft
Theaters		
Drive-in	400 - 500	0.010/car space
Indoor	240 - 400	0.010/seat
Travel trailer or RV park		
No water/sewer hook up	400 - 800	0.25/space
With water and sewer	400 - 800	0.30/space

TABLE I

from 7081.0130

University of Minnesota
Onsite Sewage Treatment Program

Estimated Sewage Flow from Other Establishments (Gallons/day)		
Dwelling units	**Unit**	**Average daily flow**
Hotel or luxury hotel	guest	55
	square foot	0.28
Motel	guest	38
	square foot	0.33
Rooming house	resident	45
	add for each nonresident meal	3.3
Daycare (no meals)	child	19
Daycare (with meals)	child	23
Dormitory	person	43
Labor camp	person	18
Labor camp (semi permanent)	employee	50
Commercial	Industrial	
Retail store	square foot	0.13
	customer	3.8
	toilet	590
Shopping center	employee	11.5
	square foot	0.15
	parking space	2.5
Office	employee 8-hour shift	18
	square foot	0.18
Medical office*	square foot	1.1
	practitioner	275
	patient	8
Industrial building*	employee 8-hour shift	17.5
	employee 8-hour shift with showers	25
Laundromat	machine	635
	load	52.5
	square foot	2.6
Barber shop*	chair	68
Beauty salon*	station	285
Flea market	nonfood vendor space	15
	limited food vendor space	25
	with food vendor space	50

TABLE I

from 7081.0130

University of Minnesota
Onsite Sewage Treatment Program

Estimated Sewage Flow from Other Establishments (Gallons/day)		
Dwelling units	**Unit**	**Average daily flow**
Eating and drinking establishments		
Restaurant (does not include bar or lounge)	meal without alcoholic drinks	3.5
	meal with alcoholic drinks	8
	seat (open 16 hours or less)	30
	seat (open more than 16 hours)	50
	seat (open 16 hours or less, single service articles)	20
	seat (open more than 16 hours, single service articles)	35
Restaurant (short order)	customer	7
Restaurant (drive- in)	car space	30
Restaurant (carry out including caterers)	square foot	0.5
Institutional meals	meal	5
Food outlet	square foot	0.2
Dining hall	meal	8.5
Coffee shop	customer	7
Cafeteria	customer	2.5
Bar or lounge (no meals)	customer	4.5
	seat	36
Entertainment establishments		
Drive-in theater	car stall	5
Theater	auditorium seat	4.5
Bowling alley	alley	185
Country club	member (no meals)	22
	member (with meals and showers)	118
	member (resident)	86
Fairground and other similar gatherings	visitor	1.5
Stadium	seat	5
Dance hall	person	6
Health club	gym member	35
Outdoor recreation and related lodging facilities		
Campground	person with hook- up	36
	site with hook- up	100
	site without hook- up, with central bath	62
	site to be served by dump station	14.5
Permanent mobile home	mobile home	225
Camp, day without meals	person	20
Camp, day with meals	person	25
Camp, day and night with meals	person	45
Resort	lodge hotel person	62
Cabin, resort	person	50
Retail resort store	customer	4
Park or swimming pool	guest	10
Visitor center	visitor	13

TABLE I

from 7081.0130

University of Minnesota
Onsite Sewage Treatment Program

Estimated Sewage Flow from Other Establishments (Gallons/day)

Dwelling units	Unit	Average daily flow
Transportation		
Gas station	convenience store customer	3.5
	Service station* customer	11
	service bay	50
	toilet	250
	square foot	0.25
Car wash* (does not include car wash water)	square foot	5
Airport, bus station, rail depot	passenger	5
	square foot	5
	restroom	565
Institutional		
Hospital*	bed	220
Mental health hospital*	bed	147
Prison or jail	inmate	140
Nursing home, other adult congregate living	resident	125
Other public institution	person	105
School (no gym, no cafeteria, and no showers)	student	14
School (with cafeteria, no gym and no showers)	student	18
School (with cafeteria, gym, and showers)	student	27.5
School (boarding)	student	95
Church	seat	4, add for each meal prepared 5
Assembly hall	seat	4
Miscellaneous		
Public lavatory	user	5
Public shower	shower taken	11

* Waste other than sewage is only allowed to be discharged into the system if the waste is suitable to be discharged to groundwater.

Unless otherwise noted in Table I, the flow values do not include flows generated by employees. A flow value of 15 gallons/employee/eight-hour shift must be added to the flow amount. Design flow determination for establishments not listed in Table I shall be determined by the best available information & approved by the LUG.

TABLE IV
from 7080.1860

Average daily flow for 4 to 10 dwellings (Gallons/Day)

	Classification of Dwelling			
# of bedrooms	**I**	**II**	**III**	**IV**
2 or less	300	225	180	*
3	450	300	218	*
4	600	375	256	*
5	750	450	294	*
6	900	525	332	*
	0	75	104	
> 6 bedrooms +				

For more than six bedrooms, the design flow is determined by the

Classification II: Classification II dwellings are those with 500 to

Classification III: Classification III dwellings are those with less

Table IX

University of Minnesota
Onsite Sewage Treatment Program

Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Level C and Absorption Ratios for Determining Mound Absorption Areas using Detailed Soil Descriptions

Texture	Texture Group	Structure		Consistence	Rate (gpd/ft^2)	Absorption Ratio
		Type	Grade			
Coarse Sand*	1	Single Grain	Structureless	Loose	-	1.0
				Weakly Cemented Friable	-	2.0
				Cemented-Firm	-	-
Medium Sand*	2	Single Grain	Structureless	Loose	1.20	1.0
				Weakly Cemented Friable	0.60	2.0
				Cemented-Firm	-	-
Fine Sand	3	Single Grain	Structureless	Loose	0.60	2.0
				Weakly Cemented Friable	0.24	5.0
				Cemented-Firm	-	-
Coarse and Medium Loamy Sand*	4	Single Grain	Structureless	Loose	1.20	1.0
				Weakly Cemented Friable	0.60	2.0
				Cemented-Firm	-	-
Fine and Very Fine Loamy Sand	5	Single Grain	Structureless	Loose	0.60	2.0
				Weakly Cemented Friable	0.24	5.0
				Cemented-Firm	-	-
Coarse and Medium Sandy Loam	6	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	0.45	2.6
				Firm	0.24	5.0
			Moderate or Strong	Very Friable, Friable	0.78	1.3
				Firm	0.45	2.6
		Platy	Weak	Very Friable, Friable	0.45	2.6
				Firm	0.24	5.0
			Moderate or Strong	Very Friable, Friable	0.45	2.6
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	0.24	5.0
				Firm	-	-
Fine and Very Fine Sandy Loam	7	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	0.24	5.0
				Firm	0.24	5.0
			Moderate or Strong	Very Friable, Friable	0.60	2.0
				fim	0.24	5.0
		Platy	Weak	Very Friable, Friable	0.24	5.0
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	0.24	5.0
				Firm	-	-

Table IX (cont.)

Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Level C and Absorption Ratios for Determining Mound Absorption Areas using Detailed Soil Descriptions

Loam	**8**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.45**	**2.6**
				Firm	**0.24**	**5.0**
			Moderate or Strong	Very Friable, Friable	**0.60**	**2.0**
				Firm	**0.24**	**5.0**
		Platy	Weak	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
Silt Loam	**9**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.45**	**2.6**
				Firm	**0.24**	**5.0**
			Moderate or Strong	Very Friable, Friable	**0.50**	**2.4**
				Firm	**0.24**	**5.0**
		Platy	Weak	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
Clay Loam, Silty Clay Loam, Sandy Clay Loam	**10**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	**0.45**	**2.6**
				Firm	**0.24**	**5.0**
		Platy	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	-	-
				Firm	-	-
Clay, Silty Clay, Sandy Clay	**11**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	**0.24**	**5.0**
				Firm	-	-
		Platy	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	-	-
				Firm	-	-

Table XII

University of Minnesota
Onsite Sewage Treatment Program

Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Levels A & B & Absorption Ratios for Determining Mound Absorption Areas using Detailed Soil Descriptions

Texture	Texture Group	Structure		Consistence	Rate (gpd/ft^2)	Absorption Ratio
		Type	Grade			
Coarse Sand*	1	Single Grain	Structureless	Loose	-	1.0
				Weakly Cemented Friable	-	2.0
				Cemented-Firm	-	-
Medium Sand*	2	Single Grain	Structureless	Loose	1.60	1.0
				Weakly Cemented Friable	0.78	2.0
				Cemented-Firm	-	-
Fine Sand	3	Single Grain	Structureless	Loose	1.00	2.0
				Weakly Cemented Friable	0.12	2.0
				Cemented-Firm	-	-
Coarse and Medium Loamy Sand*	4	Single Grain	Structureless	Loose	1.60	1.0
				Weakly Cemented Friable	0.78	2.0
				Cemented-Firm	-	-
Fine and Very Fine Loamy Sand	5	Single Grain	Structureless	Loose	1.00	2.0
				Weakly Cemented Friable	0.45	5.0
				Cemented-Firm	-	-
Coarse and Medium Sandy Loam	6	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	0.60	2.6
				Firm	0.45	5.0
			Moderate or Strong	Very Friable, Friable	1.00	1.3
				Firm	0.60	2.6
		Platy	Weak	Very Friable, Friable	0.60	2.6
				Firm	0.45	5.0
			Moderate or Strong	Very Friable, Friable	0.60	2.6
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	0.45	5.0
				Firm	-	-
Fine and Very Fine Sandy Loam	7	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	0.45	5.0
				Firm	0.45	5.0
			Moderate or Strong	Very Friable, Friable	0.78	2.0
				fim	0.45	5.0
		Platy	Weak	Very Friable, Friable	0.45	5.0
				Firm	0.00	-
			Moderate or Strong	Very Friable, Friable	0.24	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	0.45	5.0
				Firm	-	-

Table XII (cont.)

Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Levels A & B & Absorption Ratios for Determining Mound Absorption Areas using Detailed Soil Descriptions

Loam	**8**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.60**	**2.6**
				Firm	**0.45**	**5.0**
			Moderate or Strong	Very Friable, Friable	**0.78**	**2.0**
				Firm	**0.45**	**5.0**
		Platy	Weak	Very Friable, Friable	**0.45**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	**0.24**	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	**0.45**	**5.0**
				Firm	-	-
Silt Loam	**9**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.60**	**2.6**
				Firm	**0.45**	**5.0**
			Moderate or Strong	Very Friable, Friable	**0.78**	**2.4**
				Firm	**0.45**	**5.0**
		Platy	Weak	Very Friable, Friable	**0.45**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	**0.30**	**5.0**
				Firm	-	-
Clay Loam, Silty Clay Loam, Sandy Clay Loam	**10**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	**0.30**	**5.0**
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	**0.60**	**2.6**
				Firm	**0.30**	**5.0**
		Platy	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	-	-
				Firm	-	-
Clay, Silty Clay, Sandy Clay	**11**	Prismatic, Blocky, Granular	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	**0.30**	**5.0**
				Firm	-	-
		Platy	Weak	Very Friable, Friable	-	-
				Firm	-	-
			Moderate or Strong	Very Friable, Friable	-	-
				Firm	-	-
		Massive	Structureless	Very Friable, Friable	-	-
				Firm	-	-

Table I MOUND CONTOUR LOADING RATES:				
Measured Perc Rate	← OR →	Texture - derived mound absorption ratio		Contour Loading Rate:
≤ 60mpi	← OR →	1.0, 1.3, 2.0, 2.4, 2.6	→	≤12
61-120 mpi		5.0	→	≤6
≥ 120 mpi		-	→	-

7080 Table IXa PERCOLATION TEST SIZING	
MEASURED PERCOLATION RATE Minutes Per Inch (MPI)	MOUND ABSORPTION RATIO:
Faster than 0.1*	1.00
0.1 to 5*	1.00
0.1 to 5 (soil texture groups 3 & 5)	2.00
6 to 15	1.30
16 to 30	2.00
31 to 45	2.40
46 to 60	2.60
61-120	5.00
Slower than 120	0.00

Table I - At-Grade Contour Loading Rates				
Perc Rate (mpi)	**Loading Rate**	**Soil Texture**	**Other Characteristics in upper 48 inches**	**Loading Rate (GPD/ft)**
<0.1*	0.00	Coarse Sand	No textural change	**6**
			Saturated soil <3' Bedrock<4'	**5**
0.1 to 5.0	1.60	Sand Loamy Sand Fine Sand	No textural change	**8**
			Layers of other textures	**7**
			Banding	**4**
			Saturated soil <3'	**5**
			Bedrock<4'	**5**
6 to 15	1.00	Sandy Loam	Strong to moderate structure No textural change	**7**
			Weak structure Layers of other textures	**6**
			Platey or massive structure Saturated soil <3' Bedrock<4'	**5**
16 to 60	0.6-0.78	Loam Silt Loam Silt Clay Loam Sandy Clay Silty Clay	Strong to moderate structure No textural change	**6**
			Weak structure Layers of other textures	**5**
			Platey or massive structure Saturated soil <3' Bedrock<4'	**4**
61 to 120 >120	0.0-0.3	Clay Sandy Clay Silty Clay	Strong to moderate structure No textural change	**3**
			Weak structure Layers of other textures	**2**
			Platey or massive structure Saturated soil <3' Bedrock<4'	**2**

Table II - 4:1 Bermslope Multipliers		
Percent Slope	Upslope Multiplier	Downslope Multiplier
0	4.00	4.00
1	3.85	4.17
2	3.70	4.35
3	3.57	4.54
4	3.45	4.76
5	3.33	5.00
6	3.23	5.26
7	3.12	5.56
8	3.03	5.88
9	2.94	6.25
10	2.86	6.67
11	2.78	7.14
12	2.70	7.69
13	2.62	8.29
14	2.55	8.92
15	2.48	9.57
16	2.41	10.24
17	2.35	10.94
18	2.29	11.67
19	2.23	12.42
20	2.18	13.19
21	2.13	13.99
22	2.08	14.82
23	2.03	15.67
24	1.98	16.54
25	1.93	17.44

Maxi	
$^{1}/_{4}$ Inc	
Perforation Spacing (Feet)	
	1
2	**10**
2½	**8**
3	**8**
$^{3}/_{16}$ In	
Perforation Spacing (Feet)	
	1
2	**12**
2½	**12**
3	**12**

Volume of Liquid in Pipe	
Pipe Diameter (inches)	**Liquid Per Foot (Gallons)**
1	**0.045**
1.25	**0.078**
1.5	**0.110**
2	**0.170**
3	**0.380**
4	**0.661**

imum Number of Perforations Per Lateral to Guarantee <10% Discharge Variation								
ch Holes				$^{7}/_{32}$ Inch Holes				
Pipe Diameter (Inches)				Perforation Spacing (Feet)	Pipe Diameter (Inches)			
1¼	1½	2	3		1	1¼	1½	2
13	18	30	60	2	11	16	21	34
12	16	28	54	2½	10	14	20	32
12	16	25	52	3	9	14	19	30
ıch Holes				$^{1}/_{8}$ Inch Holes				
Pipe Diameter (Inches)				Perforation Spacing (Feet)	Pipe Diameter (Inches)			
1¼	1½	2	3		1	1¼	1½	2
18	26	46	87	2	21	33	44	74
17	24	40	80	2½	20	30	41	69
16	22	37	75	3	20	29	38	64

Perforation Discharge (GPM)				
Head (ft)	Perforation Diameter			
	$^{1}/_{8}$	$^{3}/_{16}$	$^{7}/_{32}$	$^{1}/_{4}$
1.0[a]	0.18	0.41	0.56	0.74
1.5	0.22	0.51	0.69	0.9
2.0[b]	0.26	0.59	0.80	1.04
2.5	0.29	0.65	0.89	1.17
3.0	0.32	0.72	0.98	1.28
4.0	0.37	0.83	1.13	1.47
5.0[c]	0.41	0.93	1.26	1.65

holes.

b. Use 2.0 for dwellings using 1/8 inch holes; or, for other establishments using 1/4 inch or 3/16 inch

c. Use 5.0 for other establishments using 1/8 inch perforations and media filters

3
68
64
60
3
149
135
128

Equivalent Length Factors (ft.) for PVC Pipe Fittings			
Fitting Type	Pipe Diameter (in.)		
	1½	2	3
Gate Valve	1.07	1.38	2.04
90 Deg Elbow	4.03	5.17	7.67
45 Deg Elbow	2.15	2.76	4.09
Tee - Flow Thru	2.68	3.45	5.11
Tee - Branch Flow	8.05	10.30	15.30
Swing Check Valve	13.40	17.20	25.50
Angle Valve	20.10	25.80	38.40
Globe Valve	45.60	58.60	86.90
Butterfly Valve	-	7.75	11.50

Design Flow (Gallons Per Day)	Minimum Pump Tank Capacity (Gallons)	
0-600	500	or Altnernating Du
601-4,999	100% of the Design Flow	or Altnernating Du
5,000-9,999	50% of the Design Flow	and Altnernating D

Distribution Head Loss	
Gravity Distribution = 0ft	
Pressure Distribution based on Minimum Average Head Value on Pressure Distribution Worksheet:	
Minimum Average Head	**Distribution Head Loss**
1ft	5ft
2ft	6ft
5ft	10ft

D-34: Slope Multiplier Table

Land Slope %		0	1	2	3	4
Upslope Berm	3:1	3.00	2.91	2.83	2.75	2.68
	4:1	4.00	3.85	3.70	3.57	3.45

Land Slope %		0	1	2	3	4
Downslope Berm	3:1	3.00	3.09	3.19	3.30	3.41
	4:1	4.00	4.17	4.35	4.54	4.76

ual Pumps
ual Pumps
Dual Pumps

5	6	7	8	9	10	11	12	13	14
2.61	2.54	2.48	2.42	2.36	2.31	2.26	2.21	2.17	2.13
3.33	3.23	3.12	3.03	2.94	2.86	2.78	2.70	2.62	2.55

5	6	7	8	9	10	11	12	13	14
3.53	3.66	3.80	3.95	4.11	4.29	4.48	4.69	4.95	5.24
5.00	5.26	5.56	5.88	6.25	6.67	7.14	7.69	8.29	8.92

15	16	17	18	19	20	21	22	23	24
2.09	2.06	2.03	2.00	1.97	1.95	1.93	1.91	1.89	1.87
2.48	2.41	2.35	2.29	2.23	2.18	2.13	2.08	2.03	1.98

15	16	17	18	19	20	21	22	23	24
5.55	5.88	6.24	6.63	7.04	7.47	7.93	8.42	8.93	9.46
9.57	10.24	10.94	11.67	12.42	13.19	13.99	14.82	15.67	16.54

25		
1.85		
1.93		
25		
10.02		
17.44		

D-34 Slope Multiplier Table				
Land % Slope	**Upslope** multipliers for common slope ratios			**Downs** multipliers for cor
	3:1	**4:1**		**3:1**
0	3.00	**4.00**		3.00
1	2.91	**3.85**		3.09
2	2.83	**3.70**		3.19
3	2.75	**3.57**		3.30
4	2.68	**3.45**		3.41
5	2.61	**3.33**		3.53
6	2.54	**3.23**		3.66
7	2.48	**3.12**		3.80
8	2.42	**3.03**		3.95
9	2.36	**2.94**		4.11
10	2.31	**2.86**		4.29
11	2.26	**2.78**		4.48
12	2.21	**2.70**		4.69
13	2.17	**2.62**		4.95
14	2.13	**2.55**		5.24
15	2.09	**2.48**		5.55
16	2.06	**2.41**		5.88
17	2.03	**2.35**		6.24
18	2.00	**2.29**		6.63
19	1.97	**2.23**		7.04
20	1.95	**2.18**		7.47
21	1.93	**2.13**		7.93
22	1.91	**2.08**		8.42
23	1.89	**2.03**		8.93
24	1.87	**1.98**		9.46
25	1.85	**1.93**		10.02

slope
mmon slope ratios
4:1
4.00
4.17
4.35
4.54
4.76
5.00
5.26
5.56
5.88
6.25
6.67
7.14
7.69
8.29
8.92
9.57
10.24
10.94
11.67
12.42
13.19
13.99
14.82
15.67
16.54
17.44