Job: Date:
Designer: Design number: Option number:

Worksheet for pressure distribution system design *Rev. October 2006*

This is an iterative process, so each step may have to be repeated before final design. To be used with the **Design Inputs Worksheet** and **instructions** in the **Long Form Worksheet (LFW)**.
Units: Worksheet and tables are in US gallons. See page 10 for conversions.

A. Design of the Distribution Network:

1 Establish Field length

Refer to Design Inputs Worksheet and enter appropriate values below.

SOIL TYPE = ______________________

DESIGN **HLR** = _________ LPD/SQM = ____________GPD/SQFT

DESIGN **LLR** = ____________LPD/M = ____________GPD/FT

DAILY DESIGN FLOW (Q) = _______________LPD = _____________GPD

AVERAGE FLOW = ______________LPD = _____________GPD

SYSTEM LENGTH GUIDE, L minimum = FIELD DESIGN FLOW (Q) ÷ LLR

= _______ gal per day ÷ _________gal per foot = _______________FEET **MINIMUM**

AIS = FIELD DESIGN FLOW / HLR = _______________SQUARE FEET
Remember AIS for seepage beds multiply x 1.35
TOTAL LENGTH OF TRENCHES/BED = _______________FEET

WIDTH OF TRENCH/BED = _______________FEET

NETWORK TYPE (dispersal system piping) = _________________ (eg trench, bed)

2 Establish initial trench layout, Determine lateral lengths

Based on conditions of site select appropriate trench layout and initial manifold position (eg end or center feed or no manifold). Ensure system length meets minimum required.

MANIFOLD TYPE = ______________________

LATERAL LENGTH = ___________ ____________

NUMBER OF LATERALS = ___________ ____________

MOUNDING
If you are concerned about mounding, beyond a simple consideration of LLR consider using a computer model (eg Nova Scotia mound program). Use average flows for mounding modelling.

SKETCH:
Draw a sketch of proposed layout, include constraints. Draw a schematic elevation showing the static head and forcemain length, fittings etc. Use pencil until finalized. Show any sub areas (ie areas of field in separate location but to be dosed at the same time) or zones (areas of field dosed separately).

3 Determine orifice size, spacing, position.

ORIFICE SIZE = ____________FRACTIONAL INCHES __________

ORIFICE SPACING = ____________FEET __________

4 Determine lateral pipe diameter and pipe class

Using tables *LATERAL DESIGN TABLES* (Page 17 LFW onward).

LATERAL DIAMETER = ________________INCHES ____________

LATERAL PIPE CLASS = ________________ ____________

5 Determine number of orifices per lateral

Divide orifice spacing from (A 3) above into lateral length from (A 2) above, and round to nearest whole number. Based on orifices spaced min. ½ of spacing from ends of infiltrators or trenches, and no reduction in trench length for center feed. **If your specification differs, adjust number.**

(___________ ft ÷ ___________ft) + _________ = ___________

ORIFICES PER LATERAL = _______________ ____________

6 Determine lateral discharge rate

Select distal pressure (pressure at last orifice of longest lateral), minimum is 3 feet for 3/16" and larger or 5 feet for 1/8 and 5/32" orifices. This is the **"Squirt Height"**.

DISTAL PRESSURE = _________________FEET ____________

Use *ORIFICE DISCHARGE RATE DESIGN TABLE* (page 13 LFW), or calculation.

ORIFICE DISCHARGE = _________________GPM ____________

Orifice discharge x number of orifices per lateral from (A 5) above to give

LATERAL DISCHARGE = _________________GPM ____________

CENTER OR END FEED? = _________________ ____________

NUMBER OF LATERALS = _________________ ____________

7 Select spacing between laterals and determine manifold length

For trench design spacing at 6 or 10 feet, for beds per design. Use information in (A 2) above.

SPACING BETWEEN LATERALS = _____________FEET

MANIFOLD LENGTH = _____________ FEET __________

8 Calculate manifold size

Using information from (A 2) and (A 7) determine manifold length and then use *MAXIMUM MANIFOLD LENGTHS* tables (pages 22 and 23 LFW) to select minimum manifold size, using lateral discharge from (A 6) above, Orifice size from (A 3) above and lateral spacing from (A 7) above. For center feed, flow per lateral on either side of manifold is used in table.

MANIFOLD SIZE = ___________________INCHES __________

MANIFOLD PIPE CLASS ______________

9 Determine distribution network discharge rate

Multiply lateral discharge rate from (A 6) above x number of laterals from (A 6) above, check against total number of orifices X orifice discharge rate.

NETWORK DISCHARGE RATE = __________________GPM ____________

TOTAL NUMBER OF ORIFICES (γ) = ____________ X ______gpm = ___________GPM

B. Design of the Force Main, Pressurization Unit (Pump or Siphon), Dose Chamber and Controls.

1. Develop a system performance curve.

Distal pressure (from (A 6) above) x 1.31. = _______________ feet X 1.31 =

NETWORK HEAD REQUIREMENT = _______________FEET ____________

Determine static head, from off float of pump chamber to highest point of network.

STATIC HEAD (Indicate if anti siphon required) = __________FEET SIPHON?_______

NETWORK DISCHARGE (from (9) above) = ____________________GPM

NETWORK 2 DISCHARGE (if more than 1 sub area or zone 2) = _____________GPM

NETWORK 3 DISCHARGE (if more than 1 sub area or zone 3) = _____________GPM

NETWORK 4 DISCHARGE (if more than 1 sub area or zone 4) = _____________GPM
Add more as required.

ANTI SIPHON/PRIMING ORIFICE DISCHARGE (if used) = _____________GPM

PUMP DISCHARGE Required = ____________________GPM

Determine friction loss in force main (transport line to field), first select initial force main sizing, use manifold size or next pipe size up (guide pg 16 LFW) . Base on maximum **network** discharge.

Check that flow velocity is over 2 and under 10 feet per second using table *FRICTION LOSS IN PLASTIC PIPE* (page 14 LFW) assuming use of PVC sch 40, then use that table to provide head loss for force main based on system discharge and length,. Add equivalent length for fittings as required from *EQUIVALENT LENGTHS OF FITTINGS* Tables (PAGE 15 LFW). **OR** use other friction loss/flow velocity calculation. Note that for end suction pumps it is necessary to also consider losses in the suction piping and fittings, using the same methods.

FORCE MAIN LENGTH α = _______________________FEET

FORCE MAIN DIAMETER = ___________ INCHES

FORCE MAIN TRUE INTERNAL DIAMETER = ___________ INCHES
Only required if not using Sch 40 pipe and the table.

Fittings used, including size.	Number	Equivalent length per fitting	Total equivalent length

FITTINGS EQUIVALENT LENGTH β = ____________________ FEET

TOTAL EQUIVALENT LENGTH $(\alpha + \beta) / 100$ = **L** = ____________________ FEET / 100

HEAD LOSS PER 100' (from table) = _____________________

FRICTION LOSS IN FORCE MAIN = _____________________ FEET
This is Head loss per 100' times Total Equivalent Length (L).

SUCTION HEAD LOSS (if applicable) = _______________________FEET

SUCTION LIFT (if applicable) = _______________________FEET

NET POSITIVE SUCTION HEAD REQUIRED (NPSH) = _______________FEET
Add lift plus suction head losses.

CHECK FLOW VELOCITY = __________FEET PER SECOND
If not using PD table. V= Flow (cu ft per second) / cross sectional area of the inside of the pipe (sq ft).

TOTAL DYNAMIC HEAD REQUIREMENT
TDHR = __________________FEET
This is Static Head + Network Head requirement + Friction Loss In Forcemain(s) + NPSH

PUMP DISCHARGE/HEAD = __________GPM AT __________FEET HEAD

ADDITIONAL SECTIONS OF FORCEMAIN, ZONE VALVES, EXTRA ORIFICES

Add sheets as required for additional forcemain sections, zone valves etc.

2 System curve

NUMBER OF ORIFICES = ______________________(γ) From (A 9) above.

TOTAL EQUIVALENT PIPE LENGTH (**L**) = ________________FT/100 From (B 1) above.

Squirt height (Distal Head)	Orifice flow at squirt height	Network discharge = (flow per orifice x γ)	Pump/anti siphon orifice discharge, if used	Friction factor (ft loss per 100')	Force main(s) head loss (ft) = friction factor x **L**	Network head required (1.31 X squirt ht.) (ft)	Static head (ft) plus other losses	TDHR (ft)	Total flow (gpm) = network discharge + pump orifice (if used)

Static head stays the same for all cases except for if using an anti siphon orifice. Add NPSH if necessary, use separate sheet for zone valves, extra forcemains etc.

3 Select pump (or siphon)

Use pump curves and system curves to select pump and determine operating point. Be careful to avoid undesirable pipeline velocities (too high or too low). Ensure pump will provide minimum required squirt height.

ITERATE UNTIL PUMP AND FORCEMAIN ARE ECONOMIC.

PUMP SELECTED = __________________________Voltage and max. current: ___________

Discharge diameter: _________ Height: ___________ ft Minimum water level:________ ft
(Recommended is full pump ht, often min. is ½ pump motor submerged).

OPERATING POINT = _______________ GPM at ___________ FT head.

4 Determine dose volume

Based on soil type select type of dosing and minimum/desired dose frequency.

Dosing frequency (**minimum**)	Soil type
Timed dosing	Coarse sand, gravels, sand mounds etc, certain clays
4 X per day	Medium sand, fine sand, loamy sand, Sandy Clay, silty clay or clay
2 X per day	Sandy loam, Loam, Silt Loam, Clay Loam

TYPE OF DOSING (demand or timed) = ____________________

DOSE FREQUENCY = min_______________ times per day

Determine dose volume, by dividing frequency into DAILY DESIGN flow (from A(1)). For more conservative design, use AVERAGE flow

_____________ gpd ÷ ___________ times per day

DOSE VOLUME = ___________________GALLONS

Check dose volume against draining volume of network and any part of force main that drains. Ensure dose volume is at least 5 x the draining volume. If not, consider constraints (soil type etc) and redesign manifold location etc to achieve this. Use *VOLUME OF PIPE* table, page 16 LFW.

VOLUME OF LATERALS (if draining) = _______ft x _____gallons per ft = ______g
Total length of laterals x volume per foot.

VOLUME OF MANIFOLD (if draining) = _______ft x _____gallons per ft = ______g

VOLUME OF PART OF FORCEMAIN =_______ft x _____gallons per ft = ______g

TOTAL DRAINING VOLUME = ____________________GALLONS

DOSE VOL. ÷ TOT DRAINING VOL. = ________G ÷ _________G = ________ (5 to 10)

Check pump run time per dose.

PUMP RUN TIME = Dose volume ÷ Pump flow rate

= _______G ÷ ________GPM = ____ MINS

Note that in climates where freezing may occur in undrained laterals it may be difficult to attain very small doses, equal distribution is the primary priority. Note other steps to be taken to improve distribution. **Use smallest dose/most frequent dosing possible.**

Notes for lateral hole positions and draining:

5. Size pump vault

SPM guideline for small systems; minimum vault sizes for demand activation volume 1 day design flow, for timed dosing 2 times daily flow.

DESIGN FLOW = _____________ GPD From section (A 1), peak flow

DOSE VOLUME = _____________ GAL From (B 4)

RESERVE VOLUME = _____________ GAL To alarm float from pump on float level. Minimum 15% of peak flow for demand dosed systems, per design for timed dose (Minimum 67% peak flow for small systems with lag/override operation).

RESERVE VOLUME TO LAG FLOAT = _________ GAL For timed dose systems only.

ALARM RESERVE VOLUME = ______________ GAL Above alarm float to highest allowable liquid level. Minimum 50% of peak flow, consider higher value for case where water flow can occur during power outage or in remote area, this may also include reserve volume provided by surcharge of the septic tank.

TOTAL MINIMUM VOL. = ______________ GAL Estimate pump chamber size for initial design trial.

PUMP VAULT(S) SIZE(S) = _________________________________
Nominal size and manufacturer designation.

PUMP MINIMUM WATER LEVEL = ________ FT From (B 3) above.

DEPTH REQUIRED FOR PUMP SPACER = _________FEET

Use this information and the **float setting worksheet** (below) to determine float or other control setpoints. Ensure the above volumes will fit in the vault, iterate until satisfactory.

PUMP CONTROL FLOAT = ______________________________
If direct control, ensure float is of sufficient capacity.

FLOAT TETHER LENGTH = __________ INCHES

CHECK AGAINST VAULT INTERNAL DEPTH __________________Iterate as required

SEPTIC TANK SURCHARGE FOR ALARM VOL. ______________________________(If used)

After installation check that the floats switch as designed. Mark "**V**", float types, heights, ranges (including tether lengths if required) and dose volume on headworks for future reference.

Calculating the Dose Volume For Systems Designed to Drain Back to Pump Chamber:

Use *VOLUME OF PIPE* table, page 16 LFW.

Volume in manifold = manifold length x volume in gallons per foot

Volume in manifold = ______________________ GAL

Volume in Transport Pipe = Transport pipe length x volume in US gallons per foot

Volume in transport pipe = ____________________________ GAL

Total drain back volume = Manifold volume + Transport pipe volume

TOTAL DRAINBACK VOLUME = ___________________ GAL
Add this volume to dose volume and use per dose volume in worksheet.

TANK FLOAT SETTING WORKSHEET

JOB NAME ______________ DATE ____________

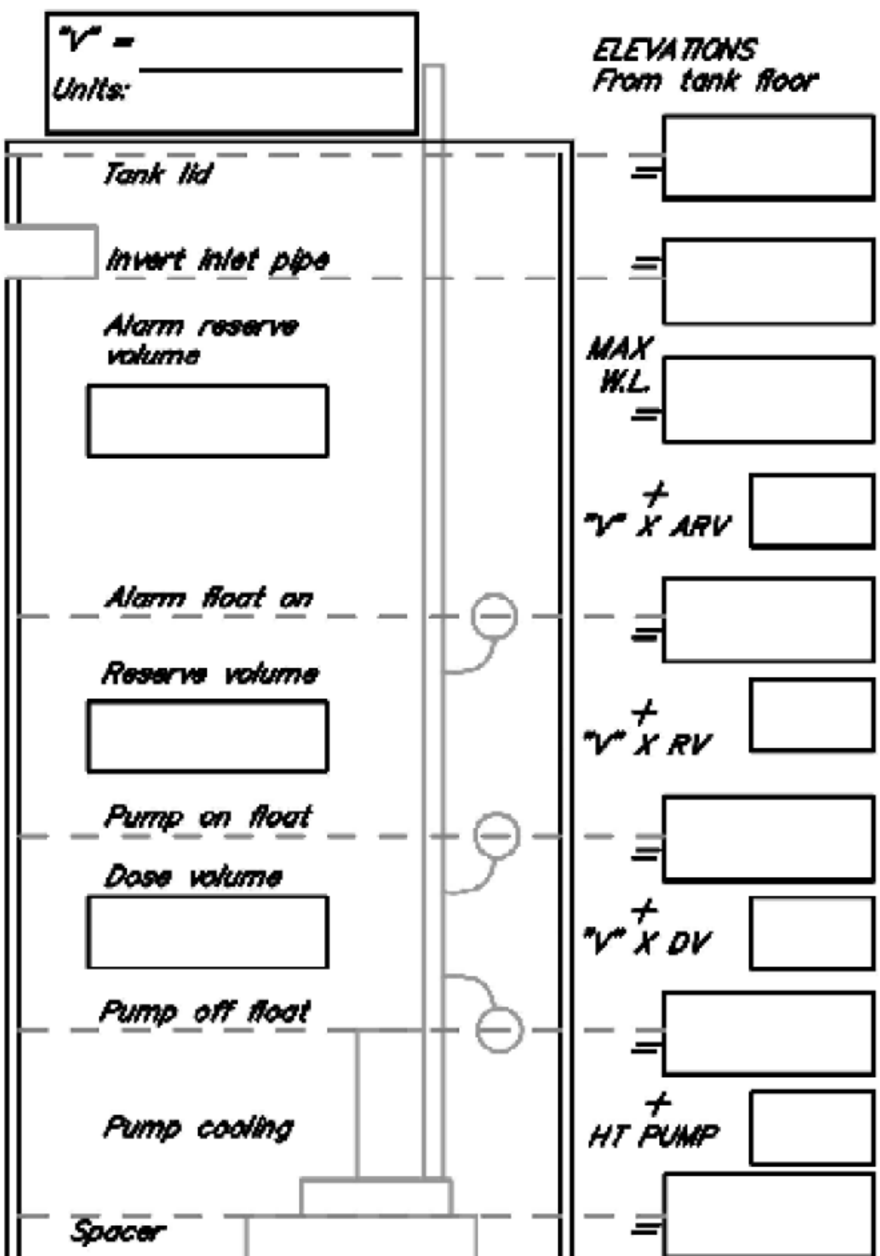
TANK SELECTED ________________________ UNITS us gal / feet

INTERNAL FLOOR AREA = (L - 2 X wall thickness) X (W - 2 X wall thickness) = _________ SQ FEET

VOLUME IN ONE FOOT OF DEPTH =_________ CU FT X 7.48 = ____________US G PER FOOT

"V" = 1 ÷ VOLUME PER FOOT = 1 ÷ ___________ = ____________ FEET PER US GALLON

"V" X VOLUME = HEIGHT HEIGHT ÷ "V" = VOLUME



CU FT X 7.48 = US GALS ~ CU IN X 0.00433 = US GALS
CU METERS X 1000 = LITERS ~ INCHES X 0.0254 = METERS

Tank dimensions:

HT:________________

L: _________________

W: ________________

Wall thickness: _______

Lid thickness: ________

Base thickness: _____

Inlet invert: _________

Internal heights:

Inlet invert: __________

Tank lid: ____________

NOTES

NOTES:

Conversions

Gallons in this worksheet are US unless shown as "IG".

US unit	X	= Metric Unit	X	= US Unit	X	= secondary unit
Gallons	3.785412	Litres	0.264172	Gallons	0.8326738	Imperial Gal.
feet	0.3048	meter	3.28083	ft of head	0.4329004	PSI
Atmosphere	101.325	Kpa	0.1450377	PSI	0.06894757	Bar (=100 Kpa)
				Gallons	0.1336806	cu ft
		Cu m	35.31467	cu ft	7.480519	gallons
GPD/sqft	40.74648	Lpd/sqm	0.024542	GPD/sqft		
GPD/ft	12.418	Lpd/m	0.080528	GPD/ft		
Sq ft	0.0929	Sq m	10.76391	Sq ft		
Inches	0.0254	Meters	39.36996	Inches		

References

This worksheet developed by Ian Ralston, TRAX Developments Ltd. Based on *Pressure Distribution Network Design By James C. Converse January, 2000* and *Recommended Standards and Guidance For Pressure Distribution, by Washington State Department of Health*. **To be used only with instructions in the Long Form Worksheet (LFW).**

For Converse's papers see:
http://www.wisc.edu/sswmp/

For Washington State guidelines see:
http://www.doh.wa.gov/ehp/ts/WW/

See also
http://www.traxdev.com/ES930/
For the most current version of this worksheet, the Design Inputs Worksheet, Timed Dosing Worksheet, and for the long form of this worksheet (LFW), with tables and instructions.