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

Worksheet for pressure distribution system design

Long form with instructions and tables *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**.*
Units: Worksheet and tables are in US gallons. See page 24 for conversions.

A. Design of the Distribution Network:

1 Establish Field length

Based on loading rates and design flows select total length of dispersal unit (trench or bed). It is critical to use a field flow consistent with the flows used by the agency or person who developed the HLR table or formula that you are using. 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**
This gives a guideline for minimum overall system length (this is for ALL trenches on a slope or in an area). Note that this may differ in different areas of the field if the laterals are of differing lengths, in which case use the worst case area. Apply to flat and to sloping sites.

AIS = FIELD DESIGN FLOW / HLR = _______________SQUARE FEET
Remember AIS for seepage beds multiply x 1.35
TOTAL LENGTH OF TRENCHES/BED = _______________FEET
For bed design use LLR to determine bed length, see mound design worksheet, or for fixed width use AIS divided by width

WIDTH OF TRENCH/BED = _______________FEET
Use decimal feet. Is AIS divided by length

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 = ______________________

Based on above determine lateral lengths and number of laterals, if there are several lengths, choose limiting lengths for initial design. Enter number of laterals in (A 6) below.

LATERAL LENGTH = ___________ ____________ Design individually for center feed.

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 modeling.

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.

Maximum 6 sqft per orifice, (24" trench this is 36" spacing). Position affects dosing design. Orifice size, for type 1 effluent start with 3/16" and adjust as necessary with respect to dose volume required and pump/force main design. For soils or situations requiring frequent dosing with filtered effluent start with 5/32". For beds, stagger orifices.

ORIFICE SIZE = ____________FRACTIONAL INCHES __________

ORIFICE SPACING = ____________FEET __________

4 Determine lateral pipe diameter and pipe class

Using tables *LATERAL DESIGN TABLES* (Page 17 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 ____________

Orifice discharge from *ORIFICE DISCHARGE RATE DESIGN TABLE* (page 13), 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 (Between lateral pairs for center feed)

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) 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

At this point, iterate (repeat) until reasonable flow and manifold size results based on your experience. Adjustments may include reducing orifice size, changing manifold location, manifolding laterals at a central location, splitting to zones. More than one option may be retained for comparison at the next stage– use separate worksheets and number options as required, destroy or label as not used options that you do not use in the final design.

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

1. Develop a system performance curve.

Determine approximate network head requirement by multiplying Distal pressure (from (A 6) above) x 1.31. This is based on assumption of a household sized system, constructed with normal manifold and lateral layout and normal fittings, if your design varies, adjust accordingly.

NETWORK HEAD REQUIREMENT = _______________FEET ____________

Determine static head, from off float of pump chamber to highest point of network.
If negative take steps to prevent siphoning of pump chamber and, if this is by using an orifice in the discharge piping in the pump chamber, add orifice discharge rate (based on orifice size) to pump discharge and use orifice head (3 feet min) plus lift from pump chamber plus 3 feet min(to avoid negative pipe pressures) subtracted from value of negative elevation difference as static head.
For sloping sites and simplified design base Static Head requirement on highest lateral. Consider this when selecting pump.

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
Sum of maximum network discharge (largest zone) (only add secondary network discharges together if they are sub areas rather than zones–since zones discharge separately) PLUS anti siphon or pump priming orifice discharge. If you have sub zones you may need to add a sheet to address subsidiary forcemains.

Determine friction loss in force main (transport line to field), first select initial force main sizing, use manifold size or next pipe size up. Can use pipe velocity guide (page 16) to select forcemain initial size 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) 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). **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 (α + β) / 100 = **L** = ____________________ FEET / 100

HEAD LOSS PER 100' (from table) = _________________ Ft/100ft

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

SUCTION HEAD LOSS (if applicable) = _______________FEET
Repeat if required for the suction lines. Ensure no cavitation. Use manufacturer's data for loss in pump intake for end suction pumps.

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
Develop more than one option if required, to examine impact of changes to network, piping, pump type etc.

ADDITIONAL SECTIONS OF FORCEMAIN, ZONE VALVES, EXTRA ORIFICES
Where there are parts of the focemain at different diameters, or if you are using a zone valve and attendant fittings (perhaps at a different diameter also) add an extra sheet to develop head loss figures for these and add them in to the TDHR. Also use to develop head losses for these at the various flows for the system head curve.

NOTES

2 System curve

Use step 1 several times for discharges either side of the system discharge (if orifice Distal pressure was based on the minimum required squirt height use mainly discharges above the theoretical discharge) to generate a system curve. This takes into account the real world as far as available pumps are concerned to show the operating points for various pumps by plotting the system curve on transparent paper and overlaying various pump curves. This will also point up any calculation errors and give you a graphical representation of the various head requirements of the system.
Note that for each new discharge a different Distal Head and thus a different Network Head Requirement is generated based on the orifice flow calculations. Pick discharges that match the increments in the *ORIFICE DISCHARGE RATE DESIGN TABLE ,* or use calculation. To facilitate this process, express total flow as equivalent flow per orifice (ie. Flow divided by number of orifices). Remember to add pump chamber office flow (if used) to give total flow, and add in losses at the network flow for additional sections of forcemain, zone valves etc.

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.
Include manufacturer, series, part number, pump voltage, discharge diameter and HP rating. For larger pumps record breaker size and switch capacity (or magnetic starter) required (do not use breaker larger than pump locked rotor amperage).

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 minimum 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.

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 = ________ (min. 5)

Check pump run time per dose is within manufacturer specifications for minimum run time, often 2 mins. Consider using twin smaller pumps (0.5HP or less) if very short run time is needed.

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. **Use smallest dose/most frequent dosing possible.**
Note other steps to be taken to improve distribution, pump constraints.
Notes: For lateral hole positions, draining and distribution:

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 design flow. **Timed dosing worksheet is also available**.

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

DOSE VOLUME = _____________ GAL From (B 4)
For time dose this is the timer allow volume.

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 with timed dose 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
With effluent filter spacer is only required to prevent rock chips etc from entering pump. Some pumps have suitable legs.

Use this information and the **float setting worksheet** (below) or timed dosing worksheet 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

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

PUMP CHAMBER "**V**" VALUE = __________________________ FT/USGAL

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. Can use more than one vault to make up required volume. With large vaults can specify smaller pump sub vault to allow float control.
NOTES:

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

When draining system back to pump chamber, the volume of effluent in the manifold and transport pipe must be added to the dose volume and considered when sizing the pump chamber Use *VOLUME OF PIPE* table, page 16.

If only part of the system drains back, use appropriate pipe lengths.

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 ____________

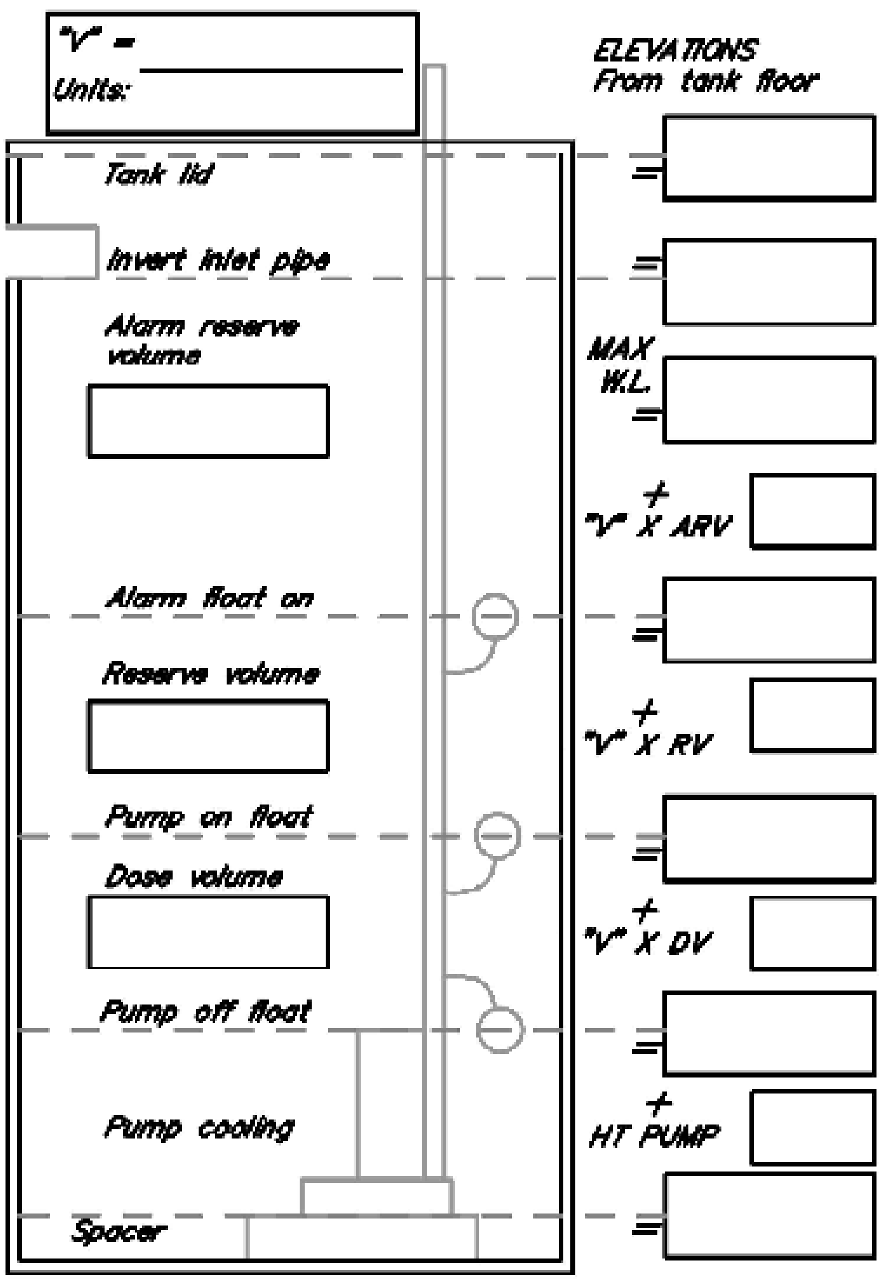
TANK SELECTED ________________________   UNITS us gal / feet

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

Add other notes on system design and operation requirements.

Orifice Discharge Rate Design Table

The following figures are guidelines based on Toricelli's equation. The orifice coefficients used are intended for use with sharp edged orifices in plastic pipe, with experience of your orifice drilling technique adjust accordingly. Figures in italics are below the recommended minimum head.

Orifice Discharge Rates (GPM)					
Squirt height (Head) (ft)	Orifice diameter (inches)				
	1/8	5/32	3/16	7/32	1/4
1			*0.43*	*0.58*	*0.77*
2	*0.26*	*0.41*	0.61	0.82	1.09
3	*0.32*	*0.51*	0.74	1.01	1.34
4	*0.37*	*0.59*	0.86	1.17	1.55
5	0.42	0.65	0.96	1.30	1.73
6	0.46	0.72	1.05	1.43	1.89
7	0.50	0.77	1.13	1.54	2.05
8	0.53	0.83	1.21	1.65	2.19
9	0.56	0.88	1.28	1.75	2.32
10	0.59	0.93	1.35	1.84	2.45
11	0.62	0.97	1.42	1.93	2.57
12	0.65	1.01	1.48	2.02	2.68
13	0.68	1.05	1.54	2.10	2.79
Coefficient used	0.61	0.61	0.62	0.62	0.63

Orifice discharge rates can be calculated using Toricelli's equation:

$$Q = C_d A_o \sqrt{2gh}$$

Where: Q = the discharge rate in ft^3/sec
C_d = the discharge coefficient (unitless)
A_o = the cross sectional area of the orifice in ft^2
g = the acceleration due to gravity (32.2 ft/sec^2)
h = the residual pressure head at the orifice in ft

Head loss in PVC pipe, table Based on table in *Converse (2000)*

Flow (usgpm)	Nominal pipe size in inches, PVC pipe sch 40. For headloss in feet per 100' of pipr							
		3/4	1	1.25	1.5	2	3	4
1								
2								
3		3.24		Velocities in this area are under 2 feet per second, too low for effective scouring.				
4		5.52						
5		8.34						
6		11.68	2.88					
7		15.53	3.83					
8		19.89	4.91					
9		24.73	6.10					
10		30.05	7.41	2.50				
11		35.84	8.84	2.99				
12		42.10	10.39	3.51				
13		48.82	12.04	4.07				
14		56.00	13.81	4.66	1.92			
15		56.63	15.69	5.30	2.18			
16		71.69	17.68	5.97	2.46			
17		80.20	19.78	6.68	2.75			
18			21.99	7.42	3.06			
19			24.30	8.21	3.38			
20			26.72	9.02	3.72			
25			40.38	13.63	5.62	1.39		
30			56.57	19.10	7.87	1.94		
35				25.41	10.46	2.58		
40				32.53	13.40	3.30		
45				40.45	16.66	4.11		
50	Velocities in this area are over 10 feet per second.			49.15	20.24	4.99		
60					28.36	7.00	0.97	
70					37.72	9.31	1.29	
80						11.91	1.66	
90						14.81	2.06	
100						18.00	2.50	0.62
125						27.20	3.78	0.93
150							5.30	1.31
175							7.05	1.74

Check with your manufacturer for design aids for other pipe.

Friction Loss for PVC Fittings

Equivalent Length of Pipe (feet) PVC Pipe Fittings								
Pipe Size (in)	90º Elbow	45º Elbow	Through Tee Run	Through Tee Branch	Male or fem. Adapter	Gate valve	Swing check	
.5	1.5	0.8	1.0	4.0	1			
.75	2.0	1.0	1.4	5.0	1.5	.55	7.0	
1	2.25	1.4	1.7	6.0	2.0	0.7	9.0	
1.25	4.0	1.8	2.3	7.0	3.0	0.9	11.5	
1.5	4.0	2.0	2.7	8.0	3.5	1.0	10	
2	6.0	2.5	4.3	12.0	4.5	1.0	11	
2 1/2	8.0	3.0	5.1	15.0	5.0	1.0	14	
3	8.0	4.0	6.3	16.0	6.5	1.0	16	
4	12.0	5.0	8.3	22.0	9.0	2.0	22	

Friction loss for fittings, steel pipe

Fitting	Equivalent length in feet per inch of pipe diameter
Angle Valve (fully open)	12.0
Butterfly valve	3.3
Gate valve (fully open)	1.1
Globe valve (fully open)	28.0
Foot valve with strainer	6.3
Swing check valve	11.0
Check valve	12.5
90 deg. Elbow	2.5

From various industry sources. Note that swing check losses vary widely, check with your manufacturer.

VOLUME OF PVC PIPE (US GALLONS PER FOOT)

	PVC pipe class		
Nominal Diameter (in)	SERIES 160	SERIES 200	Schedule 40
0.75		0.035	0.028
1	0.058	0.058	0.045
1.25	0.098	0.092	0.078
1.5	0.126	0.121	0.106
2	0.196	0.188	0.174
2.5	0.288	0.276	0.249
3	0.428	0.409	0.384
4	0.704	0.677	0.661
5	1.076	1.034	1.039
6	1.526	1.465	1.501

Guideline pipeline flow velocities

- Safe design velocity 5 feet/sec (1.5 m/s)
- Minimum scouring velocity 2 feet/sec
- Do not exceed 10 feet/sec even in short pipelines

How much flow for 5 feet/sec?

- 1” pipe 13 Usgpm (Sch. 40)
- 1.25” Pipe 23
- 1.5” Pipe 32
- 2” Pipe 52 (59 for SDR26)
- 2.5” Pipe 75
- 3” Pipe 115
- 4” Pipe 198 (211 for SDR26)

How much flow for 2 feet/sec?

- 1” pipe 5 Usgpm (Sch. 40)
- 1.25” Pipe 9
- 1.5” Pipe 13
- 2” Pipe 21 (24 for SDR26)
- 3” Pipe 46
- 4” Pipe 79 (84 for SDR26)

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
1/8	1	1.5	42	51	
1/8	1	2	50	62	
1/8	1	2.5	57.5	72.5	
1/8	1	3	66	81	
1/8	1	4	80	96	
1/8	1	5	90	110	
1/8	1	6	102	126	
1/8	1.25	1.5	66	76.5	79.5
1/8	1.25	2	80	92	96
1/8	1.25	2.5	92.5	107.5	110
1/8	1.25	3	105	120	123
1/8	1.25	4	124	144	148
1/8	1.25	5	145	165	175
1/8	1.25	6	162	186	192
1/8	1.5	1.5	85.5	96	100.5
1/8	1.5	2	104	116	120
1/8	1.5	2.5	120	135	140
1/8	1.5	3	135	150	156
1/8	1.5	4	164	184	188
1/8	1.5	5	190	210	220
1/8	1.5	6	210	240	246
1/8	2	1.5	132	141	145.5
1/8	2	2	160	170	176
1/8	2	2.5	185	197.5	202.5
1/8	2	3	207	222	228
1/8	2	4	248	268	276
1/8	2	5	290	310	320
1/8	2	6	324	348	360
5/32	1	1.5	31.5	39	39
5/32	1	2	36	46	46
5/32	1	2.5	42.5	52.5	52.5
5/32	1	3	48	60	60

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
5/32	1	4	56	72	72
5/32	1	5	65	80	85
5/32	1	6	72	90	96
5/32	1 1/4	1.5	48	55.5	58.5
5/32	1 1/4	2	58	68	70
5/32	1 1/4	2.5	67.5	77.5	80
5/32	1 1/4	3	75	87	90
5/32	1 1/4	4	92	104	108
5/32	1 1/4	5	105	120	125
5/32	1 1/4	6	120	138	144
5/32	1 1/2	1.5	63	70.5	73.5
5/32	1 1/2	2	76	84	88
5/32	1 1/2	2.5	87.5	97.5	102.5
5/32	1 1/2	3	99	111	114
5/32	1 1/2	4	120	132	136
5/32	1 1/2	5	140	155	160
5/32	1 1/2	6	156	174	180
5/32	2	1.5	96	103.5	106.5
5/32	2	2	116	124	128
5/32	2	2.5	135	142.5	147.5
5/32	2	3	150	162	168
5/32	2	4	184	196	200
5/32	2	5	210	225	235
5/32	2	6	240	252	264
3/16	1	1.5	24	30	
3/16	1	2	28	36	
3/16	1	2.5	32.5	42.5	
3/16	1	3	39	45	
3/16	1	4	44	56	
3/16	1	5	50	65	
3/16	1	6	60	72	
3/16	1.25	1.5	37.5	43.5	45
3/16	1.25	2	46	54	56
3/16	1.25	2.5	52.5	62.5	62.5
3/16	1.25	3	60	69	72
3/16	1.25	4	72	84	88

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
3/16	1.25	5	85	95	100
3/16	1.25	6	96	108	114
3/16	1.5	1.5	49.5	55.5	57
3/16	1.5	2	60	68	70
3/16	1.5	2.5	70	77.5	80
3/16	1.5	3	78	87	90
3/16	1.5	4	92	104	108
3/16	1.5	5	110	120	125
3/16	1.5	6	120	138	144
3/16	2	1.5	76.5	81	84
3/16	2	2	92	98	102
3/16	2	2.5	105	112.5	117.5
3/16	2	3	120	129	132
3/16	2	4	144	152	160
3/16	2	5	165	180	185
3/16	2	6	186	198	210
7/32	1	1.5	19.5	24	
7/32	1	2	24	30	
7/32	1	2.5	27.5	35	
7/32	1	3	30	39	
7/32	1	4	36	44	
7/32	1	5	45	55	
7/32	1	6	48	60	
7/32	1.25	1.5	31.5	36	37.5
7/32	1.25	2	38	44	46
7/32	1.25	2.5	42.5	50	52.5
7/32	1.25	3	48	57	60
7/32	1.25	4	60	68	72
7/32	1.25	5	70	80	80
7/32	1.25	6	78	90	90
7/32	1.5	1.5	40.5	45	46.5
7/32	1.5	2	50	54	56
7/32	1.5	2.5	57.5	62.5	65
7/32	1.5	3	63	72	75

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
7/32	1.5	4	76	88	88
7/32	1.5	5	90	100	105
7/32	1.5	6	102	114	114
7/32	2	1.5	63	66	69
7/32	2	2	76	80	84
7/32	2	2.5	87.5	92.5	95
7/32	2	3	99	105	108
7/32	2	4	116	124	132
7/32	2	5	135	145	150
7/32	2	6	156	162	168
1/4	1	1.5	16.5	21	
1/4	1	2	20	24	
1/4	1	2.5	22.5	27.5	
1/4	1	3	27	33	
1/4	1	4	32	40	
1/4	1	5	35	45	
1/4	1	6	42	48	
1/4	1.25	1.5	27	30	31.5
1/4	1.25	2	32	36	38
1/4	1.25	2.5	37.5	42.5	45
1/4	1.25	3	42	48	48
1/4	1.25	4	48	56	60
1/4	1.25	5	55	65	70
1/4	1.25	6	66	72	78
1/4	1.5	1.5	34.5	39	39
1/4	1.5	2	42	46	48
1/4	1.5	2.5	47.5	52.5	55
1/4	1.5	3	54	60	63
1/4	1.5	4	64	72	76
1/4	1.5	5	75	85	85
1/4	1.5	6	84	96	96
1/4	2	1.5	52.5	55.5	58.5
1/4	2	2	64	68	70
1/4	2	2.5	72.5	77.5	80

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
1/4	2	3	81	87	90
1/4	2	4	100	104	108
1/4	2	5	115	120	125
1/4	2	6	126	138	144

Manifold design tables based on *Washington State design manual*

These tables can be used to determine maximum manifold lengths for various manifold diameters, lateral discharge rates and lateral spacings. For 6" manifolds see *Washington State design manual*.

The maximum lateral lengths were developed to assure there will be no more than a 10% variance (drop) in the discharge rates between the proximal and distal orifices in any given lateral. The maximum manifold lengths in the tables below were developed to assure there will be no more than a 15% variance in discharge rates between any two orifices in a given distribution system (assuming the system is designed using the above procedure and tables). These tables are quite conservtative.

Two assumptions used to develop these tables are: (1) the maximum variance in orifice discharge rates within a network occurs between the proximal orifice in the first lateral connected to a manifold and the distal orifice on the last lateral connected to the manifold and (2) the friction loss that occurs between the proximal orifice of a lateral and the point where the lateral connects to the manifold is negligible. If your fittings are not normal, additional network head loss may need to be considered.

For marginal situations consider use of series 200 pipe. For situations where feeder pipes are used from a short manifold, design using head loss calculations, on sloped sites the slope assists where top fed feeder pipes are used.

Note that the Central Manifold discharge rates are ½ the end fed rates—this is because the discharge is PER LATERAL, and with a central manifold there are 2 laterals per lateral spacing.

Instructions:

Example A: Central manifold configuration, lateral discharge “Q” = 40 gpm (this is discharge for each lateral, one both sides of the center manifold), lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 18 ft.

Example B: End manifold configuration, lateral discharge “Q” = 30 gpm, lateral spacing = 6 ft., manifold length = 24 ft.; Minimum diameter = 3 inch

Round flows to nearest number in table.

Make sure you are using the table that matches your orifice size!

Lateral discharge rate (gpm per lateral)		Maximum Manifold Length (ft) For 1/8" and 5/32" orifices and min. 5' distal pressure																															
		Manifold diameter (inches), Schedule 40																															
		1 1/4						1 1/2						2						3						4							
		Lateral spacing (feet)																															
Central Manifold	End Manifold	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	6	9	8	12	16	10	8	12	12	18	16	20	14	18	20	30	32	40	30	39	48	60	72	80	48	63	76	96	120	130
10	20	4	3	4	6	8	10	4	6	8	6	8	10	8	12	12	18	16	20	18	24	28	36	40	50	30	39	48	60	72	80
15	30	2	3	4				4	3	4	6	8	10	6	6	8	12	8	10	14	18	20	24	32	30	22	30	36	42	56	60
20	40	2						2	3	4	6			4	6	8	6	8	10	12	15	16	18	24	30	18	24	28	36	40	50
25	50							2	3	4				4	6	4	6	8	10	10	12	12	18	16	20	16	21	24	30	40	40
30	60							2						4	3	4	6	8	10	8	9	12	12	16	20	14	18	20	24	32	40
35	70							2						2	3	4	6			8	9	12	12	16	20	12	15	20	24	24	30
40	80													2	3	4				6	9	8	12	16	10	12	15	16	18	24	30
45	90													2	3	4				6	6	8	12	8	10	10	12	16	18	24	20
50	100													2	3					6	6	8	6	8	10	10	12	12	18	24	20
55	110													2	3					4	6	8	6	8	10	8	12	12	18	16	20
60	120													2						4	6	8	6	8	10	8	9	12	12	16	20
65	130													2						4	6	4	6	8	10	8	9	12	12	16	20
70	140													2						4	6	4	6	8	10	8	9	12	12	16	20
75	150																			4	3	4	6	8	10	6	9	8	12	16	20
80	160																			4	3	4	6	8	10	6	9	8	12	16	10
85	170																			4	3	4	6	8		6	9	8	12	16	10
90	180																			2	3	4	6	8		6	6	8	12	8	10
95	190																			2	3	4	6	8		6	6	8	12	8	10
100	200																			2	3	4	6			6	6	8	12	8	10

Lateral discharge rate (gpm per lateral)		Maximum Manifold Length (ft) For 3/16" and up orifices and min. 2' distal pressure																													
		Manifold diameter (inches), Schedule 40																													
		1 1/4						1 1/2						2						3						4					
		Lateral spacing (feet)																													
Central Manifold	End Manifold	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	4	6	4	6	8	10	6	6	8	12	8	10	10	12	16	18	24	20	22	27	32	42	48	60	34	45	52	72	80	90
10	20	2	3	4				2	3	4	6	8		6	6	8	12	8	10	12	15	20	24	32	30	22	27	32	42	48	60
15	30	2						2	3	4				4	6	4	6	8	10	10	12	12	18	24	20	16	21	24	30	40	40
20	40							2						2	3	4	6	8		8	9	12	12	16	20	12	18	20	24	32	30
25	50													2	3	4				6	9	8	12	16	10	10	15	16	18	24	30
30	60													2	3	4				6	6	8	6	8	10	10	12	16	18	24	20
35	70													2	3					4	6	8	6	8	10	8	12	12	18	16	20
40	80													2						4	6	4	6	8	10	8	9	12	12	16	20
45	90																			4	3	4	6	8	10	6	9	8	12	16	20
50	100																			4	3	4	6	8	10	6	9	8	12	16	10
55	110																			2	3	4	6	8		6	6	8	12	8	10
60	120																			2	3	4	6			6	6	8	12	8	10
65	130																			2	3	4	6			6	6	8	6	8	10
70	140																			2	3	4				4	6	8	6	8	10
75	150																			2	3	4				4	6	8	6	8	10
80	160																			2	3	4				4	6	4	6	8	10
85	170																			2	3					4	6	4	6	8	10
90	180																			2	3					4	3	4	6	8	10
95	190																			2	3					4	3	4	6	8	10
100	200																			2						4	3	4	6	8	10

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 Atmosphere	0.3048 101.325	meter Kpa	3.28083 0.1450377	ft of head PSI	0.4329004 0.06894757	PSI 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		
Feet	0.3048	Meters	3.28083	Feet		

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*.

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 a short form version of this worksheet, without tables and instructions (for use as part of a record of design).