Appendix A Sources of Topographic Maps

Ordering USGS topographic maps

To locate or order USGS topographic maps, refer to the following sources of information:

- Call 1-888-ASK-USGS (1-888-275-8747).
- Write to USGS Information Services, Box 25286, Denver, CO 80225.
- Contact any state-affiliated USGS Earth Science Information Center, typically located within state government or at a land-grant university. Your local NRCS or Soil and Water Conservation District office should be able to help you identify the appropriate state contact.
- In some locations, the local NRCS or Soil and Water Conservation District may be a source of USGS topographic maps.

Finding USGS topographic maps online

There are many options for obtaining topographic maps. A general site that offers a range of information is at:

http://topomaps.usgs.gov/

Topopgraphic maps may be viewed at:

http://www.topozone.com/default.asp

or

http://www.terraserver.microsoft.com

Electronic files for much of the United States may be downloaded from:

http://data.geocomm.com/catalog/index.html

The files downloaded from this site are TIFF files. They can be inserted into most word processing (Corel® WordPerfect® or Microsoft® Word) or presentation software (Microsoft® PowerPoint) that contain simple drawing tools for identifying farm locations, field boundaries, and adding labels. There are also other image-viewing software options that enable you to view and work with the TIFF image directly.

Local sources of aerial or topographic maps:

- Local NRCS center
- Soil and Water Conservation District office
- County planning/zoning office

Appendix B How Much Runoff Will Come from the Feedlot?

Single storm event

The volume of runoff from a feedlot for a single storm event is commonly estimated using the NRCS Curve Number method. This method is commonly use to estimate the storage volumes required for design storm events such as a 25-year, 24-hour storm (fig. B–1). It is described in the NRCS National Engineering Handbook, Part 630, Chapter 10. For the purpose of estimating the volume of storm runoff from a feedlot, the following equation is solved for Q:

$$Q = \frac{\left[P - 0.2\left(\left(\frac{1000}{CN_1}\right) - 10\right)\right]^2}{P + 0.8\left\{\left(\frac{1000}{CN_1}\right) - 10\right\}} \qquad (1)$$

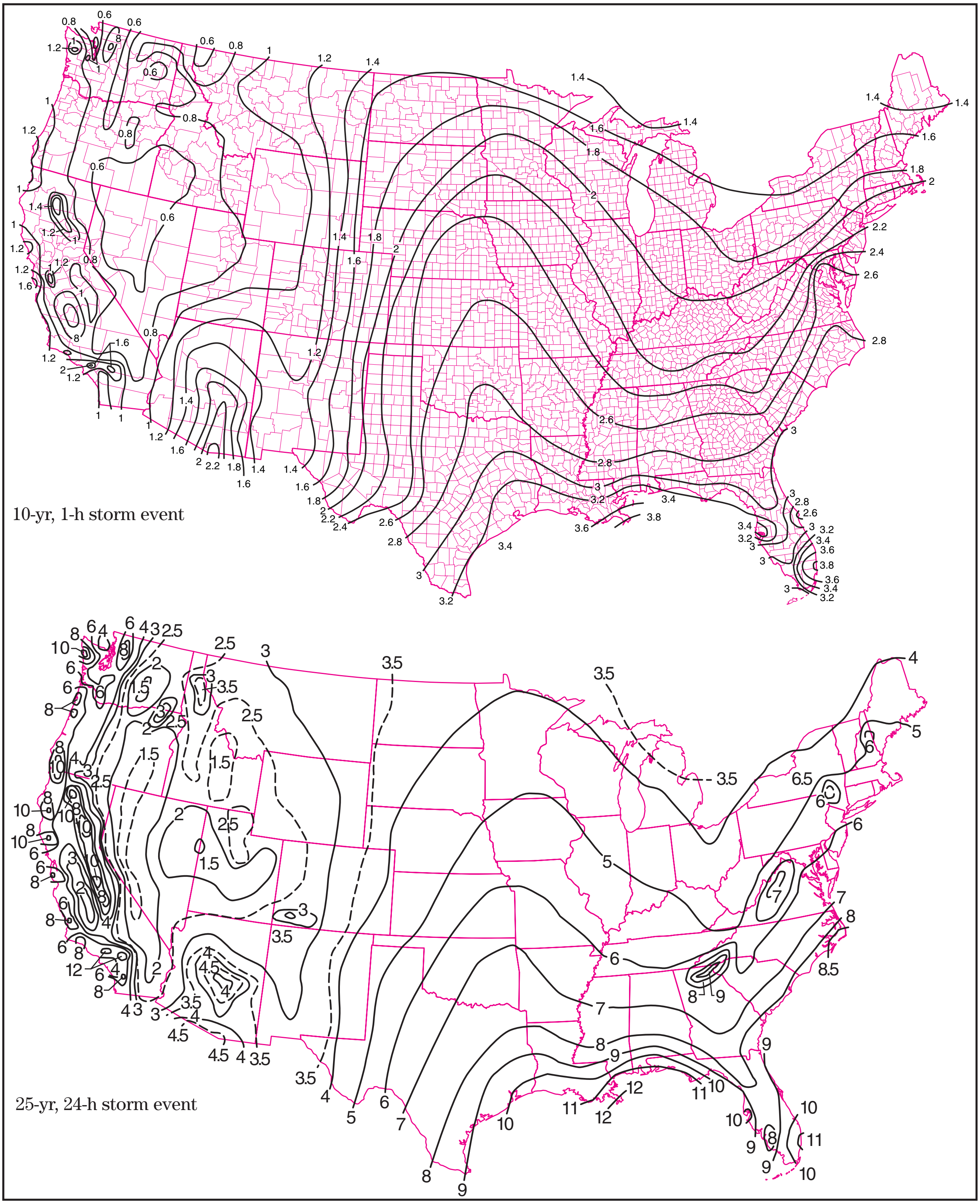
where:
Q = volume of runoff (in)
P = rainfall (in)
CN_1 = NRCS 1-day curve number

A CN_1 of 89 or 90 is commonly used for an unpaved feedlot, and a CN_1 of 97 or 98 is commonly used for a paved feedlot. The volume of rainfall for this application is usually the volume of a 25-year, 24-hour or a 10-year, 1-hour (fig. B–1) storm event. Estimates of runoff for four different surfaces are illustrated in table B–1.

Table B–1 Volume of runoff in inches associated with an individual storm event for four surfaces based upon equation 1

	Surfaces			
Rainfall event (in)	Concrete lot or compacted surface (CN_1 = 98)	Earthen feedlot surface (CN_1 = 90)	Medium texture cropland (CN_1 = 75)	Medium texture grassland (CN_1 = 70)
2.0	1.8	1.1	0.4	0.2
2.5	2.3	1.5	0.7	0.5
3.0	2.8	2.0	1.0	0.7
3.5	3.3	2.4	1.3	1.0
4.0	3.8	2.9	1.7	1.3
4.5	4.3	3.4	2.1	1.7
5.0	4.8	3.9	2.4	2.0
5.5	5.3	4.4	2.9	2.4
6.0	5.8	4.8	3.3	2.8
6.5	6.3	5.3	3.7	3.2
7.0	6.8	5.8	4.1	3.6
7.5	7.3	6.3	4.6	4.0
8.0	7.8	6.8	5.0	4.5

Figure B–1 Precipitation (in) resulting from a single storm event



Monthly runoff

Monthly runoff is of used to estimate the storage requirements between periods of land application (storage period). Monthly runoff may be estimated using the thirty day curve number (CN_{30}). Using this method the CN_1 is converted to a CN_{30} using the following equation:

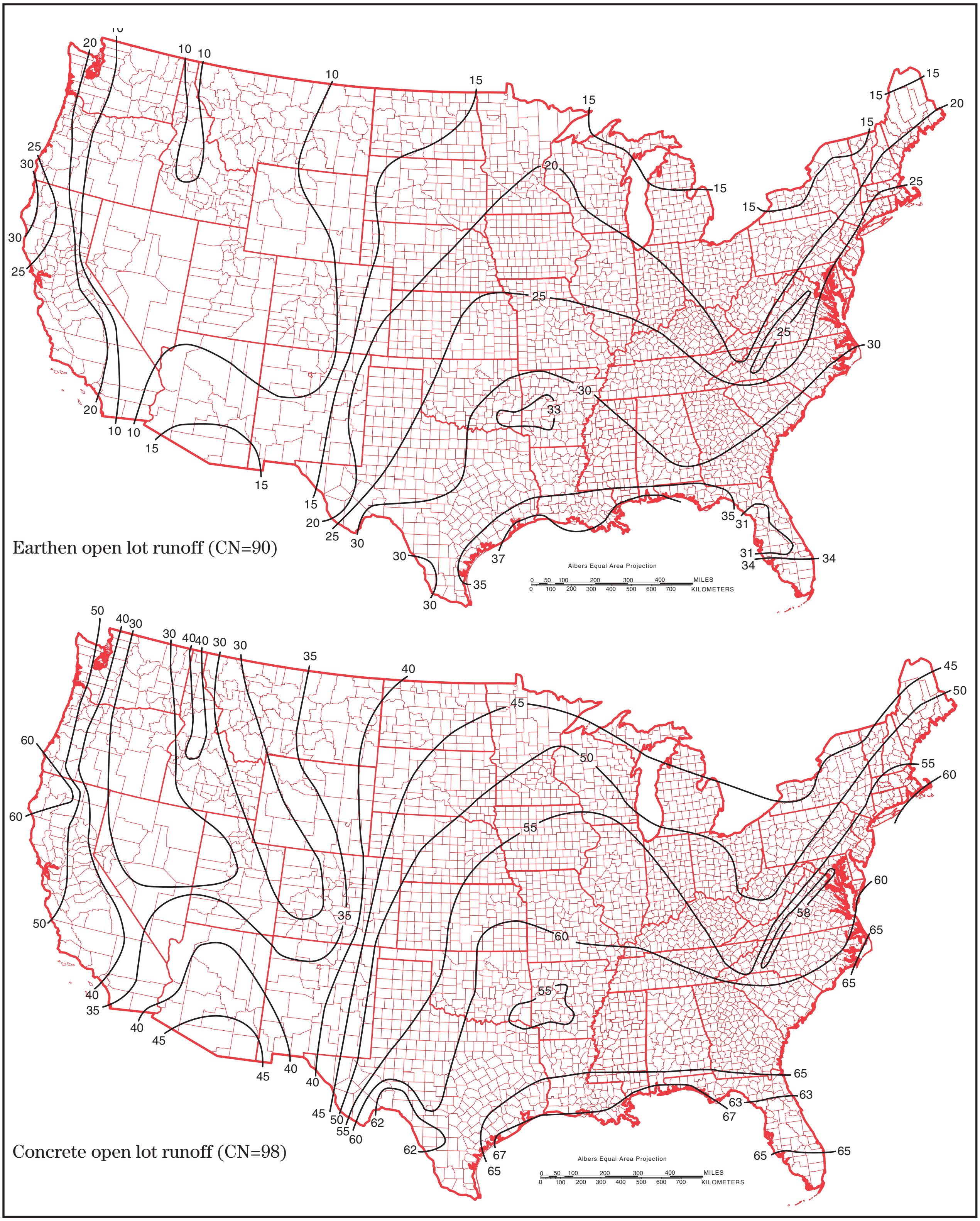
$$CN_{30} = CN_1 - \left\{ CN_1 - \left[\left(\frac{CN_1^{2.365}}{631.79} \right) - 15) \right] \right\} \log 30 \quad (2)$$

A CN_{30} for an unpaved feedlot is commonly 73 to 76, and a CN_{30} for a paved feedlot is commonly 95 to 98. The monthly runoff from a feedlot is computed by substituting CN_{30} for CN_1 in equation 1. In this application, P would be the average rainfall for a given month. If a storage period is required for the months of December through March to avoid winter application, then a CN_{30} is calculated and used with monthly precipitation values to estimate runoff for each of the 4 months. The summation runoff for the 4 months would represent the volume required for the storage period. The volumes computed using CN_{30} is typically high when compared with actual data. They work better on smaller watersheds than on larger watersheds. National maps showing average monthly runoff percentages are also available from chapter 10 of the NRCS Agricultural Waste Management Field Handbook (see *http://www.wcc.nrcs.usda.gov/awm/awmfh.html*).

Annual runoff

Annual totals for feedlot surfaces are summarized in figure B–2. Annual runoff values might be used in planning nutrient runoff from feedlot for sizing of a land application area (sec. 6) or other planning roles.

Figure B–2 Annual runoff from open lots as a percent of mean annual precipitation (NRCS Agricultural Waste Management Field Handbook, ch. 10 (*http://www.wcc.nrcs.usda.gov/awm/awmfh.html*))



Example—Calculation of runoff

Determine the runoff for a 2,000 head capacity dirt feedlot (finishing 4,000 head of cattle per year) located in central Iowa. The feedlot is 11.5 acres in area an additional 8 acres of roads, drainage ditches, feed storage and preparation areas, and compost site drains into the settling basin. Annual precipitation is assumed to be 34 inches.

10-year, 1-hour storm runoff: 2.3 inches of rainfall (from fig. B–1) which produces 1.4 and 2.1 inches of runoff from feedlot (table B–1, CN=90) and additional drainage area (assumed to be primarily compacted surfaces, thus selecting CN=98 from table B–1), respectively. This single event would produce:

$$= (1.4 \text{ in} \times 11.5 \text{ feedlot a}) + (2.1 \text{ in} \times 8 \text{ additional a})$$
$$= 33 \text{ a-in of runoff}$$

25-year, 24-hour storm runoff: 5.5 inches of rainfall (from fig. B–1) which produces 4.4 and 5.3 inches of runoff from feedlot (table B–1, CN=90) and additional drainage area (assumed to be primarily compacted surfaces, thus selecting CN=98 from table B–1), respectively. This single event would produce:

$$= (4.4 \text{ in} \times 11.5 \text{ feedlot a}) + (5.3 \text{ in} \times 8 \text{ additional a})$$
$$= 93 \text{ a-in of runoff}$$

Monthly runoff: Estimate runoff for the month of June when average precipitation is 3.5 inches. The CN_{30} value is estimated using equation 2 as follows:

$$\text{Feedlot: } CN_{30} = 90 - \left\{ 90 - \left[\frac{\left(90^{2.365}\right)}{631.79} \right] - 15 \right\} \log 30 = 77$$

$$\text{Additional area: } CN_{30} = 98 - \left\{ 98 - \left[\frac{\left(98^{2.365}\right)}{631.79} \right] - 15 \right\} \log 30 = 95$$

Monthly runoff is calculated from equation 1 as follows:

$$\text{Feedlot: } Q = \frac{\left\{3.5 - 0.2\left[\left(\frac{1,000}{77}\right) - 10\right]\right\}^2}{\left\{3.5 + 0.8\left[\left(\frac{1,000}{77}\right) - 10\right]\right\}} = 1.4 \text{ in}$$

$$\text{Additional area: } Q = \frac{\left\{3.5 - 0.2\left[\left(\frac{1,000}{95}\right) - 10\right]\right\}^2}{\left\{3.5 + 0.8\left[\left(\frac{1,000}{95}\right) - 10\right]\right\}} = 2.9 \text{ in}$$

Average June open lot runoff is:

$$= (1.4 \text{ in} \times 11.5 \text{ feedlot acres}) + (2.9 \text{ in} \times 8 \text{ additional acres})$$
$$= 39 \text{ a-in of runoff}$$

Example—Continued

Monthly runoff maps are found in chapter 10 of the NRCS Agricultural Waste Management Field Handbook.

Annual Runoff: Annual runoff from the feedlot is estimated to be:

$$\text{Annual runoff} = \text{Annual precipitation} \times \% \ \text{runoff} \times \frac{\text{area}}{100}$$

(fig. B–3) (fig. B–2)

For feedlot, annual runoff is:

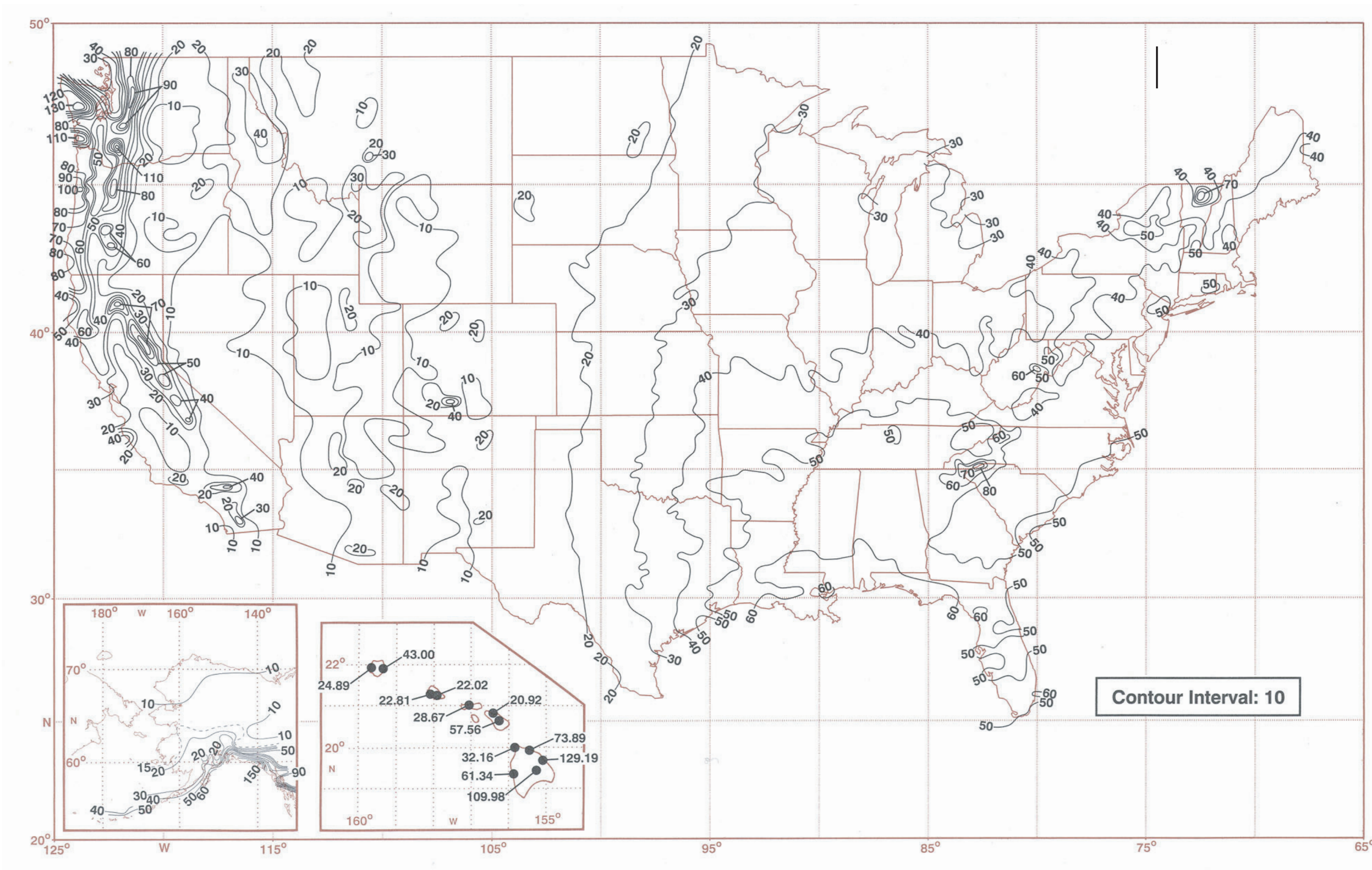
$$\begin{aligned} &= 34 \text{ in} \times 23 \times \frac{11.5 \text{ a}}{100} \\ &= 90 \text{ a-in} \end{aligned}$$

For additional contributing area (roads, drainage ditches, feed storage and preparation areas, and compost site), it is assumed that the concrete open lot runoff value in figure B–2 is a reasonable (and likely a conservative) approximation of runoff:

$$\begin{aligned} &= 34 \text{ in} \times 55 \times \frac{8 \text{ a}}{100} \\ &= 150 \text{ a-in} \end{aligned}$$

Total annual runoff should not exceed 240 acre-inches (sum of feedlot and contributing area estimates).

Figure B–3 Mean annual precipitation (inches) for 1961 to 1990 (National Climate and Data Center, *http://www.ncdc.noaa.gov/img/documentlibrary/clim81supp3/precipnormal_lowres.jpg)*



Appendix C Example Sizing of Settling Basin

Problem

Design a settling basin for a 2,000 head dirt feedlot located in central Iowa. The outflow of the basin will be to a VTA. The feedlot is 11.5 acres in area an additional 8 acres of roads, drainage ditches, feed storage and preparation areas, and compost site drains into the settling basin. The basin will be cleaned once a year in late summer. The site restricts basin depth to 4 feet. There will be a sloped screen and a perforated riser pipe with an orifice plate at the basin outlet. Basin must have a detention time of at least 1 hour. Basin capacity of equivalent runoff from a 25-year, 24-hour storm will also be assumed necessary because liquid release will be spread over a 72-hour period for this storm event. Sizing procedures are described in section 5.

Solution

1. Rainfall volume for a 25-year, 24-hour storm in central Iowa (fig. B–1) is 5.5 inches. Rainfall volume for a 10-year, 1-hour storm in central Iowa (fig. B–1) is 2.4 inches.

2. Peak flow rate off lot

$$= 19.5 \text{ a} \times 43{,}560 \text{ ft}^2 / \text{a} \times \frac{2.4 \text{ in/h}}{43{,}200}$$
$$= 47 \text{ ft}^3/\text{s}$$

3. Use settling rate of 4 feet per hour.

4. Basin surface area

$$= \frac{(47 \times 3{,}600 \text{ s/h})}{4}$$
$$= 42{,}300 \text{ ft}^2$$

5. Liquid storage depth $= 4 \text{ ft/h} \times 1 \text{ h}$
$= 4$ ft. maximum depth
Select actual storage depth of 2.75 feet liquid depth and 0.25 feet freeboard depth for solids storage.

6. Liquid volume

$$= 2.75 \text{ ft} \times 42{,}300 \text{ ft}^2$$
$$= 116{,}000 \text{ ft}^3$$

(Provides about a 40-min detention time)

Liquid volume = 93 acre-inch or 338,000 cubic foot (based from 25-yr, 24-hr storm as calculated in app. B example). Select larger of two volumes or 338,000 cubic foot for settling basin storage volume.

Recalculate basin surface area holding depth constant:

Basin surface area

$$= \frac{338{,}000 \text{ ft}^3}{2.75 \text{ ft liquid depth}}$$
$$= 123{,}000 \text{ ft}^2$$

7. Solids storage volume

$$= 0.5 \text{ a-in/a} \times 11.5 \text{ a} \times 1.0 \text{ yr} \times \frac{43{,}560 \text{ ft}^2/\text{a}}{12 \text{ in/ft}}$$
$$= 21{,}000 \text{ ft}^3$$

8. Solids storage depth

$$= \frac{21{,}000 \text{ ft}^3}{123{,}000 \text{ ft}^2}$$
$$= 0.2 \text{ ft}$$

(Slightly less solids storage will be required than 0.25 ft allowed in step 5…no design change will be made at this time.)

9. Overall basin depth

$$= 2.75 + 0.25$$
$$= 3 \text{ ft}$$

10. Screen area

$$= \frac{(2.2 \times 60 \text{ s/min})}{(0.6 \times 2.5 \text{ ft/min})}$$
$$= 88 \text{ ft}^2$$

Screen length

$$= \frac{88 \text{ ft}^2}{3 \text{ ft}}$$
$$= 32 \text{ ft}$$

11. Minimum basin length

$$= 3 \text{ ft} \times \frac{12}{1} \text{ ramp ratio} + 32$$
$$= 68 \text{ ft}$$

(based on screen length and ramp…actual basin length will be much longer)

12. Assume basin average width of 59 feet (50 ft wide bottom and 3 to 1 slope sidewalls for 3 ft depth basin).

Basin length

$$= \frac{123{,}000 \text{ ft}^2}{59 \text{ ft}}$$
$$= 2{,}100 \text{ ft}$$

13. a. Average flow rate from basin

Outlet flow rate

$$= \frac{338{,}000 \text{ ft}^2}{(72 \text{ hr} \times 3{,}600 \text{ s/h})}$$
$$= 1.3 \text{ ft}^3/\text{s for a 72 hour release rate into VTA}$$

b. Assume that two riser pipes will be used (0.65 ft^3/s per pipe). Orifice diameter from table 5–2 for a 0.65 cubic foot per second flow and a 2.75 foot head is between 3.75 (0.62 ft^3/s), and 4 inches (0.71 ft^3/s). Select the 3.75-inch orifice with a flow rate of 0.62 cubic foot per second.

c. Open area for riser pipe is estimated from table 5–3 to be 6 square inch per foot for a flow rate of 0.62 cubic foot per second.

d. Select 7.5 inches per foot allowing for 25 percent greater open area per foot of riser than that shown in table 5–3 for orifice flow rate. This is done to ensure orifice diameter controls discharge.

14. Assuming separate mainlines for each riser, a 1 percent mainline pipe slope, and a flow rate of 0.62 cubic foot per second for each line, an 8 inches mainline pipe is required according to figure 5–6.

15. The minimum riser pipe size selected should be the largest of the following three possibilities:

(1) The diameter of the mainline or offset line if used, (8 in) determined in step 14,

(2) 2 inches larger than the selected orifice diameter (3.75 + 2 = 5.75 in), or

(3) The diameter from table 5–4 for the design flow rate of 0.62 cubic foot per second (3.6 in).

Select a riser diameter of 8 inches. If each 8-inch riser were equipped with two slots of 1 foot by 4 inches per linear foot of riser, the 7.5 square inch per linear foot requirement would be satisfied. Thus, two 8-inch riser pipes with 3.75-inch orifice plates would be recommended. Each riser would have 8-inch mainline conveying water to the VTA.

Appendix D Tile Design Example

Design a VIB for a 2,000 head dirt feedlot located in central Iowa

The feedlot is 11.5 acres in area with an additional 8 acres of roads, drainage ditches, feed storage and preparation areas, and compost site that drains into the settling basin. The areas of the settling basin and VIBs are 2.8 and 6 acres, respectively. The VIB will be located in a soil with an infiltration rate of 0.6 to 2 inches per hour. It is desirable that the basin drain in 72 hours for a 25-year, 24-hour storm.

From example calculation in section 7 on VIB sizing:

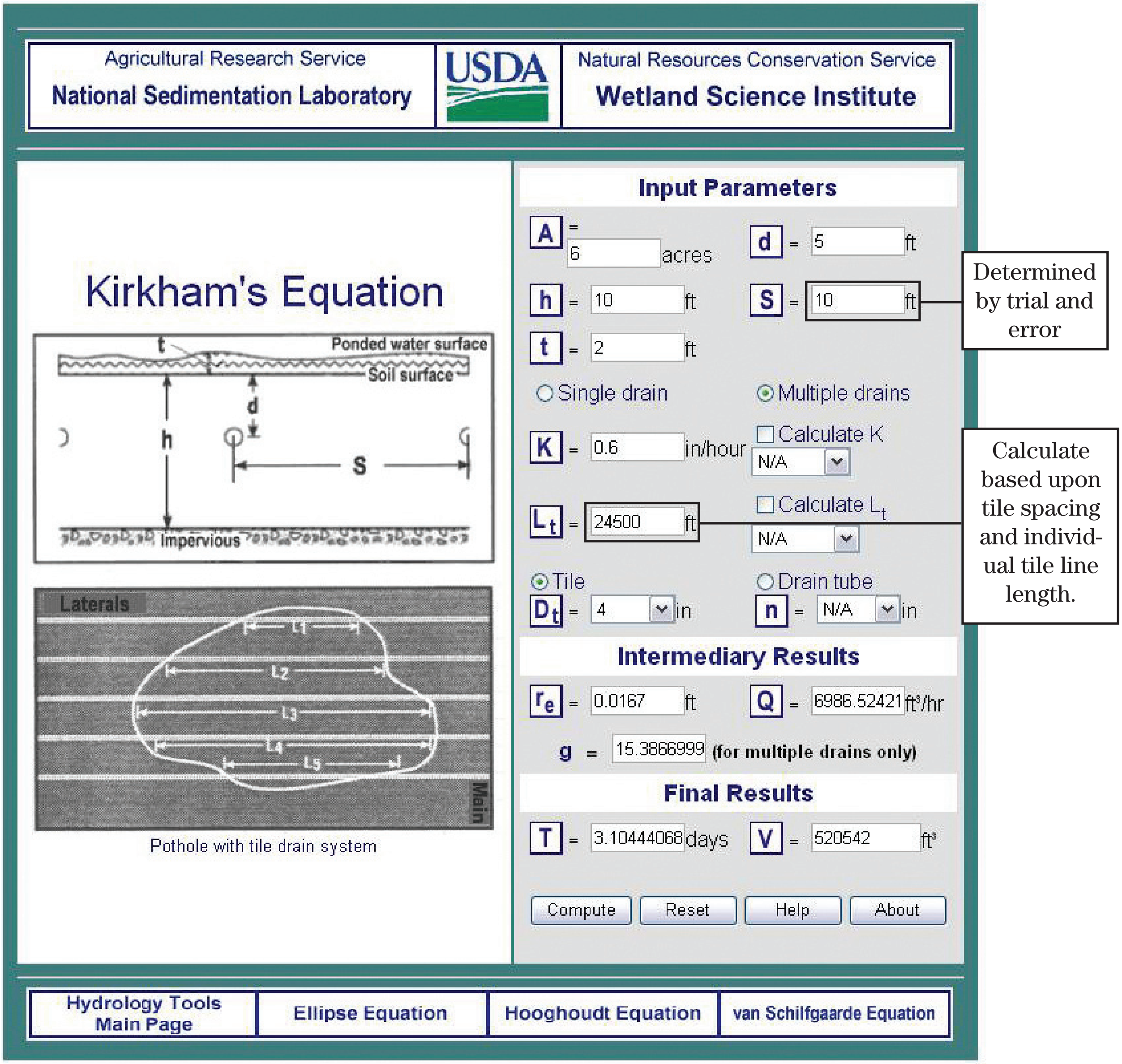
– Total runoff from area contributing to the VIB for the 25-year, 24-hour event is 109 acre-inches (excluding rainfall on the VIB) and 142 acre-inches (including rainfall on 5.9-acre VIB)

– Area of VIB = 5.9 acres

Tile design variables	*Example problem values*
A = area of the infiltration basin	6.0 acres with dimensions of 510 square foot
d = depth of tile drains	5 feet
h = depth to impermeable layer	10 feet
S = tile spacing	Determined by trial and error
t = depth of ponding	2 feet
K = permeability of the soil in the VIB select lower value of range of soil permeabilities listed in county soil survey	County soil survey suggests 0.6 to 2.0 inch per hour. Select 0.6 inch per hour
L_t = total length of tile under the infiltration basin	Tiles installed to within 10 feet of edge of VIB or 490 feet per tile line L_t = 490 feet per tile line x [(VIB width / tile spacing) – 1] L_T = 490 x [(510 / S) – 1]
Tile lateral diameter	4 inches

Use Kirkham's equation for ponded conditions to determine required tile spacing. Use software tool found at *http://msa.ars.usda.gov/ms/oxford/nsl/java/Kirkham_java.html* to solve by trial and error for S (the tile spacing) as illustrated in figure D–1. Tile spacing to achieve required drainage is 10 feet, assuming a drain time of 3.1 days or 74 hours is acceptable. 24,500 feet of tile line will be required. The 10-foot tile spacing may be unreasonably close in some situations. This design will be re-evaluated to achieve more reasonable tile spacing.

Figure D–1 Example of tile drainage spacing design using USDA design tool based upon Kirkham's method (Kirkham 1957). The Web site for this design tool is *http://msa.ars.usda.gov/ms/oxford/nsl/java/Kirkham_java.html*



Redesign of tile spacing

Assume a maximum ponding depth of 12 inches instead of 24 inches. Use equation 5 in section 6 to compute area of VIB based upon a practical depth:

$$A_{VIB} = \frac{\left[R + \left(A_{SB} \times P\right)\right]}{\left[\left(D_P - F\right) - P\right]}$$

$$A_{VIB} = \frac{\left[93 + \left(2.8 \times 5.5\right)\right]}{\left[12 - 5.5\right]}$$

$$A_{VIB} = 16.7 \text{ a}$$

Substitute results of equation 5 into equation 2 of section 7 to calculate VIB volume:

$$V_{VIB} = R + \left(A_{SB} + A_{VIB}\right) \times P$$

$$V_{VIB} = 93 + \left(2.8 + 16.7\right) \times 5.5$$

$$V_{VIB} = 200 \text{ a-in}$$

Accounting for precipitation on the VIB and a maximum ponding depth of 12 inches, the size is approximately 16.7 acres. Design the tile system on 16.7 acres (600 ft wide by 1,210 ft long) to drain the VIB in 72 hours.

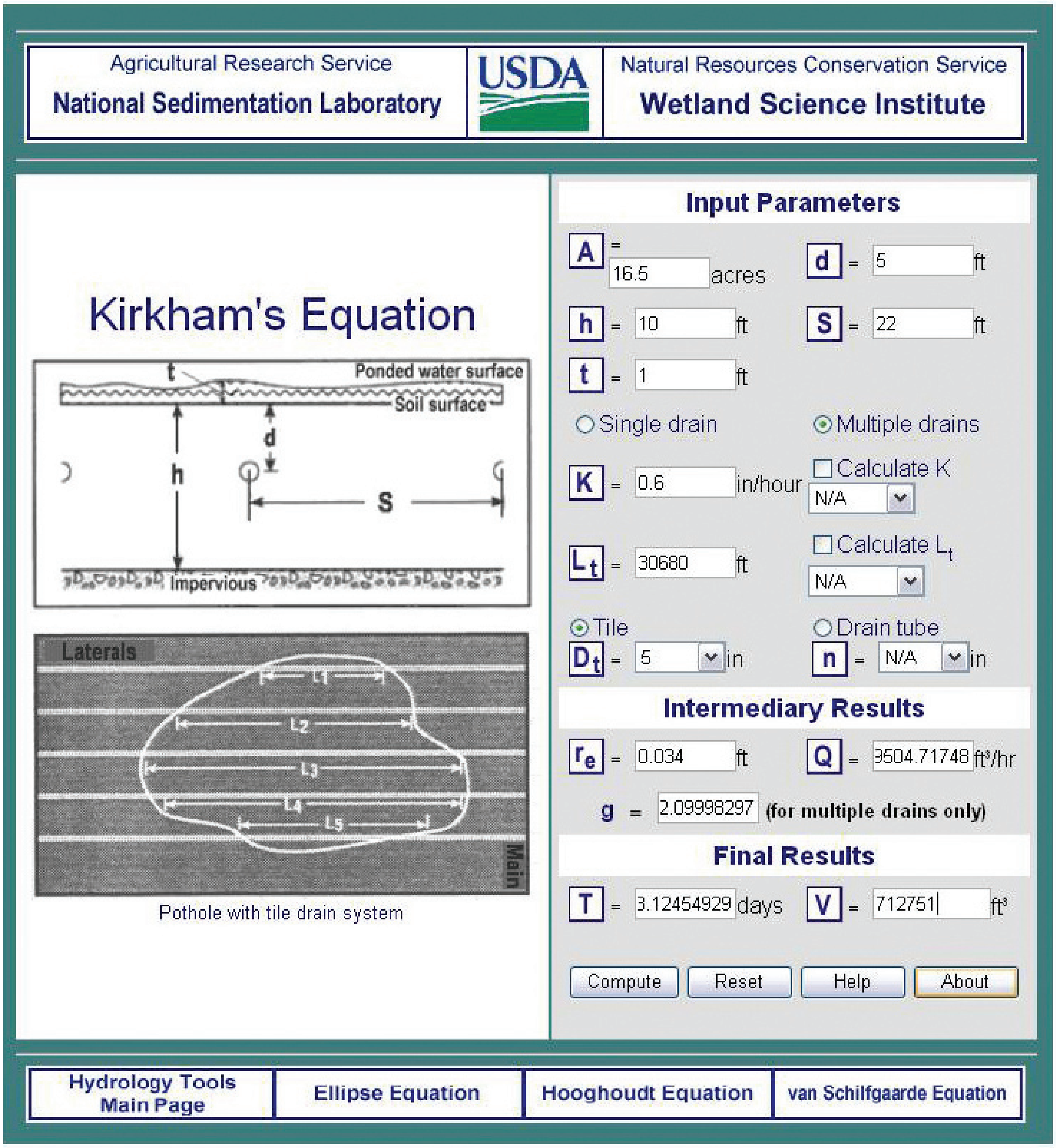
Tile design variables for redesigned VIB	*Example problem values*
A = area of the infiltration basin	16.7 acres with dimensions of 600 by 1,210 feet
d = depth of tile drains	5 feet
h = depth to impermeable layer	10 feet
S = tile spacing	Determined by trial and error
t = depth of ponding	2 feet
K = Permeability of the soil in the VIB. Select lower value of range of soil Permeabilities listed in county soil survey	County soil survey suggests 0.6 to 2.0 inch per hour. Select 0.6 inch per hour
L_t = total length of tile under the infiltration basin	Tiles installed to within 10 feet of edge of VIB or 1,190 feet per tile line. L_t = 1,190 ft/tile line x [(VIB width / tile spacing) – 1] $L_T = 1{,}190 \times \left[\left(\frac{600}{S}\right) - 1\right]$
Tile lateral diameter	5 inches

Use Kirkham's equation for ponded conditions to again determine required tile spacing (software tool found at *http://msa.ars.usda.gov/ms/oxford/nsl/java/kirkham_java.jtml;* see fig. D–2).

The redesigned system allowed for a larger spacing of tile line (20 vs. 10 ft) and has the advantage of a berm height (18 vs. 30 in). The larger tile spacing requires a significantly larger VIB (16.5 vs. 6.0 a), longer berms to be built (3,620 vs. 2,040 ft) and significantly greater length of tile (30,940 ft of 5-in tile vs. 24,500 ft of 4-in tile).

The remaining option for reducing VIB area and increasing tile spacing is to accept a longer VIB drain time. The ability of the selected vegetation is an important consideration as to whether this change is acceptable.

Figure D–2 Tile spacing to achieve required drainage is 22 feet with VIB drain time of 3.1 days or 75 hours for a 16.7-acre VIB. 30,940 feet of tile line will be required.



Sizing of VIB laterals

Compute the required tile size:

1) Assume slope of the pipe = 0.20 percent (0.002 ft/ft) (assume plastic pipe not subjected to fine sand or silt)

2) Calculate overall drainage rate = 9,505 ft^3/h / (600 ft x 1,200 ft) = 0.0132 ft/h (12 in 72 h)

3) Calculate discharge from each lateral = 0.0132 ft/h x (1,180 ft x 22 ft) = 343 ft^3/h = 0.095 ft^3/s

4) Calculate tile diameter using equations 6 and 7 of section 7 as follows:

$$AR^{\frac{2}{3}} = \frac{Q}{\frac{1.49s^{\frac{1}{2}}}{n}} \qquad (1)$$

where:
A = cross-sectional area of drain tile
R = hydraulic radius of drain tile if flowing full (0.25 x tile diameter (D))
Q = discharge, ft^3/s
s = grade of tile (0.002)
n = Manning's roughness = 0.015

By substitution into equation 1:

$$\frac{\pi D^2}{4}\left(\frac{D}{4}\right)^{\frac{2}{3}} = \frac{0.095}{\frac{1.49\times(0.002)^{\frac{1}{2}}}{0.015}}$$

$$D = 0.37 \text{ ft} = 4.4 \text{ in}$$

Thus, tile with a 5 inch diameter is adequate size for the laterals

(5) Compute velocity if pipe (5-in diameter) were flowing full

$$V = \frac{1.49\times R^{\frac{2}{3}}\times s^{\frac{1}{2}}}{n}$$

$$= \frac{1.49\times(0.104)^{\frac{2}{3}}\times(0.002)^{\frac{1}{2}}}{0.015}$$

= 0.98 ft/s (below maximum velocity of 1.5 ft/s to prevent erosion)

Sizing the VIB tile main

(1) Assume two mains sections, one draining each side of VIB

(2) Assume slope of pipe = 0.05% (0.0005 ft/ft)

(3) Non-perforated pipe so shouldn't have to worry about exceeding maximum velocity

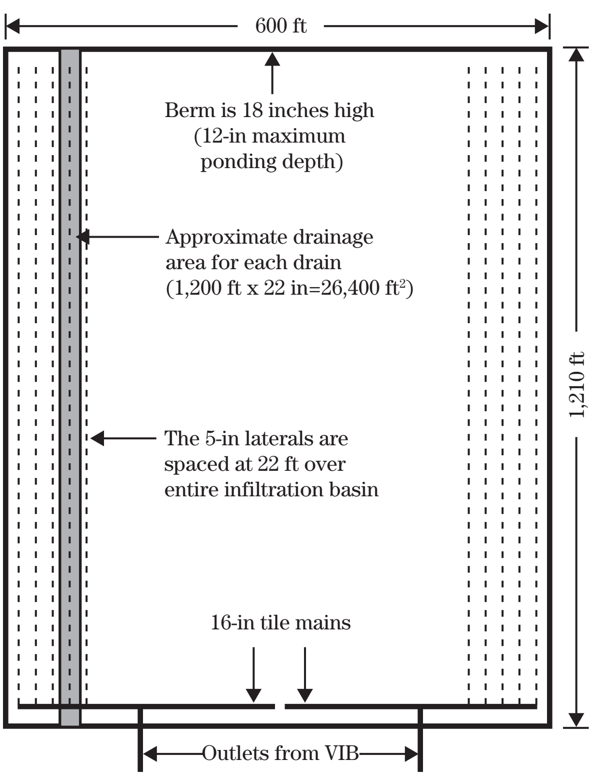
(4) Discharge from each main section

$$= 0.0132 \text{ ft/h} \times 0.5 \times (600 \times 1{,}200)$$
$$= 4{,}750 \text{ ft}^3\text{/h} = 1.32 \text{ ft}^3\text{/s}$$

$$\frac{\pi D^2}{4}\left(\frac{D}{4}\right)^{\frac{2}{3}} = \frac{1.32}{\frac{1.49 \times (0.0005)^{\frac{1}{2}}}{0.015}}$$
$$D = 1.27 \text{ ft} = 15.2 \text{ in}$$

Size of the main should be at least 16 inches.

Design summary



Appendix E Tolerance Factors

Table E–1 is a listing of a several tolerance factors for forages and legumes to various soil and moisture conditions as assembled by a team from the University of Montana and USDA NRCS. For information on additional crop tolerance factors not listed in this table log onto:

http://www.animalrangeextension.montana.edu/Aticles/Forage/Main-species.htm

Published with authors' permission based upon S. Smoliak, R.L. Ditterline, J.D. Scheetz, L.K. Holzworth, J.R. Sims, L.E. Wiesner, D.E. Baldridge. Comparative Characteristics of Forage Species in Montana Plant Species. From Montana Interagency Plant Materials Handbook. Copyright © 2001. Montana State University. Used with permission of Ray Ditterline e-mail rld@montana.edu.

Table E–1 Tolerance factors

Species	pH tolerance	Salt tolerance	Moisture range	Tolerance to water table	Tolerance to early spring flooding	Drought tolerance
Forages						
Big bluegrass	2,3		12–22	4		2
Kentucky bluegrass	2,3		14–22	2		2
Smooth bromegrass	2,3	2	12+	3	35–56	2
Meadow bromegrass	2,3	2	14+	3		2
Reed canarygrass	1,2,3	2	15+	1	35–56	2
Tall fescue	1,2,3,4	1	16+	2		2
Creeping foxtail	2,3,4	2	18+	1		3
Meadow foxtail	2,3		18+	1	21–42	3
Green needlegrass	3		18–22	4		1
Orchardgrass	2,3	2	15+	3		2
Timothy	2,3		15+	2	21–56	3
Beardless wheatgrass	3		12–18	3		1
Bluebunch wheatgrass	3		10–18	4		1
Crested wheatgrass, fairway	3	1	10–18	4		1
Crested wheatgrass, standard	3	1	11–18	4		1
Intermediate wheatgrass	2,3	1	13–22	3	21–28	2
Pubescent wheatgrass	2,3	1	12–20	3		2
Siberian wheatgrass	3		10–18	4		1
Slender wheatgrass	2,3,4	1	12–20	3	35–56	1
Tall wheatgrass	3,4	1	14+	2	35–56	1
Thickspike wheatgrass	3	2	10–18	3		1
Western wheatgrass	3,4	1	12+	2		1
Russian wildrye	3,4	1	10–18	3	21–35	1
Altai wildrye	3,4	1	12–18	3	2	1
Legumes						
Alfalfa	2,3	2	12+	3	7–14	2
Red clover	1,2,3	3	16+	3		3
Alsike clover	1,2,3	3	16+	2	7–14	3
Ladino or white clover	1,2,3	3	16+	2		3
Dutch clover	1,2,3	3	14+	2		2
Sainfoin	3		12–20	4		2
Sweetclover, yellow or white	2,3	2	10+	3	7–14	1
Birdsfoot trefoil	1,2,3	2	14+	2		2
Cicer milkvetch	2,3	2	14+	2		2

pH tolerance

Soil pH levels:
1 = < 5.5 pH: Tolerant to strong acid conditions.
2 = 5.6 – 6.5 pH: Tolerant to weak acid conditions.
3 = 6.6 – 8.4 pH: Tolerant to neutral to moderately alkaline conditions.
4 = >8.5 pH: Tolerant to strongly alkaline conditions.

Salt tolerance

Salt tolerance is the relative capacity of a forage to produce satisfactory yield or cover on a salty site. Saline soils are usually a mixture of some of the chloride, sulfate or bicarbonate salts of calcium, magnesium, and sodium. The total concentration of ions in the soil-water solution influences plant response more than the specific salt composition. For most purposes, soil salinity levels can be determined using the electrical conductivity (EC) of the soil solution.

1 = Good salt tolerance
2 = Fair salt tolerance
3 = Poor salt tolerance

Salt tolerance in forage species is complex, and information on many species is lacking. Once established, most forages can tolerate fairly high levels of salinity. Caution is urged to carefully select species based on utilization needs for conservation practices, many species are available; however, for grazing or hay, salinity can affect production, palatability, and concentration of nutrients and minerals. Further, soils that are high in exchangeable sodium (sodic soils) present special problems in addition to those attributed to total salinity. High levels of exchangeable sodium break down organic matter and cause soil particles to disperse, resulting in small pores. Poor aeration, water movement, and root growth are associated with these changes in soil structure (black alkali soils). Leaching of sodium and application of soil amendments can improve soil structure.

Moisture range to which species is well adapted

Plant response to moisture is subject to many variables: elevation, exposure, total heat units, season when greatest amount of moisture is received, and runoff losses to name a few. Moisture, as used here, includes all sources: annual precipitation, natural flooding, and irrigation. Some species may do well in rows under lower moisture than shown since this makes the available moisture more effective.

In defining a moisture range for a species, the lower limit is the minimum at which the species gives satisfactory production in solid stand. The upper limit is the amount beyond which the species will not utilize additional moisture. If no upper limit is given, it means it does well under maximum precipitation experienced in forage producing areas in Montana or under irrigated conditions. Ratings are expressed as inches of moisture.

Tolerance to water table

1 = Species will grow on sites with soil-water at or above field capacity, will grow when the water is ponded on the surface for several weeks at a time, and will grow under marshy conditions.

2 = Species will grow on sites with the soil-water at or above field capacity for most of growing season. It does not grow well when water is ponded on the surface for more than a few days at a time.

3 = Species will grow on sites with the soil-water at or above field capacity for several weeks in early spring. It will not grow well on soils where the water is ponded on the surface during the growing season.

4 = Species will grow on well-drained sites without a water table.

Tolerance to early spring flooding

Ratings are given in days for several species (McKenzie, R.E., Vol. 31, 1951, Sci. Agric. pp. 358-367). Based on observations, estimates of flooding tolerance of mature plants have been made for other species. To distinguish between these and the research data these estimates are shown as follows:

Exc. = (excellent) more than 49 days
Good = 14 to 49 days
Poor = less than 14 days

Very little information is available on tolerance to summer flooding. It is known that plants are far less tolerant to flooding with warm water and even less to still, warm water.

Drought tolerance

This rates the ability of a species or strain to survive prolonged periods of dry weather. It rates survival during periodic severe drought but not relative yield in an arid climate. Ratings assume the species is well adapted to the soil site, is being utilized each year, and is under good management.

1 = High
2 = Medium
3 = Low

Appendix F Records for VTA Systems

Form 1: Livestock Manure and Effluent Discharge Notification

Caution: Individual permitting authorities will define which releases of runofff from a VTA will qualify as a discharge and require reporting within 24 hours. This question should be raised for clarification with permitting authority. The information requested in this form should also be verified with the individual permitting authority or preferred alternative record used by the permitting authority substituted for this record.

Name: ____
Permitted Operation Name

Owner/Manager: ____

Address: ____
P.O. Box/Street Address

____
City, State, and Zip Code

Legal Description of Operation

________, of ________, _____________N, ___________ ☐ E or ☐ W, ________________________ County
1/4 1/4 Section Township Range

Do you have an **NPDES** permit? ________ Yes ________ No **If** yes, Permit No. ____________________

Do you have a **State** Permit? ________ Yes ________ No **If** yes, Permit No. ____________________

Complete the following:

1. List reason(s) for discharge (i.e., power failure, large storm or chronic wet period, leak or break in the water supply system, component failure of the waste control facility; and/or releases during land application due to equipment failure, accidents or irrigation equipment failure):

   ____

   ____

2. The discharge flowed into ____
   (ditch, drainage way, stream name)

3. Did the discharge flow directly into surface water (stream, river, drainage ditch, lake, wetland) or did the discharge flow over cropland prior to discharging to surface water? ______________________

4. The approximate width and depth of the surface water (which the discharge entered):
   ____________________ (width in feet) and ____________________ (depth in feet)

5. The discharge started on (date and time): Please indicate if this was the actual time or if this was when the discharge was discovered.

   ____

   ____

6. The discharge ended on (date and time): Please indicate if this was the actual or the estimated time

   ____

   ____

(continued on next page)

Form 1: Livestock Manure and Effluent Discharge Notification (continued)

7. Average flow of the discharge was: ____(gallons/minute)

8. Estimated total volume of discharge (ft^3): ______________________________________(L x W x D)

9. List any damage to the waste control facility: ____
____
____

10. Describe factors and conditions that were used to minimize the adverse effects to the environment from the discharge:
____
____
____

Additional Information

1. You may submit rainfall, land application, and system storage records for up to a 12-month period prior to the discharge event to demonstrate the need for the discharge.

2. Samples of discharge are required for all NPDES permitted animal feeding operations. The following characteristics should be analyzed. Sample locations, at a minimum, must include point of discharge, upstream, downstream and the mix zone (where the discharge mises with surface water). Provide a map with collection sites marked.

   a) Five-day Biochemical Oxygen Demand (BOD^5)
   b) total ammonium-nitrogen
   c) nitrate-nitrite nitrogen
   d) pH (field measurement)
   e) temperature of the effluent and receiving stream (field measurement)
   f) total phosphorus
   g) total suspended solids
   h) Escherichia coli or fecal coliform

3. Was sample kept cool with ice or frozen during time between sample was taken and delivery to lab?
   ______ Yes ______ No

I HEREBY CERTIFY THAT THE INFORMATION SUBMITTED HEREIN IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

X____

Signature of authorized representative Date

Form 2: Record of Precipitation, Land Application, and Liquid Levels

Purpose: A record of precipitation, land application events, and liquid levels is required for all permitted storage facilities for containing storm related runoff from open lot production systems.

Month and Year: _________________ **Settling Basin ID:** _________________ **VTA Site ID:** _________________

Day	Precipitation	Vegetative Treatment Area					
		Hour pumping or release started	Hour pumping or release stopped	Flow rate (gpm)	Total volume released or pumped	Check if discharge from VTA[1]	Settling basin or pond liquid level[2]
1	in.			gpm	gal.		ft.
2	in.			gpm	gal.		ft.
3	in.			gpm	gal.		ft.
4	in.			gpm	gal.		ft.
5	in.			gpm	gal.		ft.
6	in.			gpm	gal.		ft.
7	in.			gpm	gal.		ft.
8	in.			gpm	gal.		ft.
9	in.			gpm	gal.		ft.
10	in.			gpm	gal.		ft.
11	in.			gpm	gal.		ft.
12	in.			gpm	gal.		ft.
13	in.			gpm	gal.		ft.
14	in.			gpm	gal.		ft.
15	in.			gpm	gal.		ft.
16	in.			gpm	gal.		ft.
17	in.			gpm	gal.		ft.
18	in.			gpm	gal.		ft.
19	in.			gpm	gal.		ft.
20	in.			gpm	gal.		ft.
21	in.			gpm	gal.		ft.
22	in.			gpm	gal.		ft.
23	in.			gpm	gal.		ft.
24	in.			gpm	gal.		ft.
25	in.			gpm	gal.		ft.
26	in.			gpm	gal.		ft.
27	in.			gpm	gal.		ft.
28	in.			gpm	gal.		ft.
29	in.			gpm	gal.		ft.
30	in.			gpm	gal.		ft.
31	in.			gpm	gal.		ft.

1. This column should be checked if pump out or VTA discharge is directed to surface waters, wetlands, ditch or drainage connecting to surface waters. Regulatory authority should be notified by phone within 24 hours.
2. Liquid level is measured from: _____low point at top of berm, dam, or spillway; _____bottom of storage; _____must pump level mark on liquid level indicator.

Measure to the nearest one foot increment.

Form 3: Vegetated Treatment System Inspection Checklist

Checks in shaded boxes suggest potential problem or risk.

Farm:__________________________ Facility ID: __________________________ Year: ______________

Date								
Inspected by (initials)								

Solids settling component observations

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Comments
Signs of berm/dam damage due to:																	
Burrowing animals?																	
Presence of trees or large weeds?																	
Erosion, gullies or poorly established sod?																	
Is solids accumulation excessive?																	
For settling basins, is maximum solids storage clearing marked and visible?																	
Are gravity drained outlets free of obstructions?																	
Security: Are gravity drain valves or pump power supplies locked/secure from tampering?																	

Vegetated Treatment Area (VTA)

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Comments
Do VTA inlets appear to evenly distribute flow?:																	
Are VTA inlets free of obstructions and debris?																	
Are there signs of erosion/damage to field border?																	
Signs of channel or non-uniform flow?																	
Presence of wheel ruts or gullies?																	
Presence of eroded areas?																	
Infield spreader erosion/maintenance needs?																	
Signs of ponding within VTA?																	
Signs of high areas which runoff does not reach?																	
Does forage need to be harvested?																	
Are there signs of fertility deficiencies?																	
Are there signs of undesirable plant species?																	
Is there a good stand of forage in first 50 ft?																	
Is there a good stand of forage in rest of)?																	

Form 3: Vegetated Treatment System Inspection Checklist (continued)

Checks in shaded boxes suggest potential problem or risk.

Date																
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

Vegetative Infiltration Basin (VIB)

																	Comments
Signs of berm/dam damage due to:																	
Burrowing animals?																	
Presence of trees or large weeds?																	
Erosion, gullies, or poorly established sod?																	
Is water flowing from all drainage tile runs?																	
Is there a good stand of forage in first 1/3 of VIB?																	
Is there a good stand of forage in last 2/3 of VIB?																	
Does water drain from VIB within three days?																	
Does water spread evenly over VIB?																	

Clean Water Diversion

Signs of berm/dam damage due to:																	
Burrowing animals?																	
Presence of trees or large weeds?																	
Erosion, gullies, or poorly established sod?																	
Are perimeter drains plugged or blocked?																	
Is roof water entering storage?																	
Is field runoff entering storage?																	
Are diversions/waterways maintained?																	

Visual Appearance and Safety

Is site neat and recently mowed?																	
Are mortality or afterbirth observed?																	
Are medical consumables observed?																	
Is area fenced and properly marked?																	

Form 4: VTA System Maintenance Record

Date	Component or equipment	Maintenance performed	Worker initials

Form 5: VTA Documentation of Nutrient Management

Review Ground Water Protection and Soil Sampling discussion in Chapter 8

Farm Owner: ______________________ **VTA ID:** ______________ **Crop:** ______________

Sample date	Nitrogen management monitoring options[1]						Shallow soil test results							
	Option 1: Soil nitrate level (ppm) and sample depth (inches)		Option 2: Forage nitrate level (ppm)	Option 3: Crop nitrogen removal			Soil organic matter		Soil residual P		Soil EC (mmhos/cm)		Soil pH	
	First 50 ft	Rest of VTA		Tons harvested	Percent protein	lbs. N[2] removal	First 50’	Rest of VTA	First 50’	Rest of VTA	First 50’	Rest of VTA	First 50’	Rest of VTA

[1] Only one of these three indicators of nitrogen management is recommended unless risk to ground water is high.
[2] lbs N removed = tons harvested x % protein x 20/6.25.