USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Roof Runoff Management Planning And Design

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Topics Covered

- Basics of planning and design of a roof runoff system
- Sizing of gutters and downspouts
- Trench drains
- Storage of roof runoff for useful purposes

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ROOF RUNOFF STRUCTURE

(No.)

CODE 558

DEFINITION

Structures that collect, control, and transport precipitation from roofs.

PURPOSE

To improve water quality, reduce soil erosion, increase infiltration, protect structures, and/or increase water quantity.

CONDITIONS WHERE PRACTICE APPLIES

Where roof runoff from precipitation needs to be:

- diverted away from structures or contaminated areas;
- collected, controlled, and transported to a stable outlet; or

clean-out as appropriate. When runoff from roofs empties onto the ground surface, a stable outlet shall be provided. When runoff is conveyed through a gutter and downspout system, an elbow and energy dissipation device shall be placed at the end of the downspout to provide a stable outlet and direct water away from the building.

Surface or ground outlets such as rock pads, rock filled trenches with subsurface drains, concrete and other erosion-resistant pads, or preformed channels may be used, particularly where snow and ice are a significant load component on roofs.

In regions where snow and ice will accumulate on roofs, guards and sufficient supports to withstand the anticipated design load shall be

Roof Runoff Structures

- Roof Runoff Structures are facilities for collecting, controlling, and disposing of runoff water from roofs.

Why Roof Runoff Management?

- **Keep clean water clean, animal waste mgt**

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- Keep clean water clean, animal waste mgt
- **Improve Waste Handling**

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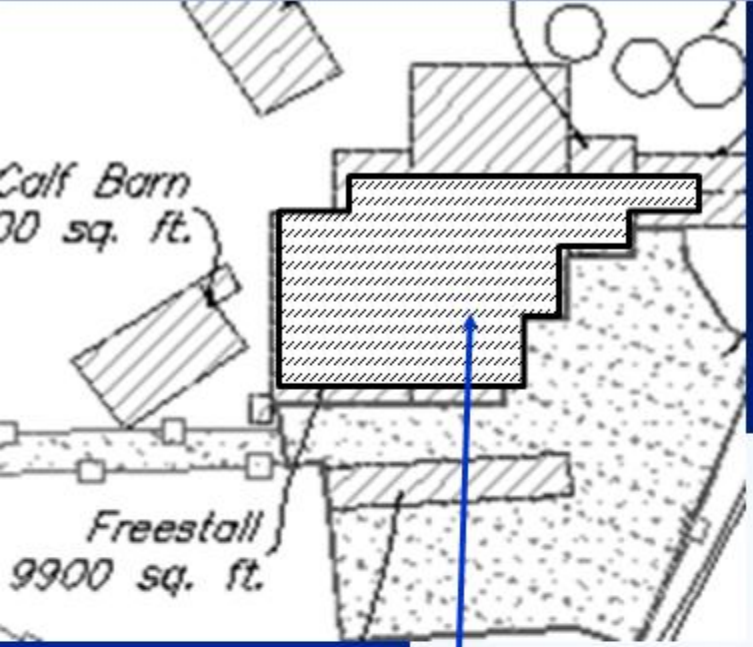
- Keep clean water clean, animal waste mgt
- Improve Waste Handling
- **Reduce the water storage requirements for Waste Storage Structures (313)**

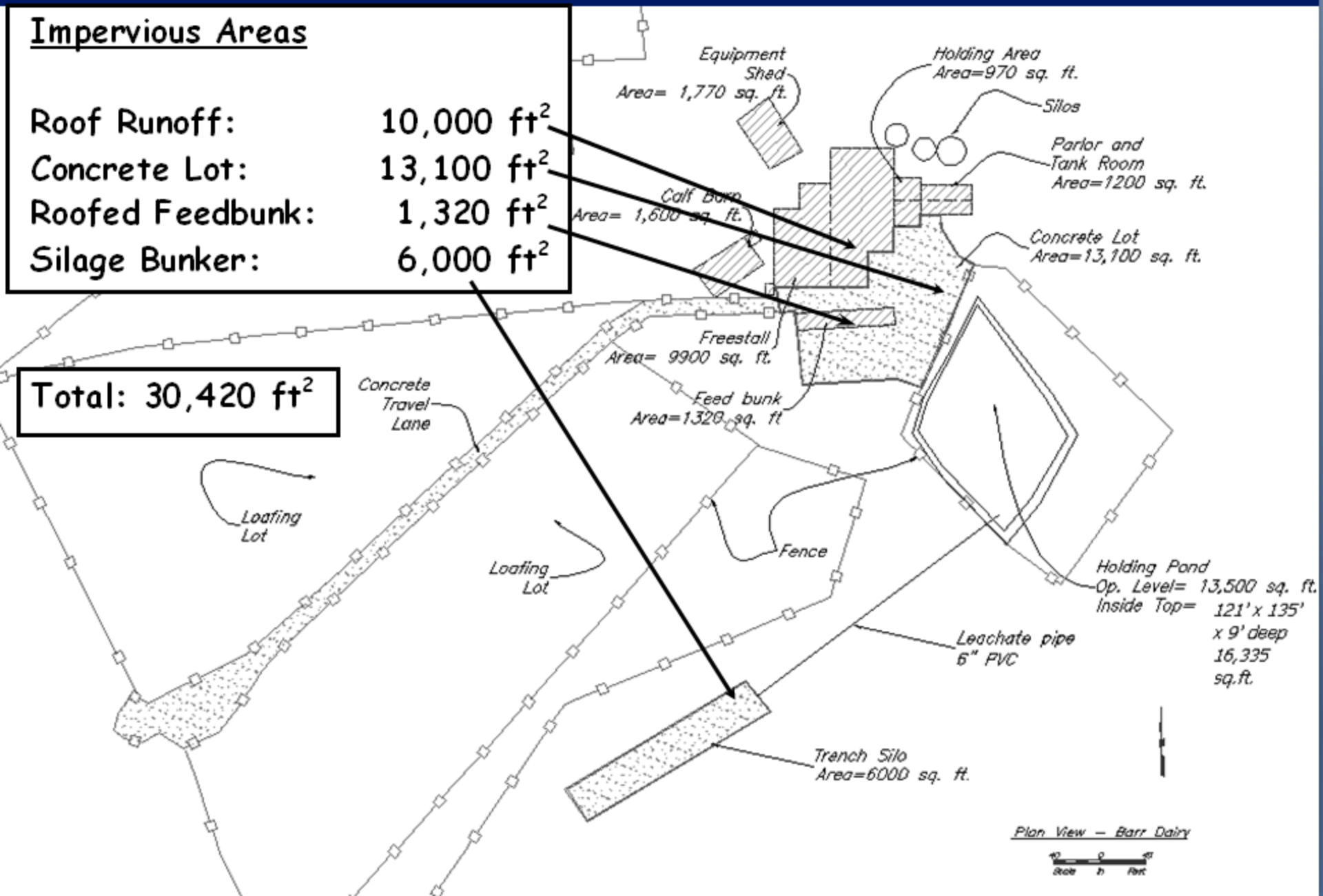
Determining Rainfall Runoff Amounts

Runoff from roofs

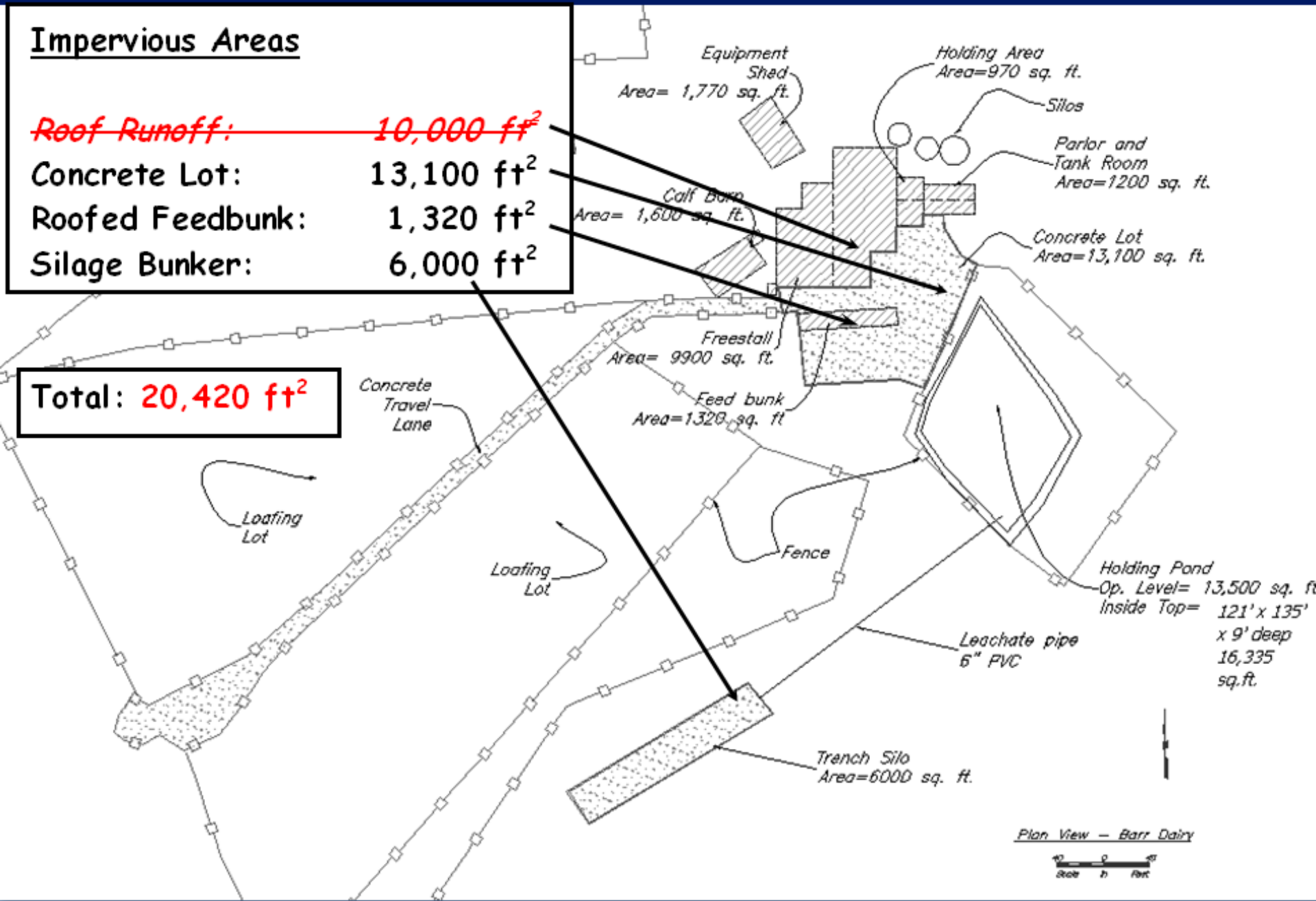


Roof Area

Determining Rainfall Runoff Amounts



Determining Rainfall Runoff Amounts



Determining Rainfall Runoff Amounts

How much clean water is removed by guttering?

115,980 cu. Ft. (all runoff areas w/o gutters)

-77,850 cu. Ft. (all runoff with gutters)

38,130 cu. Ft. (clean water removed)

= 285,212 gallons

Benefits of Gutters

- 10 to 12 hours less pumping per year
- storage period is increased
  - (120 to 150 days)
- low cost ($6.00 linear foot)
  - $6.00 x 150 linear feet = $1000 to $2000

Why Roof Runoff Management?

- Keep clean water clean, animal waste mgt
- Improve Waste Handling
- Reduce the water storage requirements for Waste Storage Structures (313)
- **Collect and Store Roof Runoff for other uses**

Livestock Watering

Irrigation Water

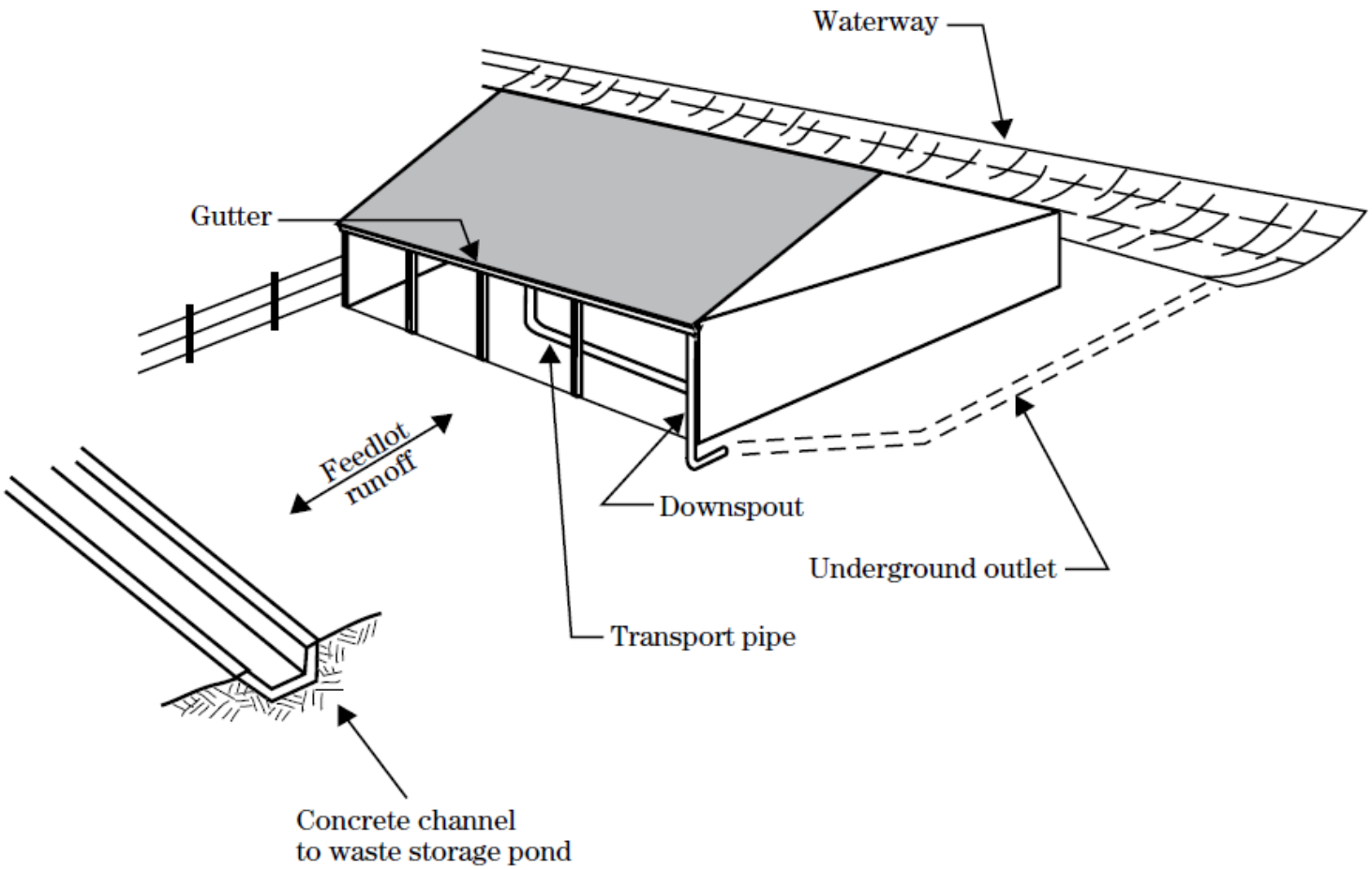
United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

**Part 651
Agricultural Waste Management
Field Handbook**

Chapter 10 Agricultural Waste Management System Component Design

Figure 10–1 Roof gutter and downspout



Gutter Capacity

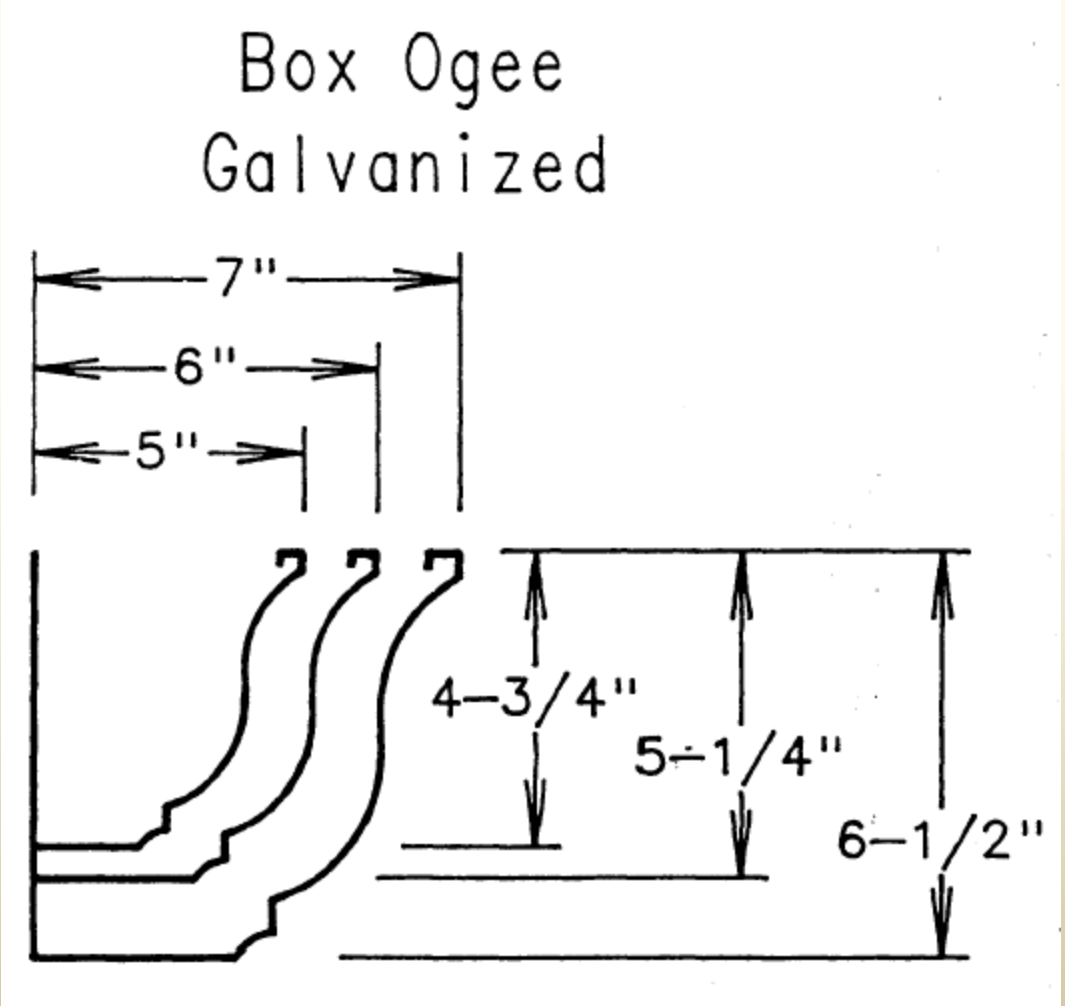
Step 1 Compute the capacity of the selected gutter size. This may be computed using Manning's equation. Using the recommended gutter gradient of 1/16 inch per foot and a Manning's roughness coefficient of 0.012, this equation can be expressed as follows:

$$q_g = 0.01184 \times A_g \times r^{0.67}$$

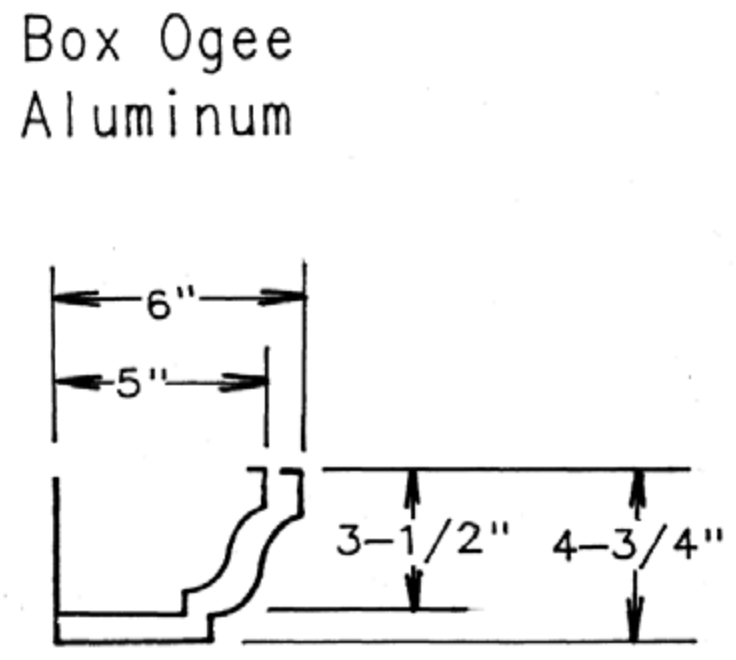
where:

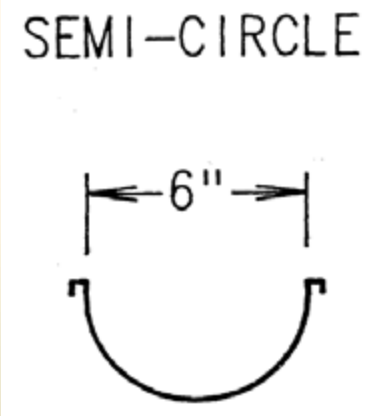
q_g = capacity of gutter, ft^3/s
A_g = cross-sectional area of gutter, in^2
r = A_g / wp, in
wp = wetted perimeter of gutter, in

Gutter Sizes



Gutter Sizes

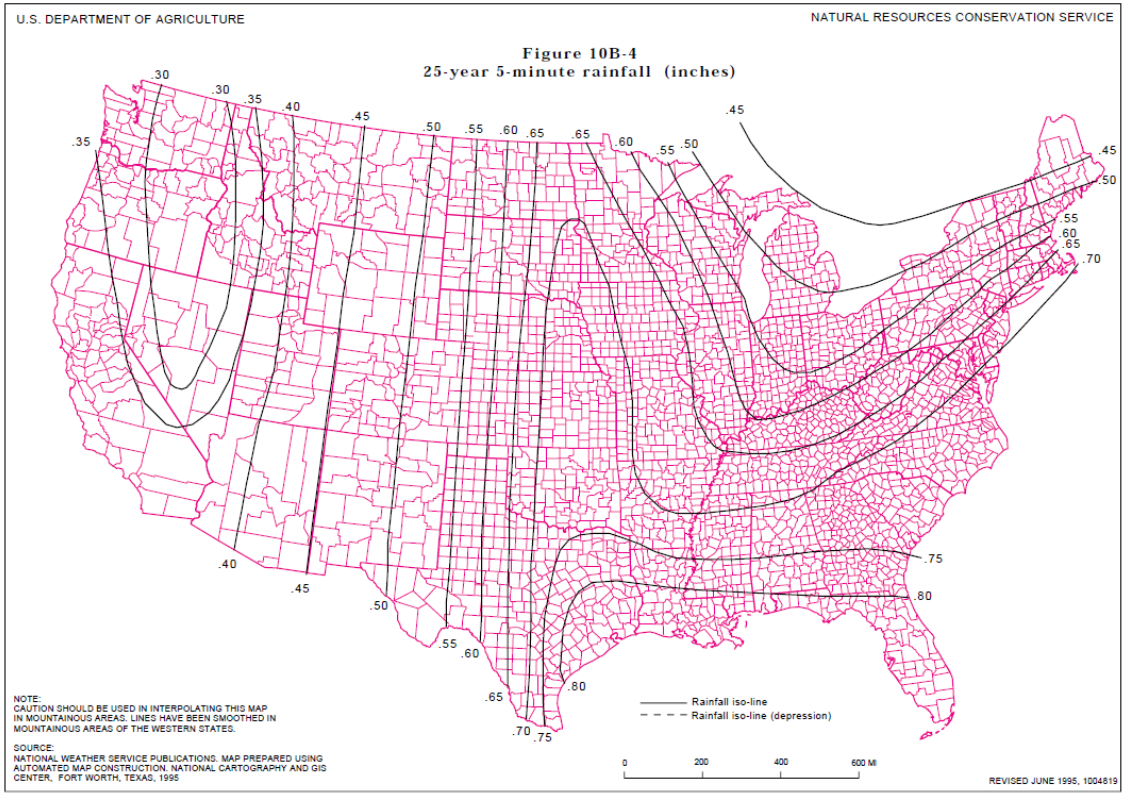




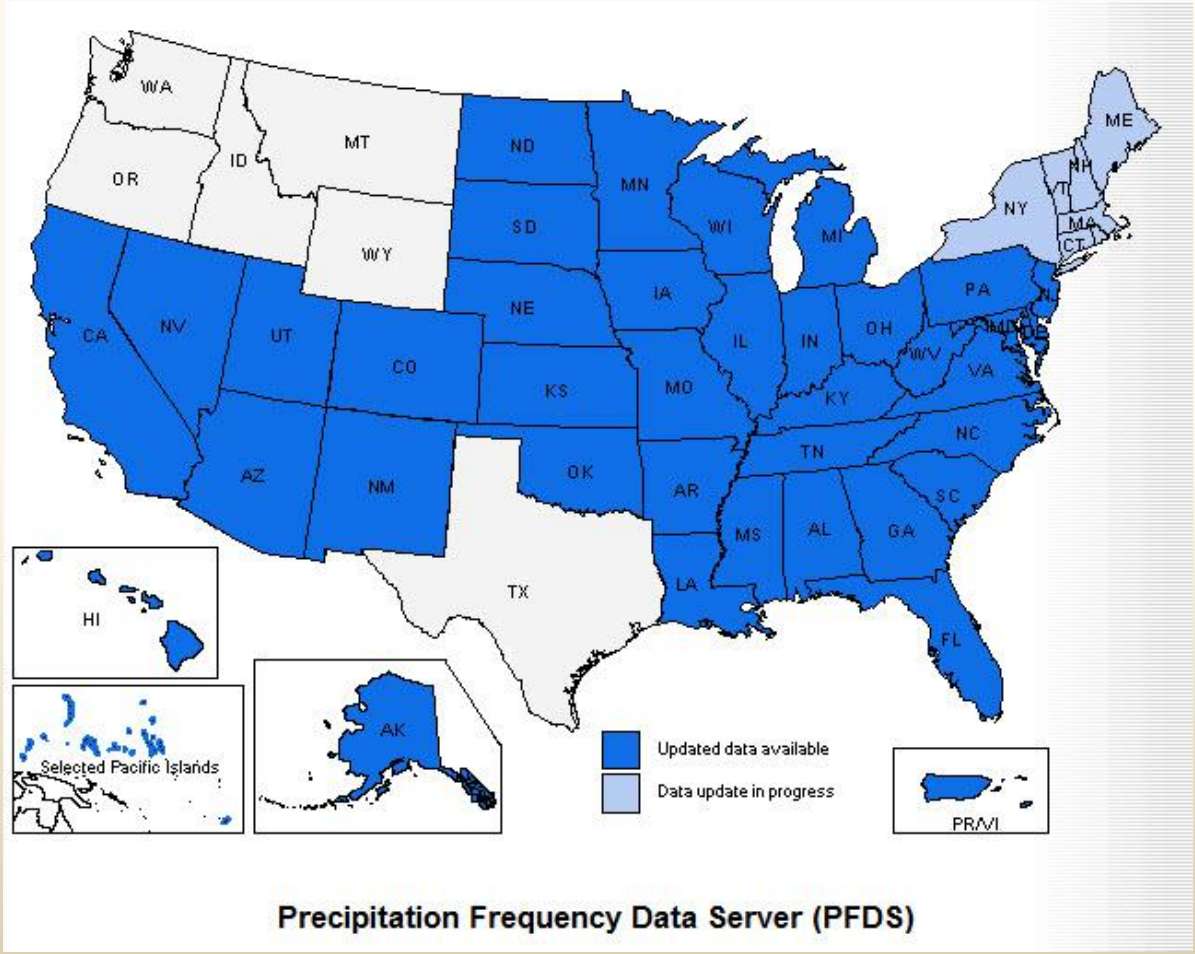
Rainfall

- 10 yr storm frequency, 5 minute rainfall
- Animal Waste Systems use 25 yr storm frequency, 5 minute rainfall

AWMFH Chapter 10, Appendix B



NOAA 14 States



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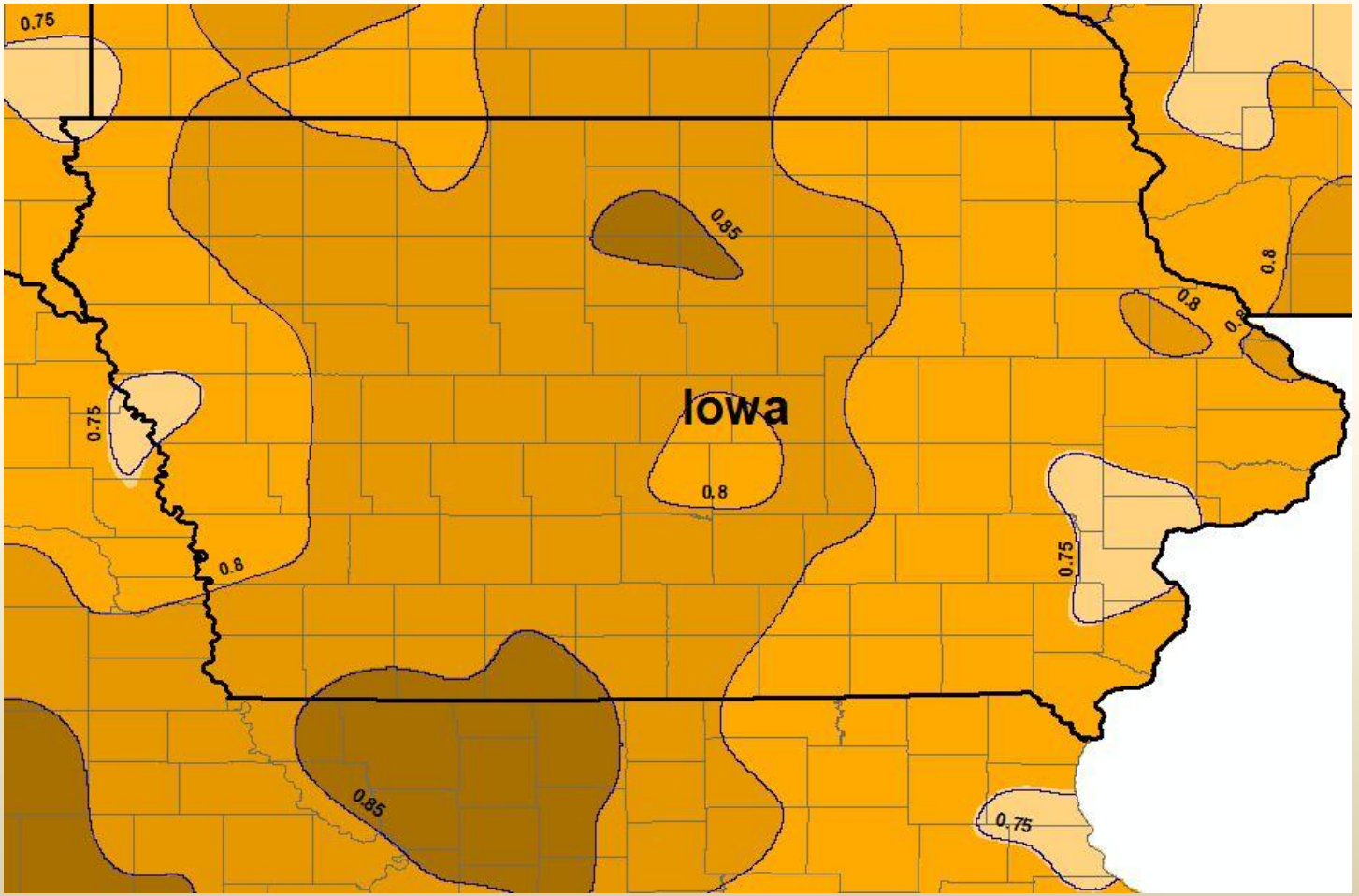


Gutter Slope

- $1/16^{th}$ inch per foot
- Works out to a little over 6 inches of fall per 100 foot of gutter
- Does the building have any slope?
- What is the width of the fascia?
- To prevent mosquitoes, your gutter system must not hold rainwater.

Downspout Capacity

Step 2 Compute capacity of downspout. Using an orifice discharge coefficient of 0.65, the orifice equation may be expressed as follows:

$$q_d = 0.010457 \times A_d \times h^{0.5}$$

where:

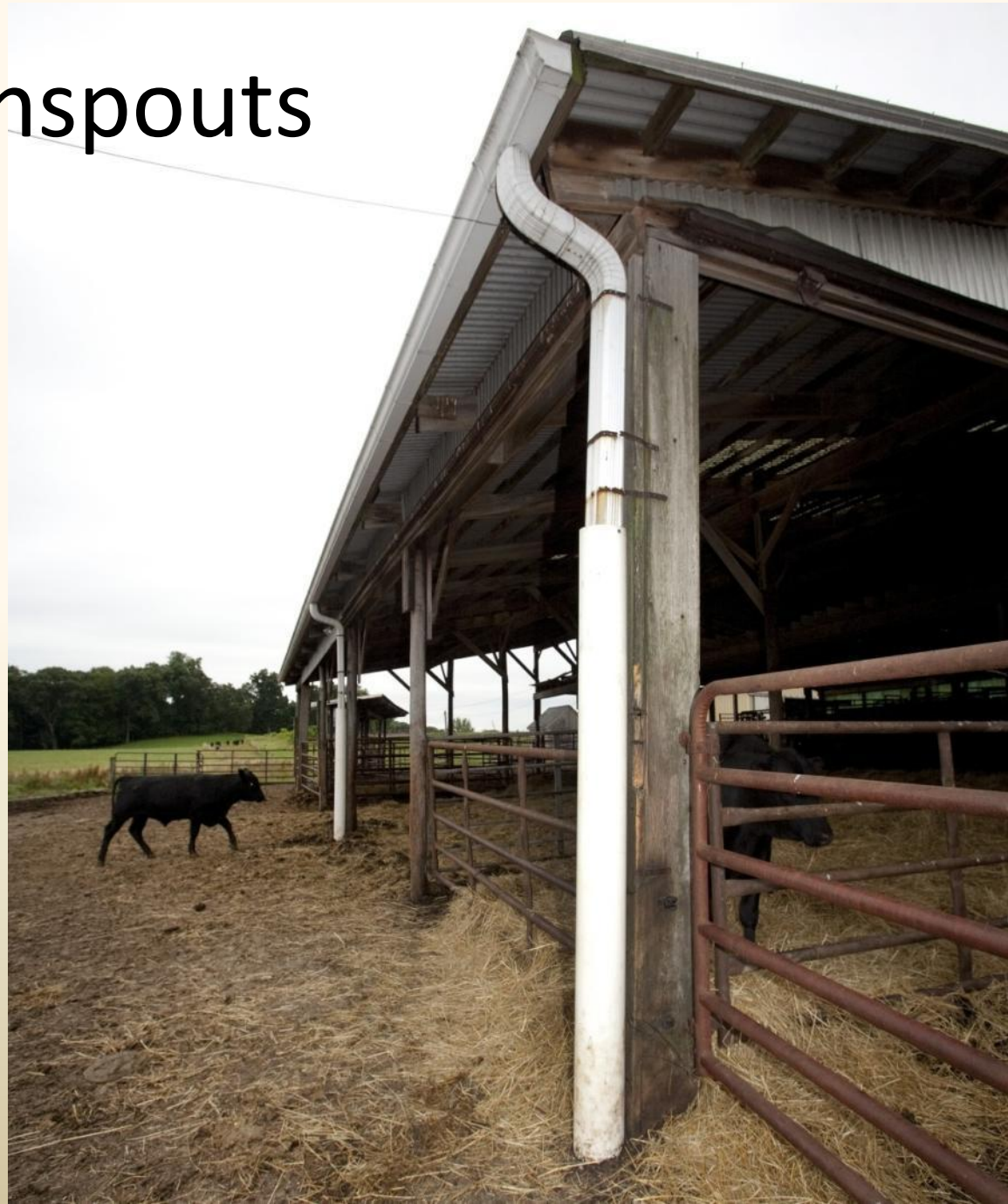
q_d = capacity of downspout, ft^3/s
A_d = cross-sectional area of downspout, in^2
h = head, in (generally the depth of the gutter minus 0.5 in)

Downspouts

- Downspout sizes must not exceed the bottom width of the gutter.
- Support downspouts at the top and bottom with intermediate support every 10 feet.
- Lateral Downspouts should be supported at least every 5 feet.

Protect Downspouts

- Areas where animals or equipment can damage downspouts, use Sch 40 PVC, steel pipe, or other ridged pipe.



Number of Downspouts

Step 3 Determine whether the system is controlled by the gutter capacity or downspout capacity and adjust number of downspouts, if desired.

$$N_d = \frac{q_g}{q_d}$$

where:

N_d = number of downspouts

If N_d is less than 1, the system is gutter-capacity controlled. If it is equal to or greater than 1, the system is downspout-capacity controlled unless the number of downspouts is equal to or exceeds N_d.

Roof Area Served

Step 4 Determine the roof area that can be served based on the following equation:

$$A_r = \frac{q \times 3,600}{P}$$

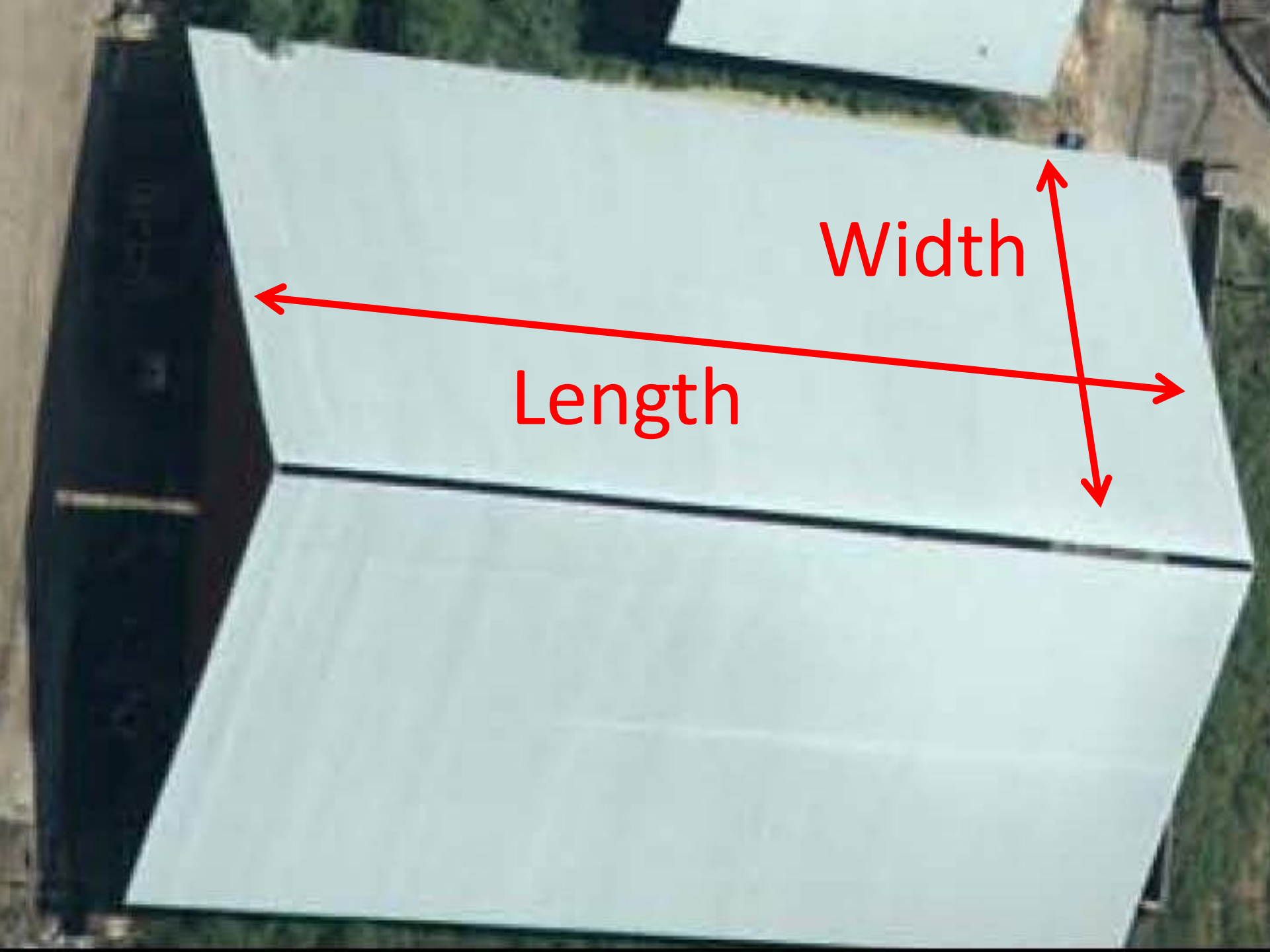
where:

A_r = area of roof served, ft^2

q = capacity of system, either q_g or q_d, whichever is smallest, ft^3/s

P = 5-minute precipitation for appropriate storm event, in

Enough Downspouts??

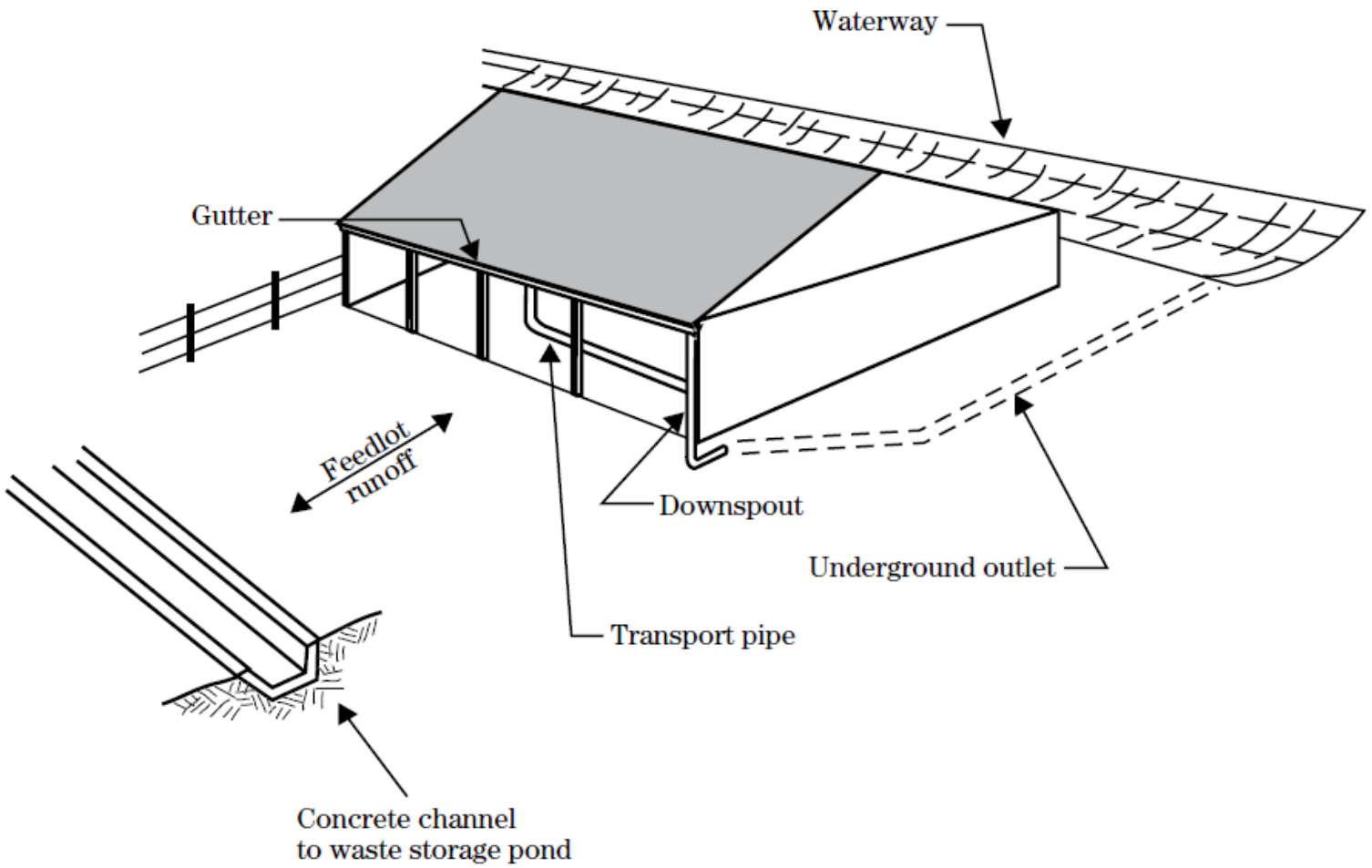

Width
Length


Requires 4 downspouts per side


Width can sometimes be controlled by the structure.

Gutter Outlets

Figure 10–1 Roof gutter and downspout

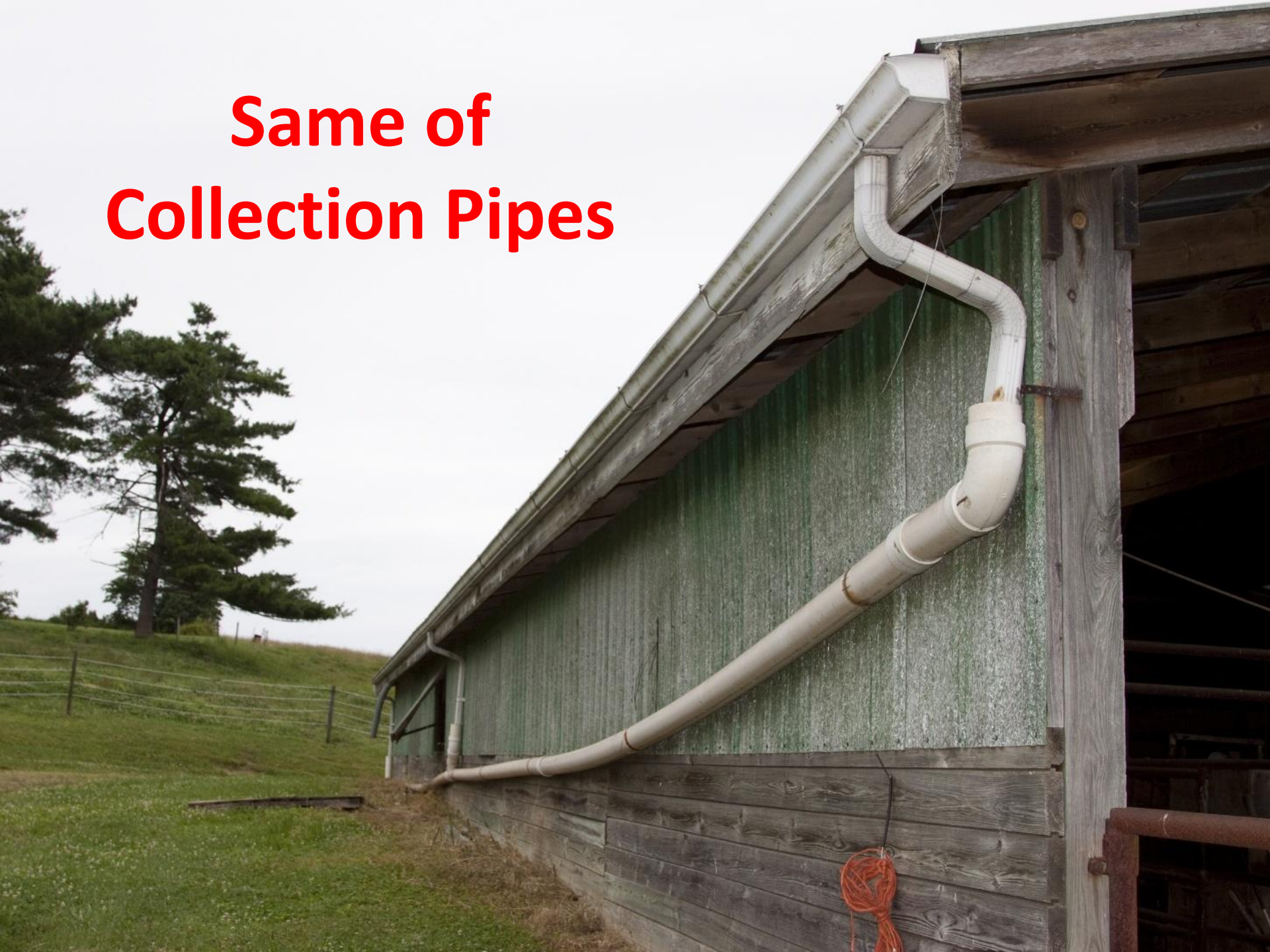


Underground Outlets

Size Underground Outlets

- Size the underground outlet much the same way you size any underground outlet
- Use the controlling discharge (gutter or downspout)
- Account for all downspouts

Same of Collection Pipes



Roof Runoff can be routed to where it is needed

Questions?

Other Factors

- Rafters and fascia boards in good condition
- Spike and ferrule apt to pull out of the fascia due to gutter expansion and contraction
- Roof gutter support spacing (closer for snow)
  - (18”) – 32” for aluminum
  - (24”) – 48” galvanized steel spacing
- All gutter and components must be the same metal type to prevent electrical corrosion.

Avoid Spike and Ferrule

Gutter hangers

Figure 1: Typical Hangers Screwed to Fascia

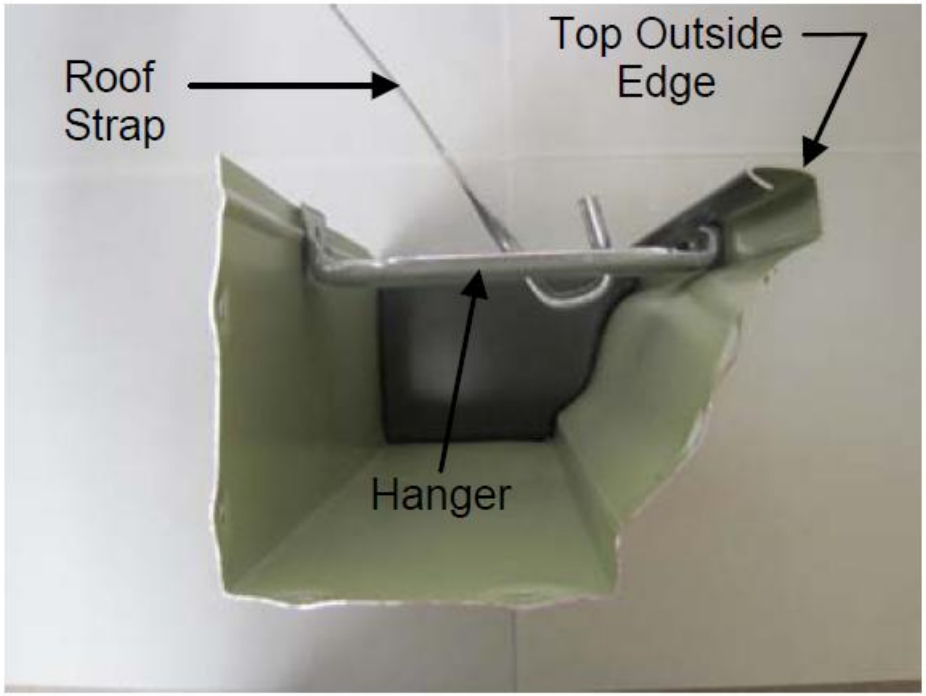


Figure 2: Typical Gutter Hanger and Roof Strap Attachment

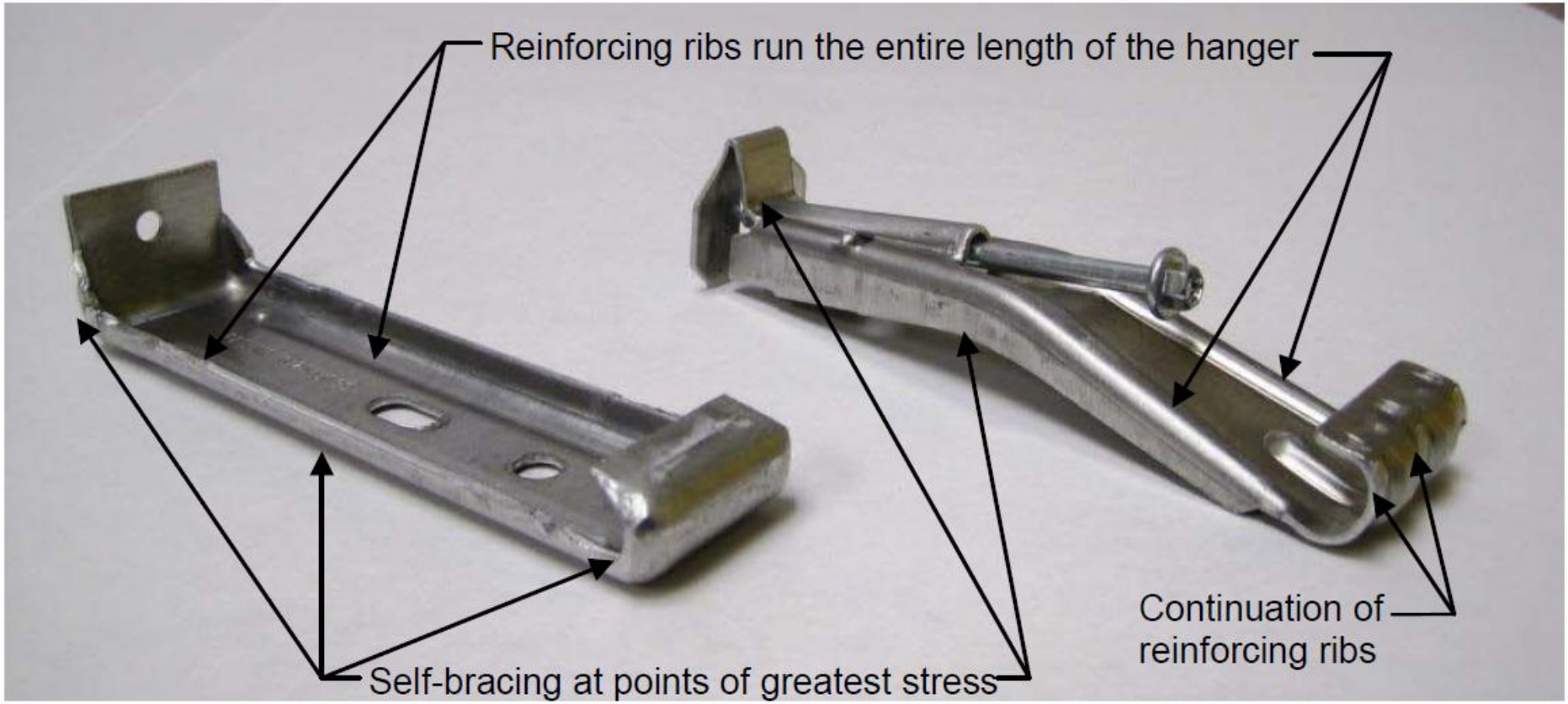


Figure 3: Heavy Duty Gutter Hanger Details

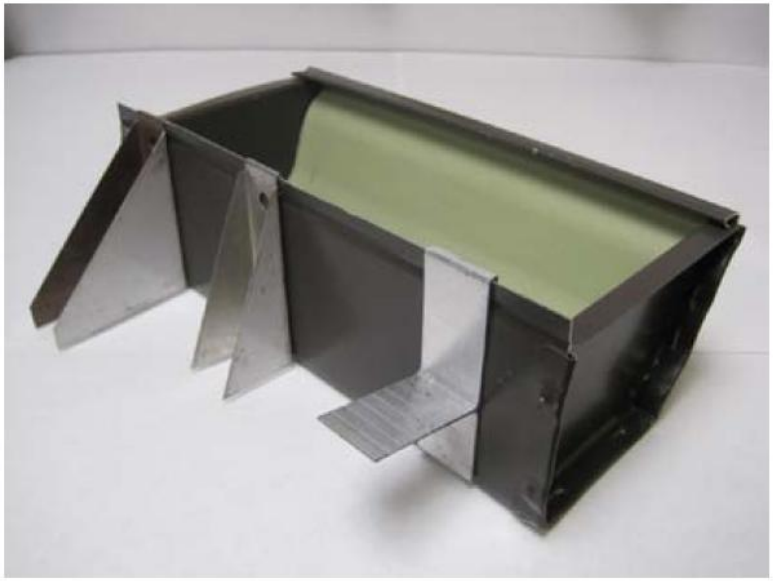
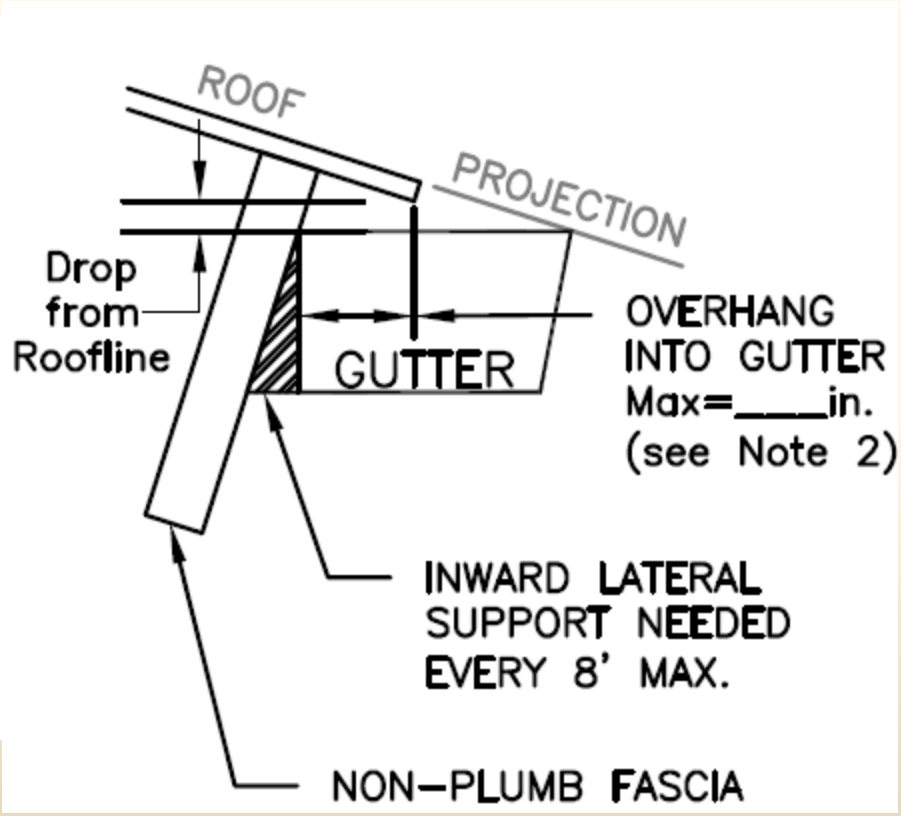


Figure 4: Typical wedges used for inward lateral support



wrap-around strap

Rigid Support

Rigid Support

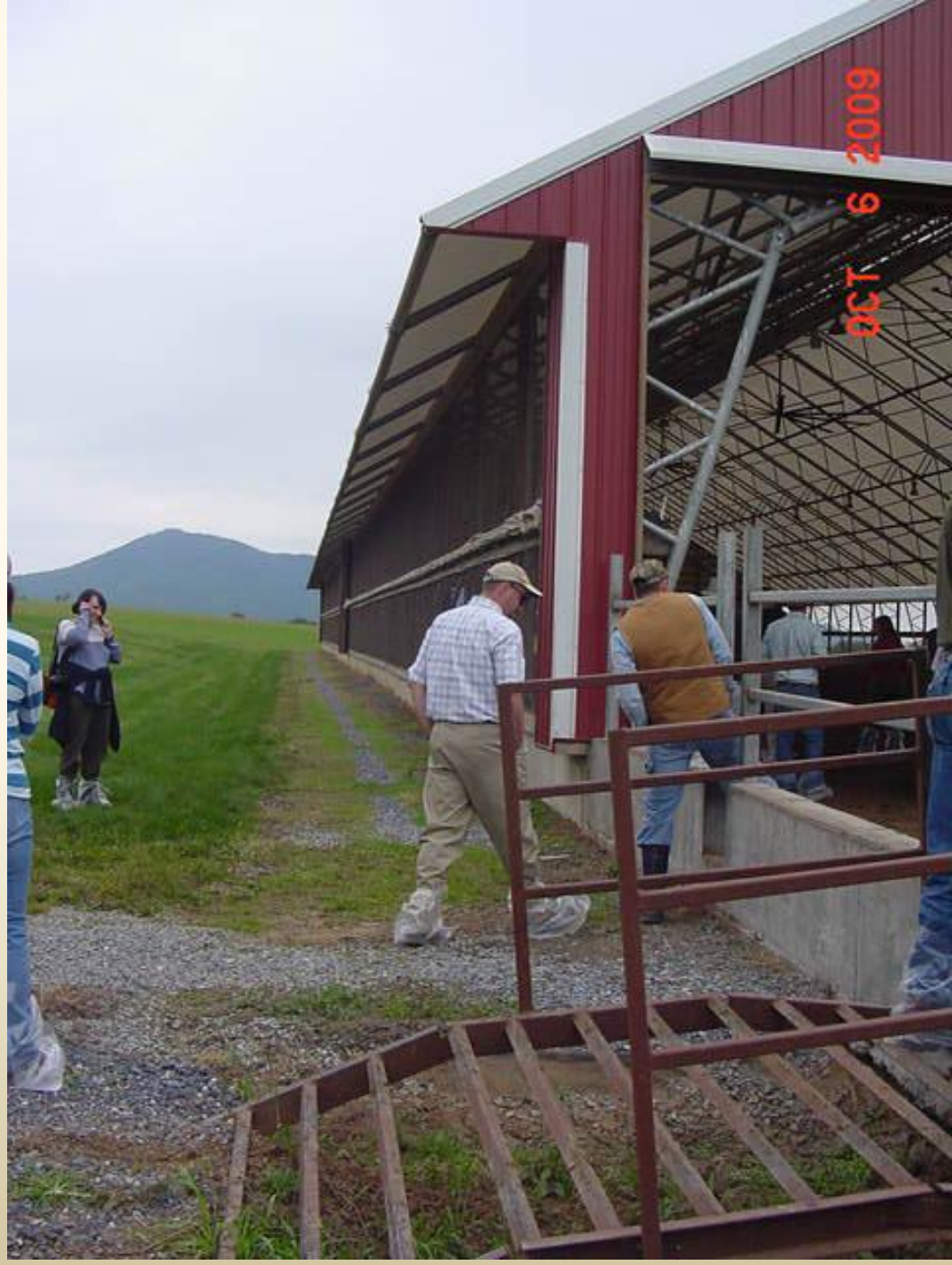
Gutter material

- Aluminum gutters and downspouts shall have a minimum thickness of 0.027 inch.
- Galvanized steel gutters and downspouts shall have a minimum thickness of 28 gage.
- Don’t mix metal types

Gravel Drains

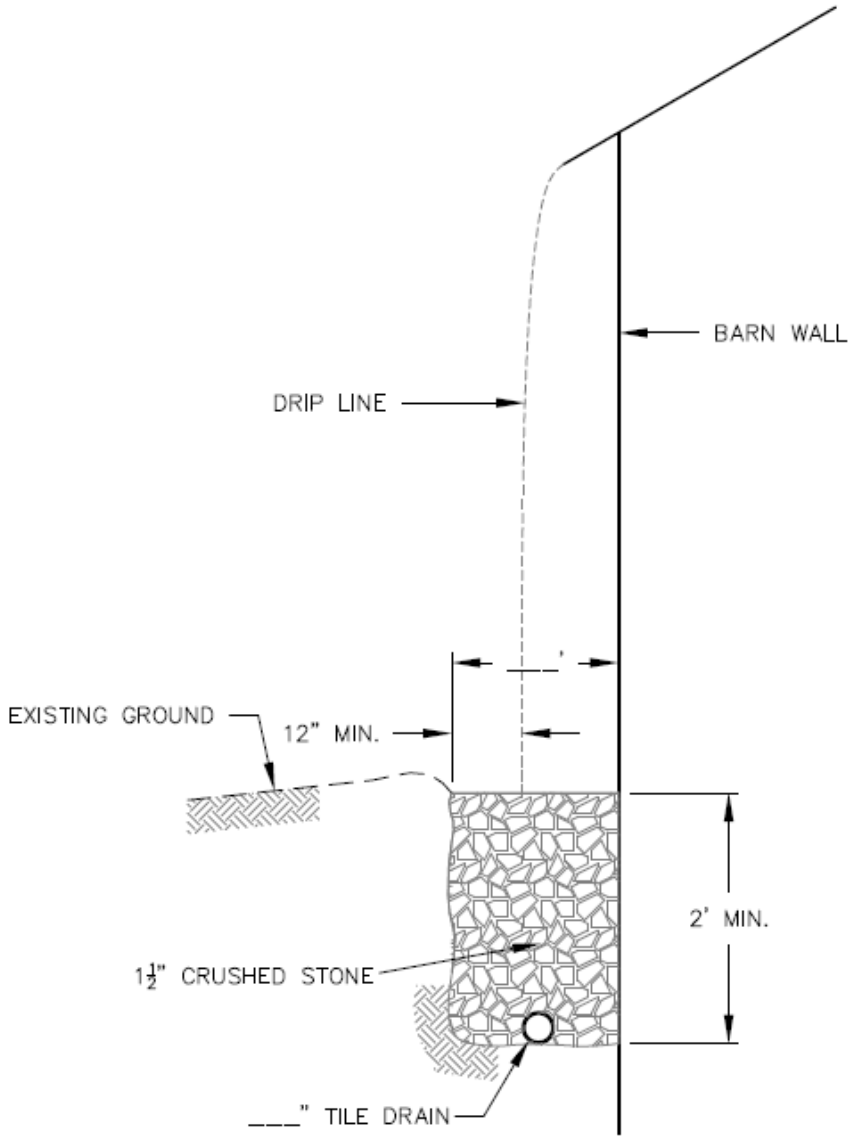
- Infiltration Channel
- Ground Gutters
- Tile Roof Drain

- Roof runoff captured by a rock filled trench with a subsurface drain
- > 12 inch overhang



TILED ROOF DRAIN DETAIL

(NOT TO SCALE)



NOTES:

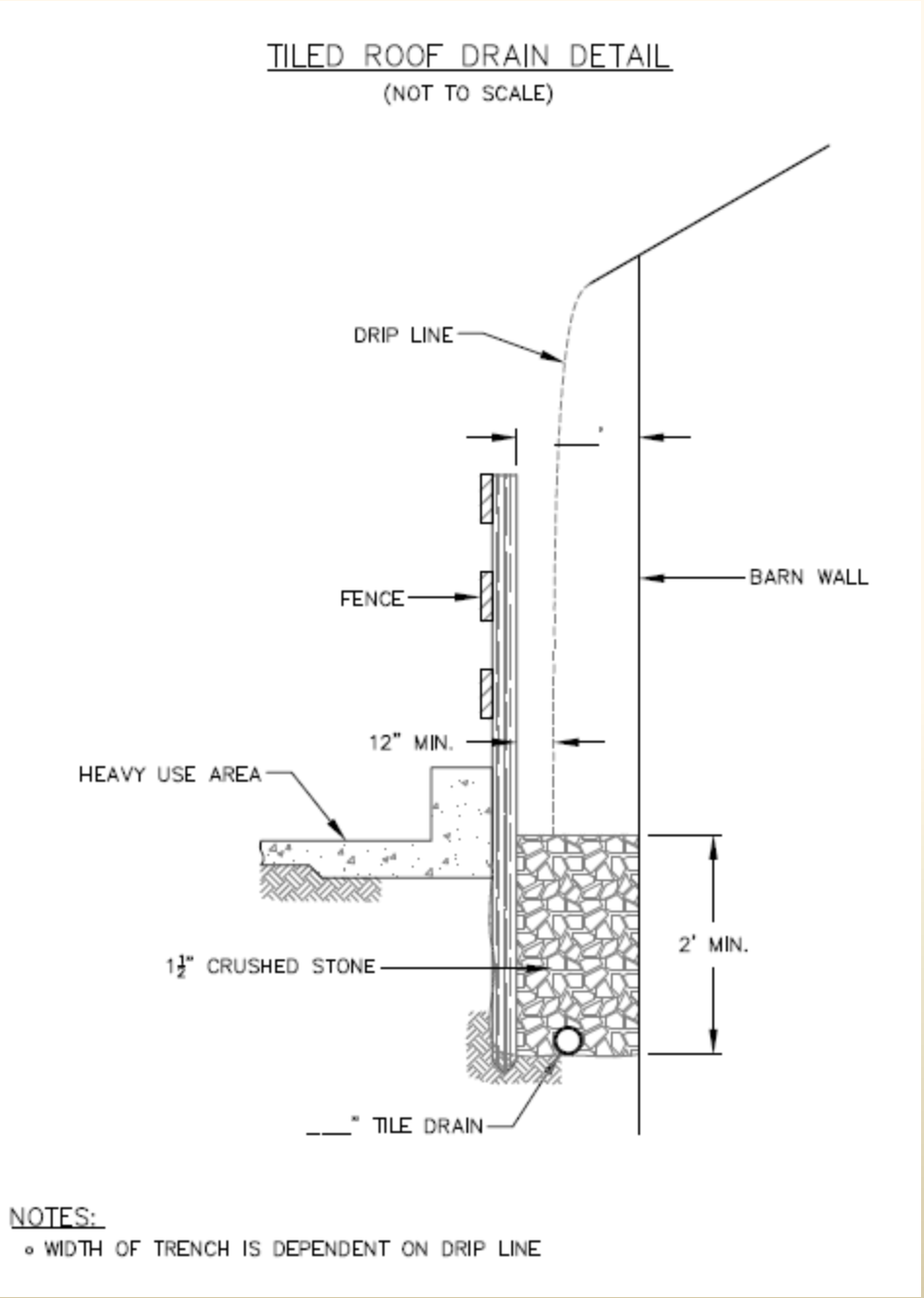
- WIDTH OF TRENCH IS DEPENDENT ON DRIP LINE

Gravel Drains

- Poorly graded rock
- Subsurface drain sized to carry design rainfall peak capacity

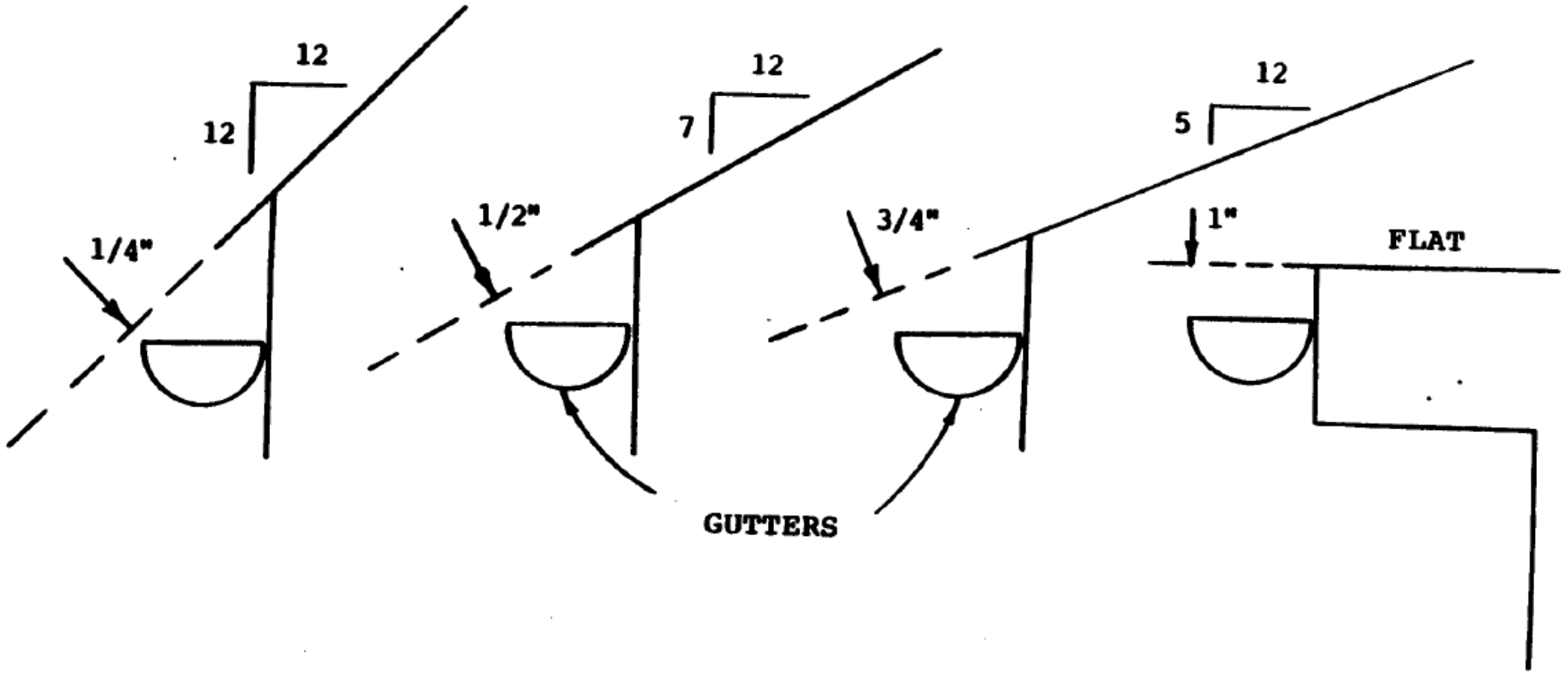
DRIP TRENCHES

Exclude Livestock from Roof Drain Systems



Snow

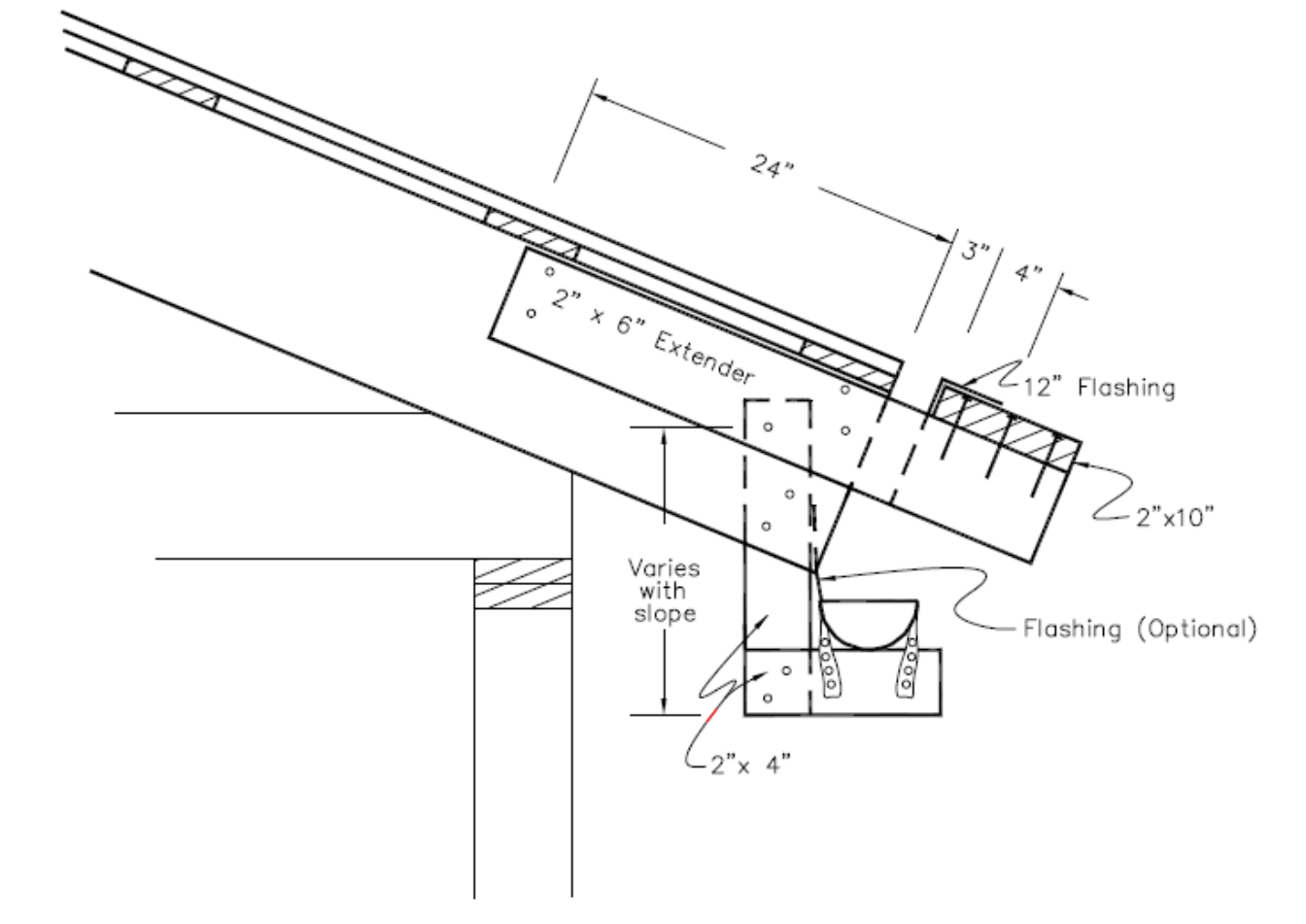
PLACEMENT OF GUTTERS



Note: Gutters Should be placed below the slope line so that snow and ice can slide clear. Steeper pitch requires less clearance.

Snow guards

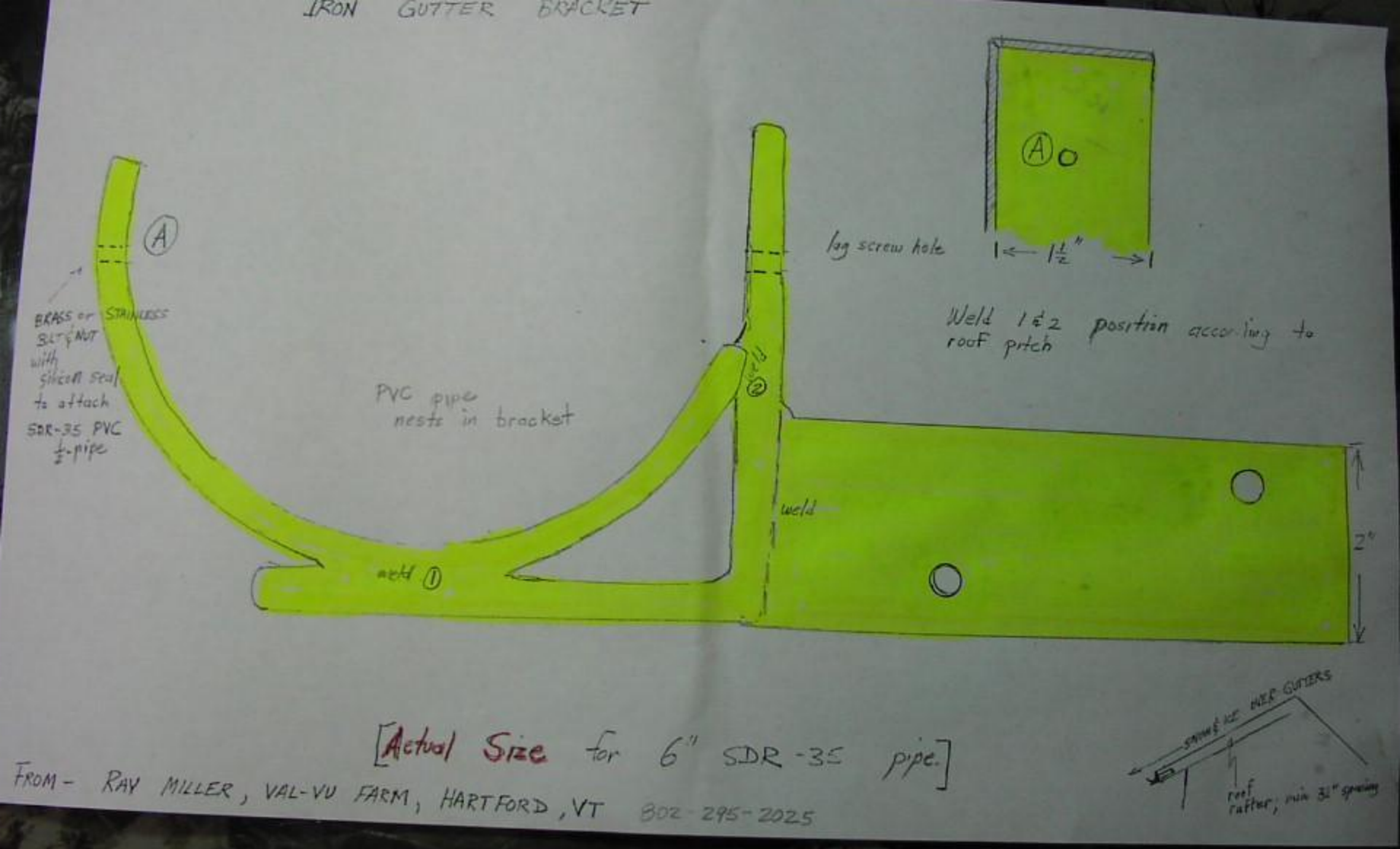
ME Snow Resistant Gutter



PVC Gutters

- Some producers will choose to make gutters from PVC
- UV Resistance is key!
- PVC Brackets can also be fabricated


T used for downspout
90 degree turn to more roof

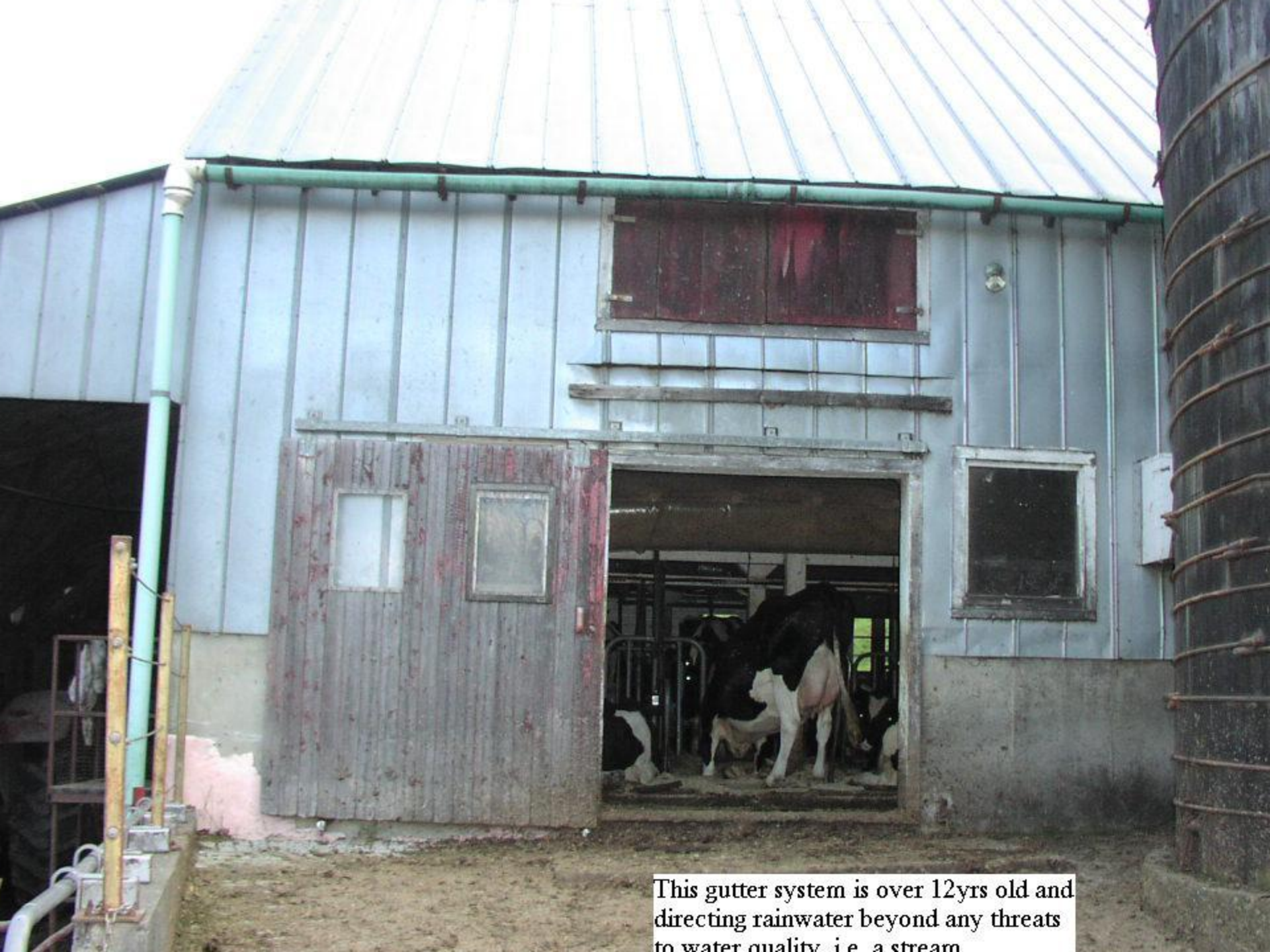


This is design sheet for the iron gutter hangers used in Windsor county.


With 6" downspoutsa trash
guard is secured over the
outlet. Silage blown into silo
will wash off this roof into
gutter.


4" lag screw in end of tail rafter is one of three achor points
SRD-35 cut on table saw nests in the hanger


Gutter set lowon tail rafter to get
pitch to drain properly



This gutter system is over 12yrs old and directing rainwater beyond any threats to water quality, i.e. a stream

Some gutter manufacturers provide gutter sizing

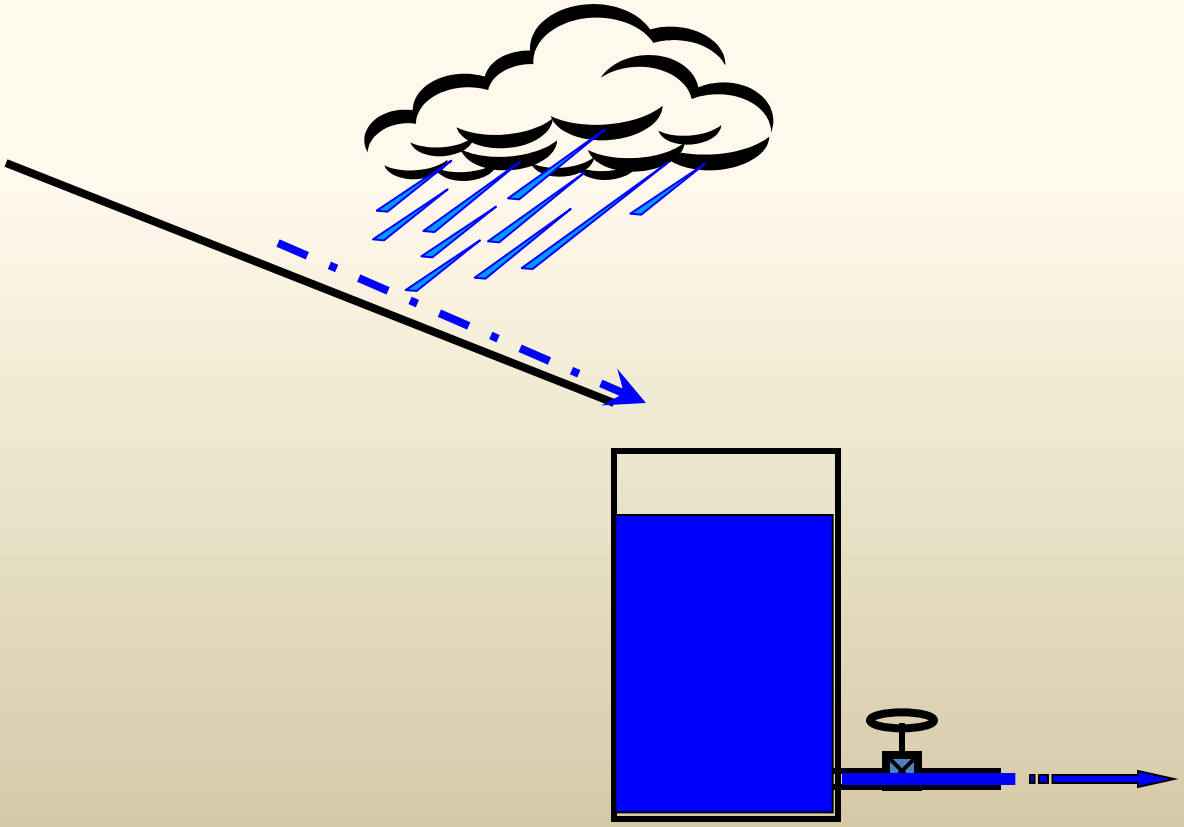
Rain Harvesting

- Rainwater is very clean
- Roofs and Gutters are NOT
- Roof Runoff can contain Fecal Coliforms
- Diverting the First Flush of rainwater from the first few millimeters of rainfall will avoid most of the contaminates.

Cisterns and Rain Harvesters

All need:

1. **Something to catch the rain**
2. **Something to store the water**
3. **Something to let the water out when needed**



Something to catch the rain

Filtration may be needed!

Can also use a first flush diverter to keep the dirt that is washed off the roof from getting into the water storage

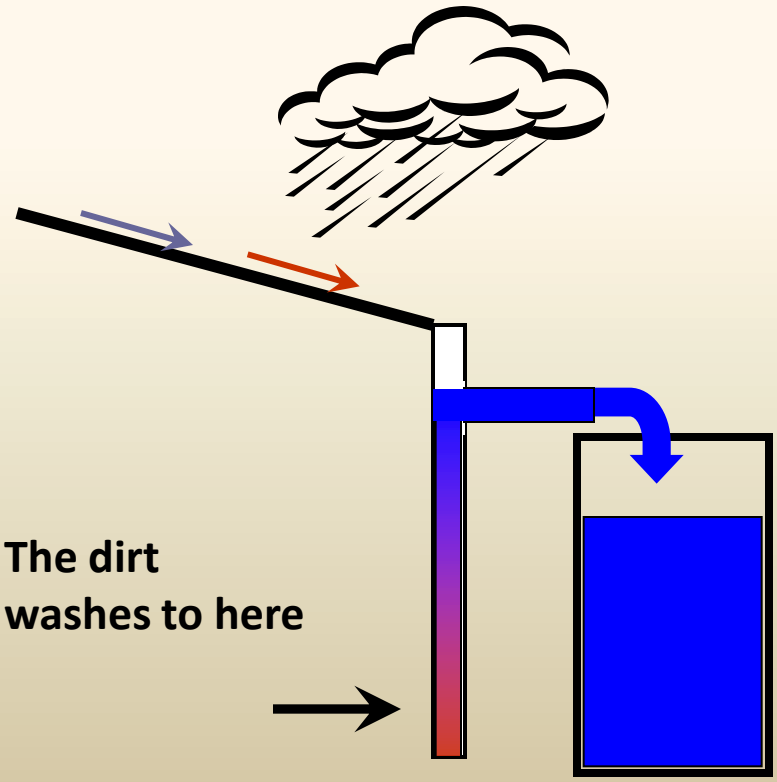
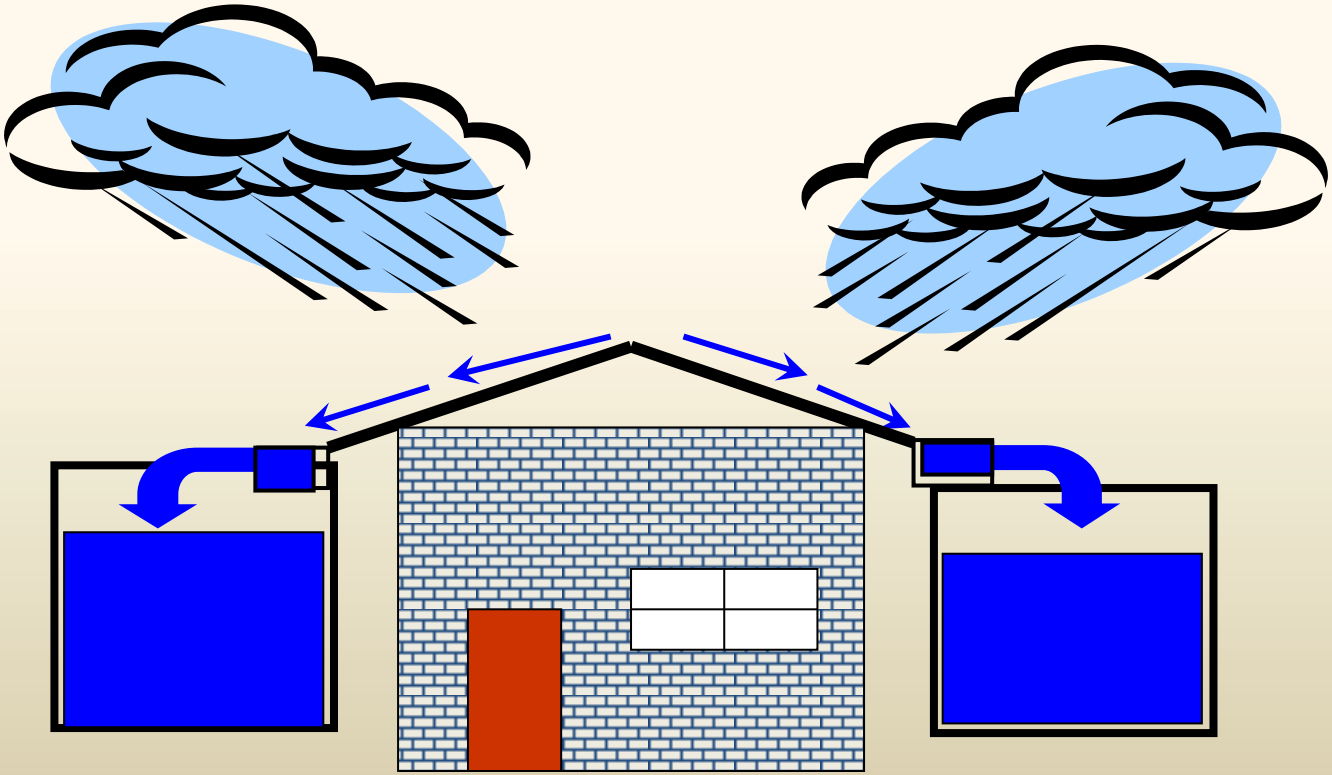


Photo from Texas Water Development Board

How much water can you get?

- When it is hot, one millimeter of rain falling on 1 square meter of roof will result in about 0.8 liters of water.
- When it is cooler, you may get 1 liter for 1 square meter of roof.




Filtration

Rain Gardens – See Handout

Gutter O&M

- Remove leaf and twig litter
- Inspect and repair loose components
- Inspect Gutter Drain rock inlet and remove any vegetation or debris that will block or divert flow
- Inspect outlet pipe and animal guards to ensure that the outlets are flowing freely.

Site Visit Inventory

- Lengths and Widths of Roofs
- Look at the building eaves. Can gutters be attached easily?
- Will new fascia board be required? How wide is the fascia board?
- Consider possible downspout locations
- If needed, can a tile outlet be installed easily? (No concrete to break.)

Site Visit Inventory

- What do downspouts outlet into?
- Will ice damage be a factor for gutter lifespan?
- Are long slopes present?
- Can /should a rock trench be used?
- Will livestock have access to site?

Handouts

- Gutter Design Spreadsheets from OH, IN, WI, FL
- Handouts from WI, MD, VT, IA, ENTSC
- Thanks for pictures/slides
  - Jon Fripp, AL, WI, PA, VT, ME
- Many other sent in helpful information
- For even more information see:
  - http://extension.missouri.edu/p/WQ322

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