Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide.

NOTE: Text in bold indicates Montana Supplemental information.

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD
VEGETATED TREATMENT AREA
CODE 635
(Ac.)

DEFINITION
An area of permanent vegetation used for agricultural wastewater treatment.

PURPOSE
Improve water quality by using vegetation to reduce the loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies where:

- A VTA is a component of a Comprehensive Nutrient Management Plan (CNMP).
- A vegetated treatment area (VTA) can treat contaminated runoff from areas such as feedlots, feed storage, compost areas, solid manure storage areas, barnyards, and other livestock holding areas in order to prevent pollutant discharge to state waters, property boundaries, and public right-of-ways.
- A VTA can treat runoff from an open silage storage areas. However, the initial 4-week compression of silage leachate must be contained or transferred to a Waste Storage Facility (Code 313).

Do not use a VTA to provide treatment for daily wastewater discharge from milk house or egg-packing facilities.

Runoff from sealed silage bags or dry feed storage (i.e., hay bales, shelled corn, earlage) does not require treatment.

CRITERIA
Size the treatment area to infiltrate watershed runoff and achieve a nutrient balance with planned vegetation.

- Water holding capacity is the soil’s capacity to infiltrate and retain runoff within the root zone without deep percolation. Base the runoff determination on the most restrictive soil layer within the root zone regardless of its thickness. Use the soil’s water holding capacity in the root zone and infiltration rate to determine its ability to absorb and retain runoff.
• Nutrient balance utilizes the nutrients from the waste runoff to meet the nutrient requirements of the vegetation. Base the nutrient balance on the most limiting nutrient (i.e., nitrogen or phosphorus).

Divert uncontaminated (clean) runoff to minimize the treatment area and the risk of VTA runoff.

Provide positive grade through the feedlot to the VTA in order to reduce the potential for ground water contamination and improve manure management. Criteria for feedlot drainage are found in Practice Standard Precision Land Forming (Code 462).

Establish permanent vegetation in the treatment area. Use a single species or a mixture of grasses, legumes, and other forbs adapted to the soil and climate. Select species to meet the current site conditions and intended use. Selected species will have the capacity to achieve adequate density, vigor, and yield within an appropriate time frame to treat contaminated runoff. Montana Plant Materials Technical Note 46 contains seeding rate specifications and recommended cultivars for Montana. Complete site preparation and seeding at a time and in a manner that best ensures survival and growth of the selected species.

Select vegetation that will withstand anticipated wetting or submerged conditions. Harvest vegetation as appropriate to encourage dense growth, maintain an upright growth habit, and remove nutrients and other contaminants that are contained in the plant tissue.

Exclude all livestock, including grazing, from the VTA. Exclude vehicle access unless necessary for VTA maintenance.

Apply discharge into and through vegetated treatment area as sheet flow. To encourage sheet flow across the treatment area, provide a means to disperse concentrated flow, such as a ditch, curb, gated pipe, level spreader, or a sprinkler system. Ensure that appropriate erosion control measures and sheet flow control measures (i.e., gravel spreaders) are adequately addressed over the entire length of the VTA. Complete land grading and install structural components necessary to maintain sheet flow throughout the treatment area.

Limit the natural or constructed slope of the VTA from 0.3 to 6 percent. The minimum slope at the upper end of a VTA is 1 percent to minimize saturation problems and prevent backwater against control measures that introduce uniform flow.

Use NRCS Conservation Practice Standard (CPS) Code 632, Waste Separation Facility, (i.e., settling basin) to prevent excessive accumulation of solids in the treatment area.

For Level II and III VTA’s, utilize inlet structures to control the rate and timing of inflow to the VTA during normal operations and to control inflow as necessary for operation and maintenance.

Unless soil moisture can be maintained to prevent drying and cracking, do not plan infiltration areas where soil features such as cracking will result in preferential flow paths that transport untreated runoff from the surface to below the root zone.

Ensure that appropriate erosion control measures and sheet flow control measures (i.e., gravel spreaders) are adequately addressed over the entire length of the VTA.

Install VTAs where the water table is below the vegetative root depth used for treatment.

**Sizing the VTA**

Design the VTA to infiltrate and treat the runoff volume from the 25-year, 24-hour storm event. Ensure a nutrient balance also is achieved for the 2-year, 24-hour storm event. Include all depressional areas within the feedlot when determining the contributing runoff area.
Drain feedlot depressions, with a contributing drainage area exceeding 5 acres and a potential ponding depth exceeding 1 foot. When surface grade is not sufficient to provide drainage, collect and drain depressional areas with surface intake structures and buried pipe (Code 620 Underground Outlet).

**Additional Criteria for VTAs within and around Floodplains**

Locate the VTA out of the 100-year floodplain whenever possible. At minimum, locate Level I VTA above the 2-year floodplain or 1-foot above bankfull elevation. At minimum, locate the Level II or Level III VTA out of the 25-year floodplain.

Floodplains can be approximated using FEMA Maps (100-year), or USGS Montana StreamStats Equations and measured cross section data, or modeled using ACOE HECRAS.

**Additional Criteria for LEVEL I VTAs**

Level I VTAs treat a substantial portion of the feedlot runoff by providing uniform runoff distribution, soil infiltration, and nutrient uptake. Level I VTAs are limited to the treatment of runoff from small AFOs as defined in Title 40, Part 122, Code of Federal Regulations. Criteria for Level I are:

1. Maximum allowable ratio of feedlot area to VTA area is 6:1. Clean water contributing area needs to be included with the feedlot area in this ratio as it adds to the volume of effluent that requires treatment.
2. Limit the volume of clean water contributing to the VTA to 5% of the feedlot area. Contributions of clean water runoff which exceed 5% of the total feedlot area are allowed when MontFARM can demonstrate an Index Score less than or equal to 19.
3. Minimum length of VTA is 35 feet.
4. Maximum allowable feedlot slope is 10 percent. Feedlot slope for this criteria is evaluated as the maximum slope which occurs over 25% or more of the total feedlot area.
5. Provide sediment control, as needed, to effectively contain manure solids or sediments on the feedlot. Base the need for sediment control on evidence observed in the field.
6. Ensure uniform runoff distribution across the VTA. When needed, use one or more of the following methods:
   a. Level the VTA.
   b. Partition the feedlot to discharge at different points on the VTA.
   c. Utilize a level spreader to baffle and distribute the discharge.
7. Design spreader berm and spreader ditch such that runoff from a 2-year storm event will access the VTA.
8. Apply Level II criteria to VTAs where the operation is defined as a small AFO but Level I criteria cannot be met.

**Additional Criteria for LEVEL II VTAs**

Level II Treatment provides assurance against discharge of a 25-year, 24-hour precipitation or snowmelt event to a prohibited location. Criteria for Level II are as follows:

1. Include all depressional areas within the feedlot when determining contributing runoff area. Determine the Runoff Curve Number according to NEH, Part 651, Agricultural Waste Management Field
Handbook, Amendment MT37, “Runoff Curve Number Determination for Feedlots in Montana.” The maximum manure depth under a cleaned condition shall be 2 inches or less. The minimum runoff curve number shall be 90 for concrete lots.

2. Design the VTA to demonstrate complete infiltration without discharge from the end or deep percolation below the rooting depth.

3. Apply feedlot runoff with an orifice, weir, pipe, or other means that results in a controlled and measureable discharge. Apply at a rate determined by the soil infiltration model.

4. Incorporate a storm water detention basin, when necessary, to dampen peak flows to the VTA. A liner for the detention basin is not required under the following conditions:
   - Runoff is ponded less than 48 hours, and
   - The soil (cylinder) intake family is less than or equal to 0.5 (Reference: Montana Irrigation Guide, Appendix A), or
   - Vegetation in at least fair condition exists within the basin, and
   - The volume of seepage does not exceed the available water holding capacity.

5. Treat feedlot runoff with a settling basin unless sediment can be effectively contained on the lot. Criteria for settling basins are found in Solid/Liquid Separation Facility (Code 632). A settling basin is not required under the following conditions:
   - The average feedlot slope is less than 3%.
   - Sub-grade materials are fine-grained soils.
   - Velocities along the longest hydraulic path are less than 1.5 feet per second during a 25-year frequency, 24-hour storm.

6. Ensure the ratio of Feedlot to VTA areas meets criteria defined in Table M-1. Feedlot area includes the contributing clean water area as this runoff picks up nutrients as it flows through the lot. Table M-1 is based on nutrient balance analyses using typical values for nutrient concentrations in lot runoff and nutrient uptake for grass/alfalfa mix.

7. Documentation must show that the winter runoff volume from a 25-year frequency snowpack will not reach a prohibited location. Utilize the following:
   - Use NOAA website to determine the 25-year frequency snowpack.
   - Limit natural or constructed storage depth of winter runoff in the VTA to 1 foot.
   - Assume the snow water equivalent is 0.1 inch per inch of snowpack.
   - Ensure potential winter discharge from the end of the VTA will be distributed amongst surface abstractions in pasture or cropland and not delivered to State waters.
   - The dike practice may be used to prevent a winter discharge off the end of the VTA.

8. Specify the VTA shall be level within the construction tolerance of 0.1 feet across the bottom width.

9. Maximum bottom width of a VTA shall be 70 feet. Multiple cells can be provided to meet this criteria. Design dikes between cells to have 3:1 side slopes and a minimum height of 1 foot.

Additional Criteria for LEVEL III VTAs

Level III Treatment combines a Level II VTA with a Waste Storage Facility to provide a higher level of assurance against discharge. A Level III VTA also creates a convenient land treatment area for stored runoff. Apply the following criteria with Level III VTAs.

1. Incorporate a waste storage pond or tank at the beginning or end of the VTA. The criteria for a Waste Storage Facility (Code 313) shall apply with the exception that normal runoff storage requirements can be eliminated to reflect the flexibility of frequent releases, under sunny day conditions, onto the VTA.
2. Meet criteria identified for Level II VTAs with the exception of requiring winter runoff analysis from a 25-year snowpack.

**Modeling Infiltration**

A soil infiltration model is required for Level II and III VTAs.

1. Use the SRFR program for infiltration modeling.

2. Rooting depth used in the infiltration model shall correlate to the grass/legume species reasonably expected to grow on the VTA (Reference: NEH, Part 652, National Irrigation Guide, Table 3-4). Do not account for water holding capacity below the depth of the seasonal high water table, clay pan, or bedrock.

3. Compute the target infiltration depth as:
   \[ I = (0.75 \times \text{water holding capacity}) - P_{25} + RO_{25} \]

4. Set the Manning’s "n" value to 0.25 when modeling flow across the VTA.

5. If runoff storage is provided upstream of the VTA, compute the average orifice discharge rate onto the VTA using the following equation:
   \[ Q = 0.6A\sqrt{2g(0.7H)} \]
   Where: \( Q \) = discharge (cfs), \( A \) = orifice area (sf), and \( H \) = storage depth above centerline of orifice (ft)

**Additional Criteria for Pumping Discharge to a Remote VTA**

Distribute effluent over the VTA through sprinkler irrigation or other pressure application/dosing system. Match the application rate of sprinkler nozzles to the most restrictive soil infiltration rate or other factors to prevent effluent from discharging from the VTA.

Design the pump station to discharge flows at a rate determined by the infiltration model. Meet the following criteria:

1. Do not allow feedlot runoff to enter the sump directly if a flooded condition will impede safe repair or maintenance of the pump.

2. Ensure the sump is accessible if the pump fails. Extend the top of sump at least 1 foot above the higher elevation of ground or the 25-year floodplain elevation.

3. Sump capacity below the frost line shall include; 1 foot of priming head, backwash volume from the discharge line, and temporary storage volume to maintain 0-15 pump cycles per hour as the runoff hydrograph diminishes.

4. If possible, grade feedlot runoff to an intake structure and deliver flow to the sump via a pipe or other controlled conveyance in order to maintain sump access during runoff events. Utilize at least ½-inch but not greater than 1-inch wide perforations on the intake riser. Assume that 50% of the intake holes will be plugged.

5. Specify the sump to be made of water tight, reinforced concrete. Include a concrete base and secure cover.

6. Design the sump and footing for a safety factor of 1.5 against floatation from the seasonal high water table.

7. Specify that the sump shall be equipped with:
   a. Corrosion-resistant guide rails or tether to remove the pump without human entry.
   b. Confined space warning sign.
   c. Breaker box and high-stage warning light mounted on a post nearby.
   d. 2 mercury float switches for on-off and high-stage warning.
8. Size the sump to prevent excessive pump cycling. The relationship between inflow rate, pumping rate, sump storage, and cycle time is expressed in Equation 1. The number of pump cycles increase as runoff inflow into the sump slowly diminishes, (NEH-16, Drainage, Chapter 7).

\[
\frac{60}{N} = \frac{7.5S}{Q_i} + \frac{7.5S}{Q_o - Q_i}
\]

- \(Q_i\) = Sump inflow rate (gpm); varies
- \(Q_o\) = Pumping rate (gpm); a constant
- \(S\) = Sump storage (ft³); volume stored between pump on and off elevations
- \(N\) = Number of cycles per hour; A “cycle” equals the run time plus the refill time. Maximum \(N=15\)

CONSIDERATIONS

Additional nutrient and infiltration design guidance can be found in Vegetated Treatment Systems for Open Lot Runoff, (Koelsch, et. al., 2006).

Utilize an irrigation system to support a vegetative mix that produces deeper roots and higher yields.

To minimize pump size in a pumped delivery situation, consider ponding the 25-year frequency, 24-hour storm runoff within the lot area in order to attenuate the peak flow into the sump. In this case, ensure the ponded area is completely dewatered within 48 hours.

Provide more than one vegetated treatment area to allow for resting, harvesting vegetation, and maintenance, and to minimize the potential for overloading.

Provide additional storage in the basin collection area to minimize or eliminate discharge into the VTA during rainfall events. Delay application until rainfall has ended to improve infiltration and nutrient uptake.

To maximize nutrient uptake, use warm and cool season species in separate areas to ensure that plants are actively growing during different times of the year.

Supplement water as necessary to maintain plants in a condition suitable for the treatment purpose.

Direct contaminated effluent to a waste storage facility during excessively wet or cold climatic conditions.

Consider suspension of application to treatment area when weather conditions are not favorable for aerobic activity or when soil temperatures are lower than 39° F. When soil temperatures are between 39° F and 50° F, consider reducing application rate and increasing application period while maintaining a constant hydraulic loading rate.

Manage the VTA to maintain vegetative treatment effectiveness throughout the growing season. Time the harvest of the VTA plants so vegetation can regrow to a sufficient height to effectively filter effluent late in the growing season.

Install a berm around the lower end of the VTA to contain excess runoff that may occur.

Effluent from the VTA may be stored for land application, recycled through the wastewater management system, or otherwise used in the agricultural operation.

Install fences or other measures to exclude or minimize access of the VTA to humans or animals.

Install a pumping system at the bottom of the VTA to either recirculate the effluent to the top of the VTA or transfer to a waste storage facility. Consider pumping runoff to a remote VTA for Level II or III treatment when site restrictions prevent the use of gravity flow.
PLANS AND SPECIFICATIONS
Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use.

As a minimum include:

- Plan view showing the location of the VTA.
- Critical construction perimeters and details of the length, width, and slope to accomplish the planned purpose (length refers to flow length down the slope of the treatment area).
- Necessary construction sequence.
- Level spreader requirements and/or other associated practices for delivering flow to the VTA.
- Site preparation sufficient to establish and grow selected species.
- Herbaceous species, seed selection, and seeding rates to accomplish the planned purpose.
- Planting dates, care, and handling of the seed to ensure that planted materials have an acceptable rate of survival.
- Agronomic nutrient removal.

OPERATION AND MAINTENANCE
Develop an operation and maintenance plan consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

Include the following items as appropriate:

- Control undesired weed species, especially state-listed noxious weeds, and other pests that could inhibit proper functioning of the VTA.
- Inspect and repair treatment areas after storm events to address gullies, reseed disturbed areas, and prevent concentrated flow of development of preferential flow paths in the VTA.
- Apply supplemental nutrients and soil amendments as needed to maintain the desired species composition and stand density of herbaceous vegetation.
- Maintain or restore the treatment area as necessary by periodically grading or removing excess material when deposition jeopardizes its function. Reestablish herbaceous vegetation.
- Routinely dethatch or aerate treatment areas used for treating runoff from livestock holding areas in order to promote infiltration.
- **Clip or harvest annually to maintain optimum height, growth, and nutrient uptake conditions.**
- Conduct maintenance activities only when the surface layer of the VTA is dry enough to prohibit compaction.

Monitor treatment areas in arid or semiarid regions that potentially could be affected by excessive salt and sodium buildup. **When a problem, take corrective action such as utilizing a salt-tolerant seed mix.**

Monitor all treatment areas to maintain optimal crop growth and environmental protection. Ensure that neither phosphorus is accumulating in the soil profile, nor nitrogen is leaching below the root zone.

REFERENCES


USDA/NRCS National Engineering Handbook, Section 16, Drainage of Agricultural Land, Chapter 7, Drainage Pumping.
TABLE M-1. VTA – NUTRIENT BALANCE TABLE

Maximum ratio of Feedlot Area to VTA

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<tr>
<th>ANNUAL PRECIPITATION</th>
<th>&lt; 12&quot;</th>
<th>11&quot;-14&quot;</th>
<th>13&quot;-17&quot;</th>
<th>16&quot;-19&quot;</th>
<th>≥ 18&quot;</th>
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<tbody>
<tr>
<td>Inches of Lot Runoff</td>
<td>lb. N/ac lot applied to VTA</td>
<td>Yield 1 ton/ac</td>
<td>Yield 2 ton/ac</td>
<td>Yield 3 ton/ac</td>
<td>Yield 4 ton/ac</td>
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<td>55</td>
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<td>96</td>
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<td>38</td>
<td>48</td>
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<td>2</td>
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<td>4</td>
</tr>
</tbody>
</table>

** The ratio of Feedlot Area to VTA shall be determined for both the 2-year and 25-year runoff events using infiltration areas from the SRFR Model. Determine the infiltration area of a 2-year event by modeling the runoff through the VTA dimensions designed for a 25-year event. Neither ratio can exceed the values in Table 1.

** The feedlot area includes the contribution area of clean water which becomes contaminated as it passes through the feedlot.