



NATURAL RESOURCES CONSERVATION SERVICE
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 vegetated treatment area (VTA) can be constructed, operated and maintained to treat contaminated runoff from such areas as feedlots, feed storage, compost areas, solid manure storage areas, barnyards, and other livestock holding areas; or to treat process wastewater from agricultural operations.
- A VTA is a component of a planned agricultural waste management system.
- To provide levels 2 thru 4 control of contaminated runoff from such areas as feedlots, barnyards, and other livestock holding areas
- Where the treatment system is a component of a planned agricultural waste management system
- Where the treatment system can be constructed, operated and maintained without polluting air or water resources

This practice does not apply to:

- Treatment of leachate and collected first flush volume from silo, feed storage areas, or silage bags.

The control of wastewater and feedlot runoff is bracketed into four levels of control with Level 1 being full runoff control. The primary Minnesota NRCS conservation practice standards addressing the control of wastewater and feedlot runoff and their respective levels of control are:

- Waste Storage Facility (313),
Level 1
- Waste Facility Cover (367),
Level 1, Feedlot Roof Structure
- Vegetated Treatment Area (635),
Levels 2 – 4

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](#).

Wastewater and feedlot runoff from Concentrated Animal Feeding Operations (CAFO's) must be controlled using LEVEL 1 methods, unless all necessary permits have been obtained from the Minnesota Pollution Control Agency (MPCA).

Conditions where each level of treatment covered in this standard applies are as follows:

LEVEL 2—Vegetated Infiltration Area

Runoff is pretreated in a settling basin. Liquids are discharged onto a confined vegetated area to be infiltrated into the soil root zone and utilized by vegetation. This is considered to be zero surface water discharge.

Acceptable uses:

1. Runoff from all feedlots designated as Animal Feeding Operations (AFO's) by MPCA where site conditions are appropriate and adequate land is available.
2. Where manure solids from the feedlot can be effectively trapped prior to discharge to the treatment area.

LEVEL 3—Controlled Discharge Vegetated Treatment Area (sunny day release).

Runoff is stored in an impoundment for solids separation and during periods of dormant vegetation or filter strip saturation. Liquids are discharged onto a graded vegetated treatment area with active growth in such a way as to eliminate or minimize discharge from the strip.

Acceptable uses:

1. Runoff from AFO's where a relatively high level of treatment is required to protect surface waters.
2. Where soil conditions are appropriate and adequate land area is available.
3. Where manure solids from the feedlot can be effectively trapped prior to discharge to the treatment area.

LEVEL 4—Vegetated Treatment Area

Runoff is pretreated in a settling basin. Liquids are discharged onto a graded vegetated treatment area.

Acceptable uses:

1. For runoff from AFO feedlots with less than 300 animal units on the feedlot.
2. Runoff from AFO's where receiving waters can accept occasional discharges of pollutants estimated to be within MPCA effluent limits.
3. Where manure solids from the feedlot can be effectively trapped prior to discharge to the treatment area
4. Where soil conditions are appropriate and adequate land area is available.

CRITERIA

The installation and operation of the vegetated treatment area shall comply with all federal, state, and local laws, rules, and regulations.

Size the total treatment area for the VTA on both the contributing site 25-year, 24-hour water runoff and vegetation nutrient balances.

- Water balance is the soil's capacity to infiltrate and retain runoff within the root zone. 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, infiltration rate, permeability, and hydraulic conductivity to determine its ability to absorb and retain runoff.
- Nutrient balance utilizes the nutrients from the waste runoff to meet the nutrient removal requirements in the harvested vegetation. Base the nutrient balance on the most limiting nutrient (i.e. nitrogen or phosphorus).

Divert uncontaminated water from the treatment area to the fullest extent possible unless additional moisture is needed to manage vegetation growth in the treatment area.

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. 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.

Design the VTA based on the need to treat the runoff volume from the 25-year, 24-hour storm event from the agricultural animal management facility. Infiltrate a portion or the entire volume of the design storm, based on management objectives. Unless discharge is permitted by applicable regulations, store the noninfiltrated portion of the design volume for utilization or treatment.

Exclude all livestock, including grazing, from the VTA.

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. 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 the VTA is 1 percent to minimize saturation problems near the entrance.

Use NRCS Conservation Practice Standard (CPS) Code 632, Waste Separation Facility, to pretreat influent with waste separation (i.e., settling basin) to reduce organic loading and nutrients to levels that are tolerated by the VTA and to prevent excessive accumulation of solids in the treatment area. Settling basins and impoundments used in conjunction with VTAs shall meet the requirements of practice standard 313, Waste Storage Facility (except the storage period criteria) unless:

1. Manure-contaminated runoff is purged from the settling basin within 24 hours, and
2. The floor is constructed of:
 - a. Concrete; or
 - b. One foot of cohesive soils and separated from bedrock by at least two feet of soils that are not coarser than a sandy loam.

Utilize inlet control structures to control the rate and timing of inflow during normal operations and to control inflow as necessary for operation and maintenance.

Locate VTAs outside of floodplains. However, if site restrictions require location within a floodplain, provide protection from inundation or damage from a 25-year flood event, or larger, if required by regulation.

Install VTAs where the water table is either naturally deep or artificially lowered so that the infiltrated runoff does not mingle with the groundwater at the bottom of the root zone. Subsurface drainage within the VTA is not allowed. Subsurface drainage may be used to lower the seasonal high water table to an acceptable level provided the subsurface drain lines are at least 10 feet away from the VTA boundary.

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.

Additional Criteria for Pressure Dosing Systems

Distribute the effluent over the VTA through sprinkler irrigation or other pressure 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.

Specific Criteria per Level of Treatment

LEVEL 2—Vegetated Infiltration Area

Siting Parameters. This process shall be limited to well-drained loamy soil with a published permeability between 0.2 inches per hour and 6 inches per hour to a depth of 5 feet and with a growing season typical water table greater than 5 feet deep. Subsurface drains that discharge to a receiving water may not be used to lower the water table.

Settling Basin. Contaminated runoff shall be pretreated by solid/liquid separation off the feedlot. Criteria shall match that for Level 4. In ground water sensitive areas, runoff during dormant vegetation periods must be stored until active vegetation growth resumes.

Distribution System. Effluent shall be discharged onto the infiltration area in such a way as to promote spreading the effluent over the entire area.

Infiltration Area. The minimum size of the infiltration area shall be 100% of the contributing feedlot size.

The infiltration area shall be level and on native undisturbed soils to the extent possible. Care must be taken during construction to prevent soil compaction from construction machinery. Fill soil shall be lightly compacted and consist of topsoil of the same texture as the in-place soil. The maximum topsoil fill shall be limited to 2 feet. The treatment area shall be contained such that there is no surface discharge.

LEVEL 3—Controlled Discharge Vegetated Treatment Area (sunny day release)

Impoundment. Feedlot runoff shall be stored in an impoundment during vegetation dormant periods or filter strip saturation periods. For sites where impoundment overflow can be routed onto the treatment strip the impoundment shall be sized to hold runoff from November 1 through May 30, or the 25-year, 24-hour runoff, whichever is greater. For sites where the impoundment overflow is not routed onto the treatment strip the impoundment shall be sized to hold the sum of the runoff from November 1 through May 30 plus the 25-year, 24-hour runoff. The impoundment shall be located off the feedlot. Means shall be provided to allow the operator to control outflow from the impoundment in a practical manner to facilitate the timely operation of the treatment strip.

Treatment Area Siting Parameters. The treatment area shall be situated or constructed in a 2-foot minimum depth of soil with at least 20% passing the Number 200 sieve.

Treatment Area. The treatment area dimensions shall be sufficient to provide a 30 minute flow through time for the maximum discharge from the impoundment at a depth of 1.0 inch using Manning's Equation with Manning's $n = 0.24$.

Minimum treatment area shall be 60% of the contributing drainage area size.

The treatment area shall be graded level across its width to promote sheet flow.

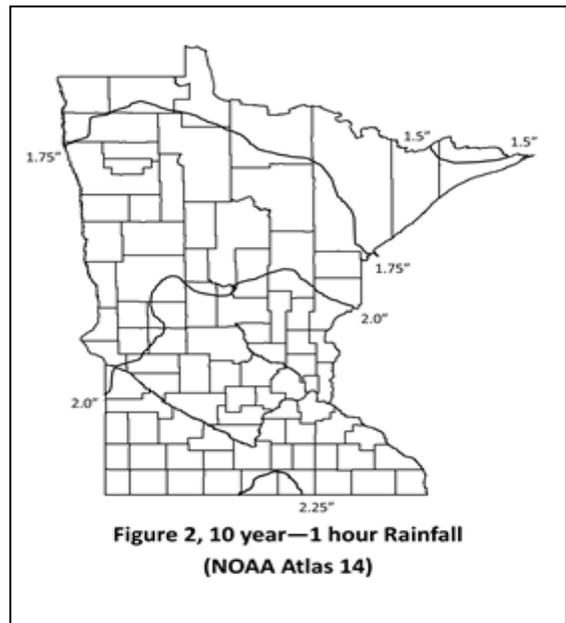
Discharge onto a treatment area shall be evenly distributed at the head of the strip by using a level spreader, weir, gated pipe or other device. Additional devices should be considered to promote sheet flow as needed down the length of the treatment area.

Derivations of Manning's Eq. for computing dimensions of vegetated treatment areas:

$$\text{Min Width (ft)} = \frac{Q * n}{0.02363 * S^{1/2}}$$

$$\text{Min Length (ft)} = \frac{510 * S^{1/2}}{n}$$

Where: Q = discharge, cfs
S = slope, ft/ft
n = 0.24 for vegetated treatment strips
Depth of flow = 1.0"
Flow Through Time for Length Computation = 30 minutes



LEVEL 4—Vegetated Treatment Strip

Settling Basin. Contaminated runoff shall be pretreated by solid/liquid separation. The settling basin shall be sized to route onto the treatment strip the runoff from the feedlot and contributing area during the design 25 year, 24-hour rainfall event. The minimum volume shall equal the runoff volume from its drainage area during a 10 year, 1-hour rainfall event. The surface area of the settling basin shall be equal to at least 5 percent of the drainage area. It is suggested to limit the settling basin design storage depth to not more than 3 feet.

If the settling basin will not be emptied after each runoff event additional volume is required. Additional volume shall be equivalent to at least 0.5 inch over the feedlot area for an earthen lot and 1.0 inch over the area of a paved lot.

Treatment Area Siting Parameters. The treatment area shall be situated or constructed in a 2-foot minimum depth of soil with at least 20% passing the Number 200 sieve.

Treatment Area. This criteria is the same as for Level 3.

CONSIDERATIONS

Design guidance can be found in *Vegetated Treatment Systems for Open Lot Runoff*, (Koelsch, et. al., 2006).

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.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use.

As a minimum include:

- Critical construction perimeters, necessary construction sequence, vegetation establishment requirements, level spreader mechanism requirements, associated practices and agronomic nutrient removal
- Plan view showing the location of the VTA
- Details of the length, width, and slope of the treatment area to accomplish the planned purpose (length refers to flow length down the slope of the treatment area)
- 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
- Site preparation sufficient to establish and grow selected species

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
- 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 a treatment area used for treating runoff from livestock holding areas in order to promote infiltration
- 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 high salinity or sodium content for excessive salt and sodium buildup. Take corrective action if excessive salt or sodium is found.

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, Part 651, Agricultural Waste Management Field Handbook.

Koelsch, R., B. Kintzer, and D. Meyer. (ed.) 2006. Vegetated Treatment Systems for Open Lot Runoff - A Collaborative Report. USDA, NRCS.