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

This practice is used to accomplish one or more of the following purposes–

- 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 improve surface or groundwater including downstream drinking water sources.
- *Paved feedlots and feed storage areas do not exceed 0.66 acre.*
- *Earthen feedlots do not exceed 1.0 acre.*

This practice does not apply on Concentrated Animal Feeding Operations (CAFO).

CRITERIA

General Criteria Applicable to All Purposes

VTAs shall comply with all federal, state, and local laws, rules, or regulations. The operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state, or local laws.

Size the total treatment area for the VTA *based* on both the contributing site 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. *Minimize deep percolation*.
- Nutrient balance utilizes the nutrients from the waste runoff to meet the nutrient requirements of the harvested vegetation. Base the nutrient balance on the most limiting nutrient (i.e., nitrogen or

phosphorus).

Nutrient balances for nitrogen and phosphorus are unlikely to be achieved. Evaluate the potential nutrient loading and vegetation uptake using NRCS Agricultural Waste Management Field Handbook (NEH) Part 651, Chapters 4 and 11, or the 2006 NRCS collaborative report on vegetated treatment systems (Koelsch, et al).

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. *Routinely remove manure, uncovered feed, or other nutrient sources from feedlot or feed storage area to reduce nutrient and pathogen loads entering the VTA in accordance with the operation and maintenance plan. Land apply removed materials per nutrient management plan.*

Establish *and maintain* 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 *as specified in NRCS CPS 342 – Critical Area Planting*. 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. *Do not apply contaminated runoff until vegetation is well established.*

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 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.

For runoff applications, design the VTA for full infiltration of a 1-year frequency, 24-hour duration runoff event with no discharge from the end and no more than 10 percent deep percolation. Use a Runoff Curve Number (CN) = 98 for the paved condition and CN = 90 for the earthen condition (Reference: National Engineering Handbook, Part 630, Chapter 10). Subtract the 1-year frequency, 24-hour duration precipitation depth from the available water holding capacity of the VTA prior to modeling the infiltration.

Use an earthen berm with a height of 12 inches (end block) on the downstream end of the VTA to increase infiltration time and inhibit formation of ephemeral gullies which can circumvent uniform flow.

Exclude all livestock, including grazing, from the VTA.

Apply discharge into and through vegetated treatment area as sheet flow. *Do not apply contaminated runoff to the VTA using a concentrated point of discharge, such as a pipe outlet.* To encourage sheet flow across the treatment area, provide a means to disperse concentrated flow, such as a ditch, curb, gated pipe, level spreader, *corrosion resistant V-notch weir/baffle assembly,* or a sprinkler system. Complete land grading and install structural components necessary to maintain sheet flow throughout the treatment area.

Space level spreaders evenly over the VTA length with a maximum separation of 100 feet between them and to the upstream/downstream ends of the VTA. At least one level spreader is required. If a gravel spreader is utilized, select a crushed stone gradation that will reliably accomplish the goal of increasing flow distribution without routine plugging.

Use a VTA flow width between 20 feet and 40 feet. Use a VTA flow length between 100 feet and 400 feet. Multiple VTAs may be installed in parallel to accommodate a larger overall contributory area.

Limit the natural or constructed slope of the VTA from *0.5 to 3 percent*. *If design slope is 1 percent or greater, use a uniform slope throughout the VTA. If design slope is less than 1 percent, use an entrance* *slope of 1 percent on the first 25 feet of VTA length to prevent backwater on the inlet control structure and increase distribution of small runoff events.*

Use earthen side berms with a minimum height of 12 inches to define the VTA perimeter and exclude uncontaminated runoff from adjacent areas.

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. *Design the settling basin for a 1-year, 24-hour storm event, ensure the basin is cleaned regulary in the Operation & Maintenance Plan in order to meet the expected 10-year life of the VTA. Design the settling basin concurrently with the VTA to ensure a feasible VTA application rate*.

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 naturally deep so that the infiltrated runoff does not *interface*with the groundwater at the bottom of the root zone. Subsurface drainage within the VTA is not allowed. *Do not use drainage tile to artificially lower the subsurface saturation elevation.*

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 Site Suitability

Perform a soils investigation within the planned VTA footprint at the upstream end, at the downstream end, and every 100 feet along the flow length (minimum of two required). Log the soil profile to a minimum depth of 3 feet below the planned VTA surface using the USDA Soil Classification System.

Do not construct a VTA at the proposed location if the investigation confirms the presence of sand, loamy sand, or sandy loam within the soil profile.

Maintain the minimum setbacks from the VTA listed below:

- *3 feet to bedrock. Do not excavate bedrock and backfill with soil.*
- *3 feet to subsurface saturation as defined in NRCS CPS 313 – Waste Storage Facility.*
- *50 feet from the perimeter to drainage tile.*
- *10 feet from the sides to property lines and rights-of-way.*
- *100 feet from the downstream end to property lines and rights-of-way.*
- *50 feet from the perimeter to private wells.*
- *1,000 feet from the perimeter to public wells.*
- *300 feet from the perimeter to sinkholes and quarries.*
- *100 feet from the downstream end to wetlands and artificial ponds.*
- *300 feet from the downstream end to streams, classic gullies, and surface inlets.*
- *1,000 feet from the downstream end to lakes and flowages.*

Additional Criteria for Hydraulic Design

Use current version of WinSRFR program developed by the USDA-Agricultural Research Service for VTA design. It is available on the national NRCS website (Resources > Tech Tools).

Use the following software input conditions. English units can be set under "Edit" menu.

1. *Select basin/border system after opening a simulation (click "Simulation" button).*
2. *On the "Soil / Crop Properties" tab, enter a Manning's n-value of 0.3. Select the applicable NRCS Intake Family via the "Infiltration Equation" drop-down menu (Ref: National Engineering Handbook, Part 623, Chapter 4):*
   - *Silt Loam – NRCS Intake Family = 0.8*
   - *Clay Loam – NRCS Intake Family = 0.5*
   - *Sandy Clay – NRCS Intake Family = 0.3*
   - *Clay – NRCS Intake Family = 0.1*
3. *Enter a 12-inch basin depth as the "Maximum Depth, Y" on the "System Geometry" tab to establish an end block. Select the blocked downstream condition on the "Inflow / Runoff" tab.*
4. *Enter the design slope on the "System Geometry" tab. Design slope shall be the uniform slope downstream of the initial 25 feet of VTA length. Adjust slope as necessary to keep the "Verr" value in the simulation results within ±0.5%.*
5. *Select standard hydrograph method on "Inflow / Runoff" tab. Enter the design discharge rate from the Settling Basin as the constant inflow rate with no cutback. Design an inflow rate from the settling basin by dividing the 1-year, 24-hour runoff volume by a drawdown ("cutoff") time of 4 to 12 hours. As a starting point for optimizing infiltration, the following durations are recommended based on soil type.*
   - *SIlt Loam = 4 hours*
   - *Clay Loam or Sandy Clay = 7 hours*
   - *Clay = 12 hours*
6. *Select the available water holding capacity based on soil type (Ref: National Engineering Handbook, Part 652, Chapter 2). Required depth on the "Start Simulation" tab is defined as the net available water holding capacity within a rooting depth of 3 feet minus direct precipitation on the VTA from the design storm event.*
   - *Silt Loam – Available Water Holding Capacity = 2.4 inches per foot*
   - *Clay Loam – Available Water Holding Capacity = 2.4 inches per foot*
   - *Sandy Clay – Available Water Holding Capacity = 1.9 inches per foot*
   - *Clay – Available Water Capacity = 1.8 inches per foot*

   The example calculation assumes silt loam, rooting depth of 3 feet, and 1-year, 24-hour precipitation depth on the VTA of 2.5 inches.

   Example WinSRFR Required Depth (in) = (2.4 inches per foot x 3 ft) - 2.5 in = 4.7 in

7. *Limit deep percolation ("DP" on WinSRFR results summary) to 10 percent of calculated design volume. Applied depth in excess of the required depth is considered deep percolation.*
8. *Given the selection of an end block as the downstream condition on the "Inflow / Runoff" tab, the only solution model option on the "Execution" tab will be zero-inertia.*
9. *Run the simulation to calculate VTA performance. Perform trial adjustments to the geometry and flow parameters to optimize infiltration, prevent VTA discharge, and keep deep percolation to less than or equal to 10 percent.*

Additional Criteria for Feed Storage Area Runoff

Collect all leachate and the runoff volume from the initial 0.20 inches of each precipitation event in a reception structure designed in accordance with NRCS CPS 313 – Waste Storage Facility or NRCS CPS 634 – Waste Transfer. Land apply the collected liquid per nutrient management plan. Do not apply feed storage area leachate or initial runoff to the VTA.

CONSIDERATIONS

For the timeframe of January 1994 through July 2023 at eight weather stations across Wisconsin, 90 percent of the total rainfall volume occurred from rainfall events less than 1.95 inches based on data from the Wisconsin State Climatology Office. For comparison, the 1-year frequency, 24-hour duration precipitation depths range from 2.00 to 2.69 inches for Wisconsin counties with an average of 2.36 inches.

If the proposed VTA is within a watershed with documented surface water and/or groundwater impairments (nutrients, bacteria, etc.), consider providing more than one VTA to increase reliability and minimize the potential for overloading.

If active management will be pursued, consider providing multiple locations for influent distribution (e.g. secondary application point in middle of VTA) to increase uniformity of water and nutrient application across the entire VTA.

Minimize or prevent animal use of runoff-generating surfaces during the non-growing season to reduce VTA nutrient and pathogen loadings.

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

When near sensitive areas such as impaired watersheds (nutrients and pathogens concerns) or close proximity to housing developments (odor concerns), consider adding additional screening or additional bedding management and manure solids removal from livestock areas in conjunction with the VTA to reduce nutrient and pathogen loads being treated by the VTA and thereby further reducing the likelihood of odor or water quality concerns.

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.

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, *erosion control requirements, flow control requirements, and associated practices*.
- Plan view showing the location of the VTA.
- Details of VTAlength, width, slope, *and flow distribution controls.*
- 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 *the VTA in the spring and routinely after storm events to identify erosion issues, excessive sedimentation, plugged flow distribution controls, and unvegetated locations. Regrade, clean, and reseed problem areas as appropriate to maintain sheet flow and acceptable treatment.*
- *Consider dethatching or aerating the VTA to promote infiltration.*
- *Conduct maintenance activities only when the VTA surface is dry enough to prevent rutting or compaction.*
- *On a weekly basis, clean exposed locations of paved feedlots and feed storage areas to reduce the sediment and nutrient loading to the VTA. Empty settling basins at least quarterly and sooner if 50 percent filled with solids. Land apply per nutrient management plan.*
- *Maintain plastic covers at feed storage areas and perform routine inspections. Repair tears and punctures in plastic covers to minimize exposure to precipitation. Cover exposed feed surface after daily feeding operations are completed.*
- *Monitor VTA for excessive salinity as manifested by changes in vegetation such as dead patches or weeds. Soil areas may need to be stripped and reseeded.*
- *At the end of the 10-year life of the VTA, evaluate VTA soil phosphorus following NRCS CPS 590 – Nutrient Management. If phosphorus levels are excessive, close the VTA in accordance with NRCS CPS 360 – Waste Facility Closure.*
- *Remove cut vegetation from the VTA at least three times during the growing season to encourage dense/upright growth.*
- *Do not allow livestock on the VTA.*
- *Routinely perform snow removal to minimize feedlot runoff.*

REFERENCES

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

Koelsch, R., J. C. Lorimor, and K. R. Mankin. 2006. Vegetative Treatment Systems for Management of Open Lot Runoff: Review of Literature. Applied Engineering in Agriculture, Volume 22, pages 141-153.

USDA/NRCS, National Engineering Handbook, Part 623, Chapter 4 – Surface Irrigation (September 2012), https://directives.sc.egov.usda.gov/

USDA/NRCS, National Engineering Handbook, Part 630, Chapter 10 – Estimation of Direct Runoff from Storm Rainfall (July 2004), https://directives.sc.egov.usda.gov/

USDA/NRCS, National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Chapter 4 – Agricultural Waste Characteristics Waste (March 2008), https://directives.sc.egov.usda.gov/.

USDA/NRCS, National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Chapter 11 – Waste Utilization (September 2013), https://directives.sc.egov.usda.gov/

USDA/NRCS, National Engineering Handbook, Part 652, Chapter 2 – Soils (September 1997), https://directives.sc.egov.usda.gov/

WinSRFR, USDA/NRCS Tech Tools, https://www.nrcs.usda.gov/resources?title=&resource_type=1970