NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

VEGETATED TREATMENT AREA

(Ac.)

Code 635

I. DEFINITION

An area of permanent vegetation used for agricultural wastewater treatment.

II. PURPOSE

To improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.

III. CONDITIONS WHERE PRACTICE APPLIES

Where a Vegetated Treatment Area (VTA) can be constructed, operated and maintained to treat contaminated runoff from such areas as feedlots, compost areas, barnyards, and other livestock holding areas **and from pretreated milking center wastewater from milking center producing up to 500 gallons of wastewater per day.**

This practice does not apply to:

- **Discharge of waste milk, barn and holding area manure and sewage from restrooms and laundry facilities.**
- **Treatment of leachate from silos, bunk silos, or silage bags.**

IV. CRITERIA

A. GENERAL CRITERIA APPLICABLE TO ALL PURPOSES

1. Vegetated treatment areas shall comply with all applicable laws, rules, regulations, and permit requirements including those applicable to the discharges of waters to the state
2. Base the total treatment area for the VTA on the soil's capacity to infiltrate and retain runoff within the root zone **(water balance)** and the vegetation's agronomic nutrient requirements **(nutrient balance)**. 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. Base the runoff determination on the most restrictive soil layer within the root zone regardless of its thickness.
3. Divert uncontaminated water from the treatment area to the fullest extent possible unless additional moisture is needed to manage growth in the treatment area.
4. The VTA **water balance** design **shall be** 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. The portion of the design volume not infiltrated shall be stored for utilization or treatment unless discharge is permitted by applicable regulations.
5. The VTA **nutrient balance** design for processed water shall be based on the nutrient contents of the processed water and the VTA's ability to hold and uptake the nutrients.
6. Nutrient loading of VTAs shall be based on crop removal of the vegetation used in the VTA.
7. Permanent vegetation consisting of a single species or a mixture of grasses, legumes and/or other forbs adapted to the soil and climate shall be established in the treatment area. Selected species shall be suited to 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. Site preparation and seeding shall be done at a time and in a manner that best ensures survival and growth of the selected species. **The "Herbaceous Vegetation Establishment Guide," located in Section I of the North Dakota Field Office Technical Guide, contains recommended seeding rates and cultivars for North Dakota.**

8. Vegetation shall be able to withstand anticipated wetting and/or submerged conditions. Harvest VTA as appropriate to encourage dense growth, maintain an upright growth habit, and remove nutrients and other contaminants that are contained in the plant tissue
9. Exclude livestock access to the vegetated treatment area.
10. **Exclude vehicle access to the vegetated treatment areas unless it is necessary for VTA maintenance.**
11. Discharge into and through treatment areas shall be applied as sheet flow. Where sheet flow is planned, some means, such as a ditch, curb, gated pipe, level spreader or a sprinkler system, shall be provided to disperse concentrated flow and ensure sheet flow across the treatment area. Land grading and structural components necessary to maintain sheet flow throughout the treatment area shall be provided as necessary
12. Flood Prone Areas
    a) Locate VTAs outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by regulation.
    b) Floodplains can be approximated using FEMA Maps, or USGS Floodwater Regression Equations using standard cross sections. Water surface profiles shall be developed where significant structural components will be installed, e.g., waste storage facilities and floodplain dikes.
13. The water table shall be either naturally deep enough or artificially lowered so that the infiltrated runoff does not mingle with the ground water at the bottom of the root zone. Subsurface drainage shall not be provided within the VTA. 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.
14. Infiltration areas shall not be planned where soil features such as cracking will result in preferential flow paths that transport untreated runoff from the surface to below the root zone, unless the soil moisture can be maintained to prevent drying and cracking.
15. **The final graded surface of the VTA shall be a minimum of 18 inches above the seasonal high water table, as determined by an onsite soil investigation.**
16. **The downslope end of the VTA shall be located a minimum of 1 foot above the 24-year floodplain elevation.**
17. The natural or constructed slope of the VTA shall be 0.3 to 6 percent. The entrance slope to the VTA shall not be flatter than 1 percent.
18. **The VTA shall have a minimum 1' high border dikes parallel to the flow. Side slopes shall be 3:1 or flatter to facilitate mowing.**
19. **To the extent possible, the mineral soil base under feedlots should have positive grade to the discharge point in order to reduce the potential for ground water contamination and improve manure management.**
20. **Prohibited discharge locations include public right-of-ways and property boundaries.**
21. **Depressional areas shall not be excluded from feedlot runoff computations. Depressions, with a contributing drainage area exceeding 5 acres and a potential ponding depth exceeding 1 foot shall be drained. This can be achieved by stripping the manure, filling with fine-grained soil, and grading to a conveyance channel or discharge point. If surface grade is not available, the depression shall be drained through a surface intake and underground outlet to the discharge point.**

B. SPECIFIC CRITERIA FOR OPEN LOT FEEDING OPERATIONS

Animal Feeding Operations (AFO) that meet the following criteria may use North Dakota NRCS Field Office Technical Guide, Section IV, Conservation Practice Standard 393, Filter Strip for technical guidance regarding sizing of the treatment area:

a) **The operation shall be considered a small AFO as defined in Code of Federal Regulations, Title 40, Chapter I, Subchapter D, Part 122, Subpart B, §122.23.**

b) **Maximum contribution of clean water area entering the feedlot shall be less than 5% of the feedlot surface area. Exclusion of clean water can be achieved with diversions and roof runoff structures.**

c) **Maximum feedlot slope shall be 10%.**

d) **Provisions shall be considered to effectively contain manure solids or sediments on the feedlot. The need and extent of sediment control shall be based on evidence in the field.**

Vegetated treatment areas designed for medium and large AFO operations, or small operations that do not meet the criteria above, must meet the below requirements:

1. **The minimum VTA size shall be determined by calculating the water budget for the 25 year, 24 hour storm event and the nutrient budget. The minimum VTA size shall be determined by the larger of the water budget and nutrient budget.**

2. **The discharge rate, dimensions and slope of the VTA shall be determined by the SRFR soil infiltration model. Specific criteria for the infiltration model is listed in Section IV.E.**

3. **The VTA nutrient balance shall be based on methodology from the Vegetative Treatment Systems for Open Lot Runoff June 2006 Collaborative Report – Chapter 6: Vegetative Treatment Area Design, VTA Sizing by Nutrient Balance.**

4. **Minimum length of the VTA, measured in the direction of flow, shall be 100 feet.**

5. **Maximum bottom width of a VTA shall be 70 feet. Multiple or divided cells in parallel or in series can be designed to meet the minimum VTA area required. Dikes between cells shall have 3:1 side slopes and a minimum height of 1 foot.**

6. **Soil investigation shall include:**
    a. **The number and distribution of soil investigations sufficient to characterize the soils in the VTA and to a minimum depth of below the planned VTA grade to ensure separation distance is achieved. Minimum of 1 soil boring per 3 acres of VTA.**
    b. **The depth to bedrock or restrictive layer encountered in soil investigation(s).**
    c. **Depth to seasonal high water table encountered in the soil investigation(s).**
    d. **Irrigation group category as defined by the North Dakota Irrigation Guide, Chapter 2 – Soils.**

7. **Soil Intake Characteristics**
    a. **The intake family shall be field verified using the method described in the North Dakota Engineer Practice Planning Guide for Vegetated Treatment Area.**
    b. **The number of field verification measurements shall be determined by the soil investigation.**
    c. **A minimum of one field verification measurement per irrigation group (as defined by the North Dakota Irrigation Guide, Chapter 2 - Soils) shall be performed. Irrigation Groups that comprise less than 20% of the VTA do not require field verification.**

8. **Feedlot runoff shall be applied on the VTA with controlled discharge from an orifice, weir, or pipe.**

9. **Settling Basin**
    a. **Feedlot runoff shall be pre-treated with a settling basin, unless the**

feedlot has the following characteristics: 1) average slope is less than 3%, 2) sub-grade is earth, and 3) flow velocities along the longest hydraulic path are less than 1.5 feet per second during a 25-year frequency, 24-hour storm. Criteria for settling basins are found in Solid/Liquid Separation Facility (Code 632).

b. If a settling basin is utilized in the design, it does not require a liner if runoff is ponded less than 48 hours and the intake family is 0.5 or less.

c. A portion of the feedlot can function as a settling basin if the runoff is ponded less than 48 hours and the intake family is 0.5 or less.

d. In the case of a shallow settling basin with vegetative cover, a liner is not required if the volume of seepage does not exceed the available water holding capacity within the root zone.

C. SPECIFIC CRITERIA FOR MILKING CENTER WASTE – IRRIGATION

1) Exclude surface water runoff from entering the milking center wastewater treatment system.

2) Pipelines shall be designed to avoid freezing.

3) Design Flow Rate shall be determined by measuring or estimating using the procedures in American Society of Agricultural and Biological Engineers Paper No: 054103 – "Design Recommendations for Milkhouse Wastewater Treatment Systems" (2005).

4) Develop a contingency plan to address unexpected volumes of waste milk, wastewater, and runoff.

5) Develop an emergency response plan to address the containment, clean-up, and reporting of spills.

6) Develop provisions to ensure that waste milk is never dumped into any treatment system requiring a pretreatment tank.

7) Develop an annual pumping and solids removal plan from pretreatment tanks. Contents of the tank shall be land applied according to a spreading plan, stored in a waste storage facility meeting the criteria of North Dakota NRCS Field Office Technical Guide, Section IV, Conservation Practice Standard 313, Waste Storage Facility, or removed by a licensed hauler.

8) Milking Center Plumbing

a) A sanitary trap is required to prevent gasses from flowing into the milking center from the treatment system.

b) Materials must be provided to ensure all riser joints, access openings, and pipe connections are installed watertight.

c) A flow diverter valve shall be installed at the discharge end of the wash water transfer line to divert waste milk from the treatment system.

9) The storage container shall be sized for the largest volume of the following conditions: a minimum three-day hydraulic retention time prior to irrigating, the size of the bulk tank, or 1000 gallons.

10) The pump tank shall be either 1 day hydraulic retention time or 500 gallons, whichever is larger.

11) Pump shall be a high-head effluent pump with high/low floats and a high alarm. Pump shall be sized to transfer waste at the required system head and flow rate. Pump size shall be based on the zone with the highest pressure and flow requirements. Pump shall have a 24-hour timer. Application shall occur at a consistent time daily.

12) The irrigated application area shall be based on the nutrient contents of the wastewater and the ability of the application area to hold and uptake the nutrients. Book values of 0.8 lb P per cow per year and 1 lb Total N per cow per year can be used if the nutrient content of the wastewater is not available.

13) Irrigation shall be discontinued 3 days prior to harvest or grazing. Care shall be taken to avoid spraying in trees or on alfalfa.

14) A minimum of 2 zones is required to allow rest periods.

15) The effective application area shall be calculated using the following formulas:

Heads with 360° Spread Patterns:

EAA=[(NL-1) * SL + D] * [(NW-1)*SW+D]

Heads with 180° Spread Patterns:

EAA=[(NL-1) * SL + D] * (D/2)

Where

- **EAA= Effective Application Area (ft^2)**
- **NL = Number of heads along the length of distribution lines**
- **NW = Number of rows of distribution lines**
- **SL = Spacing of heads along distribution lines (ft)**
- **SW = Spacing between distribution lines (ft)**
- **D = Diameter of spread pattern (ft)**

16) Distribution pipe shall be schedule 40 PVC ASTM 1785 pipe. Pipe shall drain back to the pumping tank with a minimum slope of 1%.

17) Pipes shall be buried below the plow depth or a minimum of 18 inches.

18) During winter a frost-resistant irrigation head shall be used. Heads must be placed above the maximum snow depth.

19) During the summer an impact head can be used. Impact heads shall be brass and have a minimum orifice diameter of ½ inch. Heads should be mounted higher than the crop canopy.

20) Riser pipes shall be well anchored and protected from livestock. Risers shall be well marked.

21) Valves must be accessible year-round and shall be protected from freezing.

D. SPECIFIC CRITERIA FOR FEED STORAGE CONTAMINATED RUNOFF

The initial 30 day compression of silage moisture must be contained or diverted to a Waste Storage Facility (Code 313). After 30 days, storm runoff from a silage stacking facility can be treated with the method listed in Section IV.B.

E. INFILTRATION MODEL CRITERIA

1. **The SRFR soil infiltration model shall demonstrate complete infiltration without discharge from the end of the VTA, or deep percolation below the rooting depth.**
2. **Rooting depth used in the infiltration model shall correlate to the grass/legume species reasonably expected to grow on the VTA.**
3. **Rooting depth used in the infiltration model shall not exceed the depth of the seasonal high water table, clay pan, or bedrock as determined by the soil investigation.**
4. **Subsurface drainage may be used to lower the water table and support a vegetative mix with deeper roots. Drain line(s) shall be located at least 10 feet from the outside edge of the VTA. However, drain line(s) shall be located so the lateral effect reaches the center of the VTA. Drainage Tile Lateral Effects tables may be used for reference.**
5. **An irrigation system may be used to support a vegetative mix with deeper roots and higher yield.**
6. **Target infiltration depth shall be computed as:**

   I = (0.75 x water holding capacity) – P25 + RO25

   Where

   - **I= Target infiltration depth (inches)**
   - **P_{25}= Precipitation from 25 yr ,24 hr storm (inches)**
   - **RO_{25}= Runoff from 25 yr ,24 hr storm (inches)**
7. **Manning's "n" value shall be based on the planned vegetation for the VTA.**

F. PUMPING DISCHARGE TO A REMOTE VTA

Pumped discharge to a remote VTA may be considered if site restrictions prevent the use of gravity flow. The pump shall be designed to discharge flows at a rate determined by the infiltration model. The pump station shall meet the following criteria.

1. **Feedlot runoff shall not enter the sump directly if a flooded condition will impede safe repair or maintenance of the pump. In this case, runoff shall be graded to an intake structure with gravity flow to the sump. The intake perforations shall be at least ½-inch but not exceed 2 inches. Assume that 50% of the intake holes will be plugged.**
2. **The sump shall be accessible if the pump fails. The top of sump shall extend at least 1 foot above the ground and the 25-year floodplain elevation.**
3. **The sump shall consist of water tight, reinforced concrete with a minimum diameter of 48 inches or equivalent. It shall have a concrete base, secure cover, and confined space warning sign.**
4. **The sump shall have a safety factor of 1.5 against floatation.**
5. **A breaker box and high-stage warning light shall be mounted on a post near the sump located at or above the maximum water elevation resulting from the 25-year, 24-hour rainfall event so that access is possible.**
6. **The sump shall be equipped with corrosion-resistant guide rails or tether to remove the pump without human entry.**
7. **The sump shall be equipped with 2 mercury float switches; on-off and high-stage warning.**
8. **The sump capacity below the frost line shall include; 1 foot of priming head, backwash volume from the discharge line, and fluctuation volume to maintain 5 to 15 pump cycles per hour.**
9. **To minimize pump size, consideration shall be given to ponding the 25-year frequency, 24-hour storm runoff above the intake and dewatering the pool within 48 hours.**
10. **The relationship between inflow rate, pump rate, sump storage, and cycle time shall be determined with the following formula:**

$$[\,60 / N\,] = [\,S / I\,] + S / [\,P - I\,]$$

Where

- P = **Pumping rate (gpm)**
- I = **Inflow rate (gpm)**
- S = **Storage volume (gal) between the on and off stage of the sump**
- N = **Number of complete cycles per hour where the length of the complete cycle equals the standing time plus the running time**

    i. **The number of cycles shall be computed at reasonable intervals for the full range of sump inflows (I).**

V. CONSIDERATIONS

- **Recommended constructed slope on feedlot is 5%.**
- Provide more than one treatment area to allow for resting, harvesting vegetation, maintenance, and to minimize the potential for overloading.
- Use warm and cool season species in separate areas to ensure that plants are actively growing to maximize nutrient uptake during different times of the year.
- Pre-treat influent with solid/liquid separation to reduce organic loading, odor generation, and nutrients to levels that will be tolerated by the VTA and to prevent excessive accumulation of solids in the treatment area.
- Utilize inlet control structures to prevent undesirable debris from entering the VTA, to control the rate and timing of inflow during normal operations and to control inflow as necessary for operation and maintenance.
- Supplement water as necessary to maintain plants in a condition suitable for the treatment purpose.
- Store seasonal contaminated water upstream of the VTA 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 390 F. When soil temperatures are between 390 F and 500 F, consider reducing application rate and increasing application period while maintaining a constant hydraulic loading rate.
- Manage the VTA to maintain 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.
- Fences or other measures may be needed to exclude or minimize access of the VTA to humans or animals that would inhibit its function.

VI. PLANS AND SPECIFICATIONS

Prepare plans and specifications in accordance with the criteria of this standard that describe the requirements for applying the practice to achieve its intended use. Include critical construction perimeters, necessary construction sequence, vegetation establishment requirements, and nutrient removal.

Plans and Specifications will include:

- A 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

VII. OPERATION AND MAINTENANCE

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

The plan shall include the following as appropriate:

- Control undesired weed species, especially state-listed noxious weeds, and other pests that could inhibit proper functioning of the VTA
- **Manage the VTA to maintain 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.**
- Inspect and repair treatment areas after storm events to fill in gullies, remove flow disrupting sediment accumulation, re-seed disturbed areas, and take other measures to prevent concentrated flow or 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 when deposition jeopardizes its function, and then reestablishing to herbaceous vegetation
- Routinely de-thatch and/or aerate treatment areas 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.
- **Include provisions that vegetation will be clipped or harvested annually to maintain optimum height, growth, and nutrient uptake conditions. Harvesting**

vegetation also functions to provide good sunlight penetration to kill pathogens.

- Treatment areas in arid or semiarid regions that potentially could be affected by high salinity and/or sodium content should be monitored for excessive salt and sodium buildup. If excessive salt or sodium is found, an appropriate corrective action shall be taken, which may include a salt-tolerant seed mix.
- **The soils within the VTA shall be sampled at a minimum of once every three years of operation to determine if there is an excess buildup of nutrients in the soil, and the records shall be maintained on file.**

VIII. REFERENCES

Electronic Code of Federal Regulations. Title 40, Chapter 1, Subchapter D, Part 122, Subpart B, §122.23. http://www.ecfr.gov

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