

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

WASTEWATER TREATMENT STRIP

(no.)
CODE 635

DEFINITION

A treatment component of an agricultural waste management system consisting of a strip or area of herbaceous vegetation.

PURPOSE

The purpose of this practice is to improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with animal manure and other wastes, and wastewater by treating agricultural wastewater and runoff from livestock holding areas with:

Rapid infiltration;

Overland flow, or;

The slow rate process.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies:

Where a treatment strip is a component of a planned agricultural waste management system;

Where a treatment strip can be constructed, operated, and maintained without polluting air or water resources;

To the treatment of contaminated runoff from feedlots, barnyards, and other livestock holding areas;

To the treatment of dilute wastewater such as milk house effluent and diluted silage leachate.

This practice does not apply to any livestock operation which would be defined as a large Concentrated Animal Feeding Operation (CAFO).

This practice does not apply to treatment of runoff from croplands, which is covered in the South Dakota Practice Standard, Filter Strip (393).

CRITERIA

Laws and regulations. This practice must meet all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving zoning, water and drainage rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and where South Dakota Department of Environment and Natural Resources (SD DENR) approval is to be obtained, SD DENR requirements must be met.

Other General Criteria. Inflow to wastewater treatment strips shall be pretreated as appropriate. Pretreatment is often needed to prevent excessive nutrient application. As a minimum, settleable solids must be removed from the liquids before the liquids enter the treatment strip.

Clean water shall be diverted from the treatment strip to the fullest extent possible unless needed to promote vegetation growth in the treatment strip.

Discharge to and through treatment strips shall be as sheet flow. Some means, such as weirs, or gated pipe, shall be provided to disperse concentrated flow and ensure sheet flow across the width (dimension perpendicular to flow length) of the treatment strip. Land grading and structural components necessary to maintain sheet flow shall be provided as necessary.

Permanent herbaceous vegetation consisting of grasses, legumes, and/or other forbs adapted to the soil and climate shall be established in the treatment strip according to South Dakota Practice Standard Pasture and Hayland Planting (512). Vegetation shall be able to withstand the planned nutrient loading and anticipated wetting and/or submerged conditions.

Conservation practice standards are reviewed periodically and updated if needed. The current version of this standard is posted on our eFOTG web site available at www.sd.nrcs.usda.gov or may be obtained at your local Natural Resources Conservation Service.

Design the system to suspend wastewater application to treatment strips when soil temperatures are below 39°F. While soil temperatures are between 39°F and 50°F, reduce the application rate and increase the application period. Storage shall be provided for use when the amount of available wastewater exceeds the design hydraulic loading rate and for non-operating periods.

Vegetative treatment strips have the potential to contaminate ground water if they are improperly sited. Locations with known aquifers, high water tables, or porous soils must be carefully evaluated.

Treatment strips should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from the 100-year flood event.

Designs shall be based on the latest edition of the U.S. Environmental Protection Agency Technology Transfer Process Design Manual for Land Treatment of Municipal Wastewater or other technically acceptable reference.

ADDITIONAL CRITERIA FOR RAPID INFILTRATION TREATMENT

Rapid infiltration treatment refers to a specific remediation technique that utilizes the filtering capabilities of moderately and highly permeable soils. Treatment for this purpose shall consist of directing wastewater or contaminated runoff from a small livestock holding area into a uniformly graded strip or area of herbaceous vegetation and allowing it to flow over and infiltrate the treatment strip. This method is not appropriate for treatment of water containing nutrient concentrations that will damage the vegetation in the treatment strips.

The treatment strip shall be a uniformly graded strip or wide-bottomed trapezoidal channel.

The treatment strip design shall be based on runoff volume from the 25-year, 24-hour storm event from the drainage area. It may be designed to allow infiltration of a portion or the entire volume of the design storm. The portion of the design volume not infiltrated shall be transferred to a waste

storage facility or otherwise prevented from entering groundwater or Waters of the U.S.

The treatment strip's area requirements shall be based on the soil's capacity to infiltrate and retain runoff within the root zone and the vegetation's capability to utilize the nutrient loading. The soil's ability to infiltrate and retain runoff shall be based on its water holding capacity in the root zone, infiltration rate, permeability, and hydraulic conductivity. This determination shall be based on the most restrictive soil layer within the root zone regardless of its thickness. The anticipated nutrient loading shall not exceed the nutrient application rates based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities.

Either naturally or by design, the water table shall not be closer than two feet to the root zone or to infiltrated, polluted water. Infiltration strips shall not be planned where soil features such as cracking will result in flow paths that transport polluted water from the surface to below the root zone.

SPECIFIC CRITERIA AND APPLICABILITY FOR RAPID INFILTRATION TREATMENT

Levels of control for wastewater and feedlot runoff, from highest to lowest are listed below.

LEVEL 1 – 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 SD-DENR 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 2 – Controlled Discharge Vegetated Treatment Strip (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 strip with active growth in such a way as to eliminate or minimize discharge from the strip.

Acceptable uses:

Runoff from AFO's where a relatively high level of treatment is required to protect surface waters.

1. Where soil conditions are appropriate and adequate land area is available.
2. Where manure solids from the feedlot can be effectively trapped prior to discharge to the treatment area.

LEVEL 3 – Vegetated Treatment Strip.

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

Acceptable uses:

1. For runoff from AFO's with a total operation size of less than 300 animal units.
2. Runoff from AFO's where receiving waters can accept occasional discharges.
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.

SPECIFIC CRITERIA - LEVEL 1, VEGETATED INFILTRATION AREA

Siting Parameters. This process shall be limited to well-drained loamy soil with 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 may not be used to lower the water table.

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. Values for the 10-year, 1-hour rainfall may be obtained from the Weather Bureau's Technical Paper No. 40 (TP-40), Rainfall Frequency Atlas of the United States. The surface area of the settling basin shall be equal to at least five percent of the drainage area. It is suggested to limit the settling basin design storage depth to not more than three feet.

If the settling basin will not be emptied after each runoff event additional volume is required. Solids storage volume shall be computed using the methods provided in South Dakota Practice Standard, Sediment Basin (350), when used as a component of a waste management system.

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 recommended minimum size of the infiltration area shall be 100 percent of the contributing feedlot size. The treatment area shall be sized to infiltrate the 25-year, 24-hour runoff from the feedlot and contributing area. Runoff shall be infiltrated into the root zone of the vegetation to be grown. The depth of water application shall be equal to the maximum available soil water capacity of the soil in the root zone minus 1".

$$\text{Area (ac)} = \frac{\text{Runoff Volume (ac-in)}}{(\text{Water Holding Capacity} - 1")}$$

The infiltration area shall be level to two percent slope 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 two feet. The treatment area

shall be contained such that there is no surface discharge in the event of the 25-year, 24-hour storm event.

SPECIFIC CRITERIA - LEVEL 2 – CONTROLLED DISCHARGE VEGETATED TREATMENT STRIP (SUNNY DAY RELEASE)

Impoundment. Feedlot runoff shall be stored in an impoundment during dormant vegetation 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 and meet South Dakota Practice Standard Waste Storage Facility (313) except for the storage volume criteria. 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 Strip Siting Parameters. The treatment strip shall be situated or constructed in an area with a 2-foot minimum depth of soil with at least 20 percent passing the Number 200 sieve and a minimum separation to the growing season typical water table of 2 feet.

Treatment Strip. The treatment strip 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 $n = 0.24$.

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

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

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

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

Minimum treatment strip slope shall be 1.0 percent and the recommended minimum treatment strip area shall be 60 percent of the contributing drainage area size.

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

Discharge onto a treatment strip shall be evenly distributed at the head of the strip by using a level spreader, weir, gated pipe or other device. Additional devices shall be installed across the filter strip to promote sheet flow at a spacing of 100 feet or less.

SPECIFIC CRITERIA - LEVEL 3, VEGETATED TREATMENT STRIP

Settling Basin. Contaminated runoff shall be pretreated by solid/liquid separation off the feedlot. Criteria shall match that for Level 1.

Treatment Strip Siting Parameters. The criteria shall match that for Level 1.

Treatment Strip. This criteria is the same as for Level 2.

ADDITIONAL CRITERIA FOR OVERLAND FLOW TREATMENT

Overland flow treatment refers to a specific microbial remediation technique that has minimal infiltration of wastewater. Treatment consists of the application of wastewater along the upper portion of a uniformly sloped strip of herbaceous-vegetation, allowing it to flow over the

vegetated surface for aerobic treatment to a collection ditch.

The design hydraulic loading rate and application rate shall be based on anticipated levels of pretreatment, content of effluent, and climatic conditions such as temperature. The hydraulic loading rate shall not exceed 2.0 inches per day and the application rate shall not exceed 8 gallons per hour per foot of slope width, except where higher rates can be justified by on-site studies.

The application period shall not exceed 12 hours per day and the application frequency shall not exceed 5 days per week except where justified by local conditions.

The nutrients anticipated to infiltrate the treatment strip shall not exceed the vegetation's agronomic nutrient requirement.

Soils with low permeability are required for overland flow treatment. The design shall be based on the most restrictive soil layer within the root zone. The maximum allowable permeability shall be 0.2 inches per hour unless a natural or constructed barrier within the soil profile prevents ground water contamination.

The minimum slope length for the applied wastewater shall be 100 feet.

The sloped areas to receive wastewater shall be uniformly graded to eliminate wastewater ponding and short-circuiting for the length of the flow. Slopes shall be between 2.0 percent and 8.0 percent.

SPECIFIC CRITERIA AND APPLICABILITY FOR OVERLAND FLOW TREATMENT

Vegetated Buffer Strip.

Solids and liquids separated. Liquids are then discharged to a vegetated buffer strip. This is considered to be overland flow treated discharge.

Acceptable uses:

1. For runoff from AFO's with less than 1 acre of open lot area (including contributing clean water areas) and total operation size of less than 300 animal units and less than 100 animal units utilizing the lot in question.

2. Where the receiving water can accept occasional discharges.
3. Where a minimum of 200 feet of separation exists between the end of the buffer and a receiving water.
4. Where manure solids from the feedlot can be effectively trapped prior to discharge to the buffer area.
5. Where soil conditions are appropriate and adequate land area is available.

SPECIFIC CRITERIA, VEGETATED BUFFER STRIP

Solids Settling. Settleable solids shall be removed from the runoff prior to discharge to the buffer strip.

Buffer Strip. The buffer strip shall be sized using the AGNPS Feedlot Evaluation model. The flow length shall be sufficient to achieve a zero ranking when modeling the vegetated strip as a buffer area in the model using the following conditions:

1. "Permanent Meadow" shall be used to describe the cover crop of the vegetated buffer area. Tilled cropland may not be considered part of the buffer under this standard.
2. Number of animal units shall be the maximum that will use the feedlot.

The width of the filter strip shall be such as to pass the discharge on to the strip from a 25-year, 24-hour rainfall at a depth of 1" using Manning's $n = 0.24$.

The flow length of the buffer strip shall be placed perpendicular to the slope contours to promote sheet flow. Means such as gravel spreaders or gated pipes should be used to promote sheet flow across the width of the buffer strip.

ADDITIONAL CRITERIA FOR TREATING WASTEWATER WITH THE SLOW RATE PROCESS

The slow rate process refers to a specific remediation technique involving the application of wastewater to a vegetated surface for treatment as it flows down through the plant-soil matrix.

Design hydraulic loading shall be based on the more restrictive of either soil permeability or nitrogen concentration in

water percolating below the root zone. Percolate nitrate-nitrogen concentration leaving the root zone shall not exceed 10 mg/L. The anticipated nutrient loading in the wastewater applied to the treatment strip shall not exceed the nutrient application rates based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities.

Wastewater shall be applied evenly over the entire treatment strip at a rate that does not exceed the soil infiltration rate.

Components Applicable to all Treatment Strip Methods

General. Waste control components must be planned, designed, and constructed to meet all federal, state, and local laws and regulations. Design criteria for individual components shall be according to standards in the South Dakota Technical Guide (SDTG). The criteria for the design of components not included in this standard shall be consistent with sound engineering and ecological principles.

Vegetation. The type of vegetation used must be tolerant of the anticipated nutrient and hydraulic loadings. Herbaceous vegetation must be established according to South Dakota Practice Standard, Pasture and Hayland Planting (512), with the following exceptions. The species selected will be suitable (good or fair rating) for an overflow (Group K) forage suitability group, and a minimum of 50 percent of the species mix will be composed of rhizomatous grasses. Vegetation must be established prior to the effluent discharge onto a vegetated strip. Vegetation must be harvested from the treatment area to maximize plant uptake and recycling of nutrients.

Harvesting is to be done in such a manner and at such a time to prevent damaging the vegetation, rutting the surface or leaving tire depressions along the flowline of the strip. Harvesting may be done by controlled animal grazing or by mechanical means, with mechanical means being the preferred method. Harvested vegetation should be tested for nitrates prior to use as forage or

feed. Grazing, when used, must follow South Dakota Practice Standard, Prescribed Grazing (528), and should be accomplished with sufficient animals so that the desired degree of use is accomplished within a one-week period.

Adequate equipment access for harvesting must be planned in the waste treatment strip design. Harvesting should be done at the early boot stage of vegetation growth and result in a minimum height of vegetation of four inches, as described in South Dakota Practice Standard, Forage Harvest Management (511).

Impoundments. All impoundments intended to store solid or liquid wastes for an extended time period shall meet South Dakota Practice Standard, Waste Storage Facility (313). This does not include settling basins used in conjunction with treatment strips and buffer areas.

Land Application. All land application of agricultural wastes or manure shall be done in accordance with an approved nutrient management plan that meets South Dakota Practice Standard, Nutrient Management (590).

Freeboard. Any impoundment constructed of earthen materials will be designed to provide one foot of freeboard.

CONSIDERATIONS

More than one treatment strip should be considered to allow for resting, harvesting, maintenance, and to minimize nutrient overloading.

Air Quality. The need for odor control must be considered in selecting system components and location.

Wetlands. In some cases, waste management systems can adversely affect wetlands. Other federal, state, or local permits or restrictions may apply to activities impacting wetlands.

Safety. Safety features and devices shall be included in waste management systems, as appropriate, to protect animals and humans from drowning, dangerous gases, and other hazards. Fencing shall be provided, as necessary, to discourage human entry and to prevent livestock from using facilities for other purposes. Warning

signs are required for storage ponds, storage structures, confined spaces and other facilities that may present a hazard to humans.

PLANS AND SPECIFICATIONS

Plans and specifications shall meet this standard and shall describe the requirements needed to achieve its purpose. Plans and/or specifications must include:

Location, construction sequence, and length, width, and slope of the treatment strips;

Site preparation requirements;

Herbaceous species, seed selection, seeding rates, planting dates, and other items needed to assure an acceptable rate of survival.

OPERATION AND MAINTENANCE (O&M)

An O&M Plan shall be developed for use by the owner/operator.

The plan shall include, as appropriate, harvest of vegetation as appropriate to encourage dense growth, maintain upright plant habit, and remove nutrients and contaminants that are contained in the plants.

Control undesired weed species, especially state-listed noxious weeds.

Control rodent and other animal damage.

Inspect and repair treatment strips after storm events to remove sediment, fill in gullies, prevent concentrated flow and re-seed disturbed areas.

Monitor nitrogen and phosphorus levels in the soils of the treatment strip to minimize potential water quality concerns. Take appropriate corrective action as necessary.

Monitor salinity and/or sodicity (sodium content) as appropriate for excessive salt and sodium buildup. Take appropriate corrective action.

De-thatch and/or aerate treatment strips to promote infiltration where appropriate.

Conduct maintenance activities only when the treatment strip is dry.

Prevent inappropriate grazing.

Prevent using the strips as a road or for routine equipment travel.

Safety warnings, particularly where there is danger of drowning or exposure to poisonous or explosive gases.

Maximum operation levels for impoundments.

Discharge schedules for controlled discharge vegetated treatment strip impoundments and from milk house wastewater settling tanks.