Section 8 Management Guidelines for Vegetative Treatment Systems

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Purpose

Just as with any conventional manure or runoff management system, proper management of alternative treatment systems is critical to their proper functioning and longevity. After the appropriate plant species are established in the VTA or VIB, there are a number of operation and maintenance activities essential to their proper function. The following critical management issues should be addressed:

- Management of vegetation (soil fertility and harvesting)
- Management of environmental risks (tracking nutrient concentration, maintaining sheet flow, and controlling release of runoff into the VTA)
- Establishment of standard operating procedures for critical management tasks
- Implementation of a record keeping system for documenting performance of overall VTS

The purpose of this section is to discuss implementation of the critical management practices. The overall management requirements of VTSs will vary with individual components and their specific design selected for the overall system. For example, a solids settling area designed with sufficient volume to hold a year's accumulation of solids may only require infrequent inspections and yearly cleaning. Other choices may require more active manager participation—an actively managed outlet from the solids setting basin to the VTA may require the manager to check VTA soil moisture levels and basin liquid levels after each storm event when timing liquid release.

Both the producer and the regulatory agency (CAFO application) should be actively engaged in planning the management program as design alternatives are being evaluated. Once the level of essential management inputs are identified, VTS designs can be finalized, standard operating procedures assembled, and appropriate record keeping identified for the producer to meet these management expectations.

Vegetation management

Vegetation is the critical component in the success of a VTA. Selection of appropriate vegetation for application to a VTA and VIB is discussed in sections 6 and 7, respectively. Vegetation is established in VIB to produce and maintain a soil condition that promotes infiltration and removes and transforms nutrients. In the VTA, the vegetation slows movement of water to improve settling out of sediments, nutrients, and other contaminants; promotes infiltration; encourages chemical transformations; maintains soil permeability; and provides forage for animal use. The roots also provide a substrate for a highly active microbial zone that breaks down organic material, utilizes nutrients, and destroys pathogens. Proper vegetation management is essential for a high-performing VIB or VTA.

Soil fertility for optimum growth

Two distinct issues should be considered in selecting a soil-sampling program: maintaining optimum crop growth and environmental protection. A general discussion of soil-sampling issues for management of a VTA or VIB follows. A later section describes the soil sampling needed to monitor environmental performance. State-specific soil-sampling recommendations are typically available from your land grant university or other accepted resources.

A key to healthy vegetation is the proper fertility status. Usually, because of the nutrient enriched nature of the runoff entering the vegetated areas, lack of nutrients is not a problem. What can become a problem is an imbalance of nutrients, resulting in poor crop growth that could compromise the effectiveness of the vegetation. To monitor the fertility status of the VIB and VTA, a regular soil-testing program should be a part of the operation and maintenance plan.

For the purposes of soil nutrient monitoring, sample the top 8 to 10 inches of the soil. A deep soil sample (preferably to a depth of 36 in) is necessary if residual soil nitrogen, measured as nitrate-nitrogen, is to be monitored. Collect sufficient samples to give a good representation of the area. Cooperative extension programs at land grant universities may provide recommended sampling procedures. Because greater nutrient settling and runoff infiltration is expected near the inlet end of both a VIB and VTA, collect separate soil samples from the first 50 feet from the inlet area and separate samples from the rest of the VTA. Figure 8–1 illustrates one way of subdividing a VTA. A separate set of samples is taken in each sub-area (A, B, and possibly C), because the soil nutrient status may be different as you move farther from the point where runoff enters the VTA.

Analyze shallow soil samples for plant available phosphorus and potassium, important micronutrients, pH, soil electrical conductivity, and salts (sodium, calcium, and magnesium). Deep soil samples should be analyzed for nitrate-nitrogen. Based upon the results of the soils report, some management changes may be necessary (table 8–1). Only a fraction of the nitrogen and phosphorus (5% or less) excreted by the animals travels with runoff. About half of that in the runoff will be removed by a well-designed solids separation component. For the nitrogen that is transported to the VTA or VIB (primarily as ammonium-nitrogen), there also will be additional losses from denitrification and volatilization.

A greater percentage of the total potassium in the system will reach the VTA or VIB than either nitrogen or phosphorus. Potassium is soluble, so it will stay in solution as runoff leaves the pens and lots. Only a small percentage stays with the solids that settle out in the settling basin. The salt level in VTA and VIB soils should be monitored. Salts may accumulate in the root zone during periods of small rain and runoff events that do not saturate the soil and leach salts. Check soil electrical conductivity as part of a soil-sampling program, and discuss the results with your crop consultant. See the vegetation discussion in sections 6 or 7 for additional information on the salinity tolerance of different species.

The frequency of soil sampling will vary depending on the purpose. To track general fertility status, follow the land grant university, NRCS, or local conservation district's guidelines for forage or grass species fertility

Figure 8–1 Suggested soil sampling locations

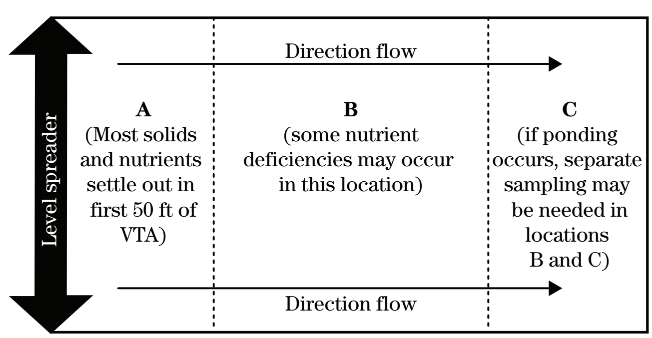

Table 8–1 Possible actions to be taken in response to soil sample test results

Soil sampling test result	Possible action to be taken
Soil P levels	
Low or medium soil test P	Follow land grant university recommendation for fertilizing VTA
High or very high soil test P levels	Is runoff from VTA occurring frequently? If no, continue to monitor frequency of runoff events If yes: • Increase the frequency of soil sampling to once every 2 years • Reduce the nutrient loading rate to the VTA, either by reducing outflow from the solids removal area or by increasing the efficiency of pretreatment solids removal • Over-seed or introduce legumes into the VTA to increase harvest of P from the VTA forage • Treat VTA with P-adsorbing material (iron or aluminum) • Stop use of the VTA until harvesting lowers the soil test
Increasing soil test P levels	Increasing soil test P levels indicate an emerging concern. Follow recommendations for high or very high soil test P levels
Soil nitrate levels	
Low or medium soil nitrate levels	Follow land grant university recommendation for fertilizing VTA
High soil nitrate levels	Increase forage removal by possibly changing harvesting frequency. Check nitrate concentrations of forage Consider alternative grasses or forages that remove greater amounts of nitrogen Consider controlled drainage to modify soil moisture in root zone
Soil potassium levels	
Low or medium soil test K levels	Follow land grant university recommendation for fertilizing VTA
High or very high soil test K levels	If harvested forage is used for livestock feed, monitoring forage K levels, and visit with nutritionist about need for modifying use of forage in diet
Soil micro-nutrient levels	
Low or medium soil test levels.	Follow land grant university recommendation for fertilizing VTA
High or toxic soil test levels	Stop use of VTA if soil analyses show unacceptable levels of heavy metals Other micro-nutrients should be monitored
Soil electrical conductivity	
High soil EC	Irrigate VTA with fresh water Provide drainage to leach away excess salts Divide the VTA into two sections so that one section can be rested except during high intensity or large storms. Resting a VTA section will allow rainfall to move salts out of the root zone

needs. If no guidelines exist, soil sample at least once every 3 years. Deep soil sampling for nitrate nitrogen may be beneficial near the VTA inlets on an annual basis. When samples are taken on subsequent occasions, try to take samples close to the same location each time. This ensures that any differences that show up are a result in the actual nutrient status of the site and not due to a soil difference.

Harvesting a VTA

Another requirement for maintaining a healthy stand of vegetation is periodic mowing and removal of the crop. VTAs and VIBs should be harvested at least once a year so that the nutrients contained in the plant material are removed from the treatment area. Depending on the plant species used in the VTA or VIB, more frequent harvesting may promote a more vigorous stand of vegetation, greater utilization and removal of nutrients, and higher quality feed. Frequent mowing promotes thicker sod and controls weeds.

When harvesting, leave a minimum stubble height of 3 inches to ensure the required stem density and stiffness to maintain sheet flow through the VTA. Some species, particularly warm-season prairie grasses, require a taller stubble height to be left to maintain plant vigor and stand density. For all species, the last harvest in the fall should be early enough to allow sufficient regrowth prior to dormancy for proper functioning during the winter.

Sometimes there are toxic levels of some salts and ions, (NH_4^+) in the runoff from concentrated livestock areas. These can have a major deleterious effect on the vegetation. If this occurs, pre-treat (usually by dilution) the outflow from the solids removal area to reduce toxic levels. The key here is to maintain vigorous crop growth and density to maximize nutrient uptake and disperse overland flow.

In the ideal world, harvest a VTA or VIB when soil moisture conditions will not produce tire tracks or ruts. Tire tracks that are parallel to the direction of runoff flow create channel flow and substantially reduce the effectiveness of a vegetative system. If harvesting equipment or other field traffic presents a risk for creating tire tracks, the equipment should travel perpendicular to the flow of water.

Management of soil moisture in VTA

Soil moisture plays an important role in the functioning of a VTA. Soil water is essential for plant growth and high level of activities by microorganisms. If soil moisture is deficient, the plants and microbes are not functioning to their potential and the benefits of a VTA are not realized. In dry climates, supplemental irrigation may be required to maintain an actively growing VTA. Historic weather data, soil moisture indicators, and visual observations can assist in supplying adequate soil moisture.

Soil moisture content is critical for the transformation of many contaminants that will be passed through the VTA. The nitrification of ammonia occurs when aerobic bacteria have ample soil oxygen to convert the ammonia to nitrate nitrogen. Without oxygen, the saturated soil conditions are conducive to anaerobic bacteria that convert nitrate nitrogen to atmospheric nitrogen gases. In this case, nitrogen is lost from the system and potential greenhouse gases are formed. Saturated soils also can change the availability and solubility of phosphorus. Soil minerals, like iron, tend to release the stable, fixed phosphorous making it more susceptible to translocation by water moving through the soil profile. Saturated soils also promote downward movement of draining water that can cause excess leaching.

Saturated soils compact easily. If machinery or livestock are used to harvest the forage in a VTA, dry, firm soil conditions are required to prevent compaction or rutting. Wheel tracks and hoof traffic can cause disruption in the surface flow down the VTA, concentrating flow and reducing infiltration.

Two management measures should be considered to alleviate saturated soil conditions. First, the surface topography should be smooth and uniform to promote sheet-like flow. This will slow the flow through the VTA, encourage uniform infiltration, and prevent depressions and wet spots. Second, soil profile moisture can be managed with subsurface drainage. Tile drains beneath VTAs must be controlled. Tile drain outlets can become sources of contaminants. Drains must be managed to allow excess soil moisture to be removed from the soil profile, but not allow for a conduit of leached nutrients, salts, and pathogens. Installing tiles at the appropriate depth and location will off set some of these risks. Being able to regulate flow (drain during rainy season, closed during dry season) will promote plant root growth and crop uptake, plus provide favorable conditions for soil biology. Effluent can be discharged into a vegetated area or routed back into the VTA. Drainage water should be monitored for elevated levels of contaminants. Local NRCS resources should be used in determining appropriate local use of subsurface drainage.

Weed and brush control

Weeds, brush, and other pests should be controlled in the VTA to ensure proper functioning. Periodic mowing, at least frequent enough to prevent seed formation, is an effective weed control measure. Harvesting the VTA forage on a prescribed schedule will usually control weeds. Herbicides are another alternative for controlling weeds. Precautions are needed in selecting the proper registered products, applying proper rates, and being knowledgeable of grazing and forage harvest restrictions. A healthy stand of vegetation, absent of any bare spots, will prevent weed encroachment. All bare spots should be reseeded.

Grazing is not commonly recommended for harvesting of VTA vegetation. Grazing removes very few nutrients from a VTA and is not a good alternative to mechanical harvesting of forage. However, occasional grazing can assist with weed control. Grazing needs to be controlled, both in timing and extent. Livestock should not be allowed when soils in the VTA are moisture saturated. Footprints can compact the soil surface and reduce infiltration. Foot traffic can also damage crowns and roots of vegetation. Care should be taken to remove cattle when proper grazing height of vegetation is reached.

Environmental management

The nutrients nitrogen and phosphorus represent a primary environmental risk associated with open lot runoff. Nitrogen in a nitrate form represents a risk to ground water and possibly drinking water supply. Nitrogen in an ammonium form can be toxic to aquatic life, contributing to fish kills. Both phosphorus and nitrogen can contribute to eutrophication (algae blooms and large swings in dissolved oxygen levels) of surface waters. Pathogens in animal manures can produce a human health risk for recreational and drinking water uses of our water resources. Management strategies designed to limit these risks and monitoring programs to document proper management implementation are essential for a VTS.

Soil sampling for environmental protection

The second soil sampling purpose is to monitor environmental performance of the VTA. There are two separate concerns: nitrogen leaching below the root zone and phosphorus accumulation. *Monitoring for increasing soil phosphorus will provide a forewarning of water quality problems originating from the VTA, enabling proactive instead of reactive management changes.*

If the nitrogen entering the VTS exceeds vegetation removal, the excess nitrogen that is converted to nitrate can move beyond the root zone under saturated soil conditions. Rainfall on the VTA and runoff from the open lot creates the opportunity for leaching nitrate past the root zone. Since plants can no longer use nitrate leached beyond the root zone, it will eventually reach tile lines or ground water.

For environmental protection, a deep sampling regime can provide a snapshot of root zone nitrate levels and the potential for future movement. Samples should be taken within the root zone and analyzed for nitrate-nitrogen content. Most of the plants that are suitable for the VTA have the majority of their roots in the top 36 inches, so the soil samples should be taken below the surface in 1-foot intervals.

For additional information on nitrogen management within a VTA, forage nitrate monitoring may provide some insights about potential excess nitrate levels in the VTA. Check with your land grant university as to the availability of recommendations for forage nitrate levels that may suggest excess soil nitrate levels. *Forage nitrate should be measured for any harvested* *material that will be fed to livestock, especially ruminants, because high nitrates can be toxic.*

Soil sampling for assessing environmental risk associated with phosphorus can be measured with surface soil samples described previously for managing a vegetative system for optimum growth. As phosphorus enters the soil, it readily precipitates out of solution and it is readily adsorbed as calcium, iron, and aluminum phosphates. It typically accumulates near the surface of the soil. If the amount removed by harvesting vegetation is less than the amount entering the VTA or VIB, the soil exchange matrix can eventually become saturated.

Excess soil phosphorus levels can have two effects. High phosphorus levels will commonly remain near the soil surface of fine textured soils such as silt loam or silty clay loam soils (higher adsorption capacity). Excess phosphorus in course textured soils, like sands and loamy sands lack adsorption capacity and allow phosphorus to migrate further into the soil profile. Excess phosphorus accumulation in the top 2 inches of soil will desorb as dissolved phosphorus when runoff water passes over these soils and transport phosphorus off site with soil erosion. Movement of phosphorus with soil erosion should not be a significant concern for well-maintained VTAs. A standard soil sample used for optimum growth (0–8-in sample) can provide an indication of potential environmental risk due to excess phosphorus. An occasional separate soil sample of the top 2 inches of soil layer analyzed for available phosphorus will detect stratification of phosphorus in the soil surface.

Course textured sandy loam or loamy sand soils (lower adsorption capacity) tend to become saturated with phosphorus more quickly allowing phosphorus movement deeper into the soil profile. This is unlikely to become an environmental concern unless the VTA is located over a shallow water table or subsurface drainage. Previously described 0- to 8-inch and 0- to 36-inch soil samples should be valuable for reviewing this risk.

If soil phosphorus test levels become excessive, the need for changes in management depends on the amount of runoff water (and associated dissolved phosphorus) exiting a VTA. A properly designed and managed VTA may rarely experience runoff with the exception of the most intense storms. Thus higher soil phosphorus levels will have little impact on surface water quality. Poor design or management may produce greater runoff and require greater attention to a need for modifying management with increasing soil phosphorus levels.

If VTA runoff is common and soil test levels reach a high or very high range for crop production, some management techniques need to be implemented (table 8–1). These can include harvest and removal of vegetation biomass, better management of solids in sediment basin, or removal and mixing of topsoil layers in the VTA. If soil test analysis shows soil test levels are extremely elevated (three times the high soil test level) the soils become a source of runoff and remedial management is necessary including end of the VTA use.

Sheet flow maintenance

For VTAs to provide maximum water quality protection, the overland flow should be as uniformly distributed as possible across the treatment area. Uniform flow minimizes localized areas of higher flow velocity and encourages greater particulate removal. In addition, since a portion of the runoff entering the VTA will infiltrate, maximizing uniform flow will allow for a greater portion of the VTA to contribute to the infiltration of runoff. Concentrated flow within the VTA reduces infiltration. A thorough discussion of options for encouraging sheet flow is reviewed in section 6 on VTA design. The literature review in section 9 summarizes the research experiences detailing the critical importance for maintaining sheet flow.

Sheet flow is not an issue with a VIB. VIBs are designed to pond water resulting from runoff from most storms. A flat or very low slope is important to creating a uniform depth of liquid within a VIB. However, other issues discussed below are relevant only to a VTA.

Inlets from the solids removal component to the VTA may require annual re-leveling to ensure initial even distribution of feedlot runoff to the VTA. Irrigation pipe distribution systems may need to be repositioned on the contour and pipe gates adjusted. Flow rates from irrigation pipe gates should be adjusted to encourage full pipe flow during most runoff events. Achievement of this goal should be checked seasonally. For concrete structures with weir plates for controlling flow, the elevation of all weir plates should be checked and matched on a periodic basis. The gravel and rock structures used to redistribute flow at the upper end of a VTA should be re-leveled and structural integrity checked. Piped outlets from the settling basin should be adjustable and periodically matched for a consistent elevation. Most distribution systems will require screening of debris to prevent plugging of outlets. Debris screens and other points of potential debris accumulation should be checked after each significant rainfall event.

Overland flow always tends to converge as it flows through the VTA. Spreaders should be installed at regular intervals and other VTA design features included as discussed in section 6 to redistribute any concentrated flow within the VTA. Maintaining reasonably uniform flow through the length of a VTA will require regular VTA inspection and

- Maintenance of in-field spreaders
- Removal of solids accumulation near runoff inlets to a VTA
- Repair to areas of erosion or wheel tracks
- Reestablishment of vegetation in areas where it has been killed
- Repair of eroded areas in berms

Any equipment operations (mowing, baling) that take place in the VTA should be done when soil conditions are such that tracks or ruts, which can disrupt sheet flow, are not formed. Grazing should be avoided, as livestock hoof action can disrupt sheet flow.

Passive versus active management of liquid release

The risk of a discharge from a VTA is significantly greater if feedlot runoff enters the VTA simultaneously with rainfall directly falling on the VTA. The infiltration rate of the soil can be overwhelmed with the two simultaneous sources of water. Delay release of runoff liquids until after the storm or limit the release of runoff during the storm to reduce the potential of a discharge of feedlot runoff with pollutants from the feedlot. Three primary options for managing the release of liquids from a solids removal component to the vegetative component are possible. The latter two are designed to minimize the potential for a discharge from the vegetative component.

- *Unrestricted runoff release*—The outlet of the settling basin is not restricted, possibly because of limited or no storage capacity in the solids settling component. Runoff release is designed to match the peak flow rate of liquids into the settling basin when the basin is nearly full.
- *Active settling basin liquid release*—The outlet of the settling basin can be physically controlled. The manager determines the best timing for the release of basin liquids, presumably when the VTA soil conditions are most appropriate. This approach requires that the settling basin has sufficient capacity to handle a 25-year, 24-hour storm, as well as some additional capacity for normal runoff for some possible storage period (a few days to possibly months). The resulting settling basin volume is very similar to that of a standard holding pond. Its frequency of discharging will be essentially no different from the conventional basin and irrigation system. Many advantages of a VTA system including reduced cost, modest storage, and less risk of management errors are no longer realized with a system based upon active settling basin liquid release. However, the risk of a release from the VTA has been significantly reduced.
- *Passive settling basin liquid release*—The outlet of the settling basin can be controlled to deliver liquid slowly over a 36- to 72-hour period. The settling basin will need to be sized to handle a 25-year, 24-hour storm. Additional volume to store normal rainfall runoff would not be necessary since liquids would be released over a short period of time (<72 h). A passive system also does not rely upon the observation and decision making of a manager thus reducing potential problems due to infrequent inspections or poor management. Common advantages of a VTA system including reduced cost and modest storage will not be realized with a passive settling basin liquid release. However, as with active release systems, the risk of a release is substantially reduced. Design information for controlling liquid release from passive systems is presented in section 5.

Active versus passive management of flow from a solids settling component to a VTA is described in section 5.

Solids harvesting

Manure and other solids in the system must be managed to ensure the proper function of the treatment components. Solids should be harvested from earthen lots at least once after each pen of cattle is marketed (approximately twice a year) and every 180 days for dairy. More frequent solids removal will have value for animal management and odor and dust control and may have some value to reducing solids in runoff.

The maximum solids volume in a settling basin should be clearly identified (marked on a level gage) and solids should be removed in advance of solids accumulation to that point. As a minimum, the solids settling basin should be cleaned out once a year. The solids should be removed frequently from settling benches and siltation fences to maintain their effectiveness, possibly after each major runoff event.

Proper feedlot surface maintenance and solids settling should prevent the buildup of solids in a VTA. If solids begin to accumulate in a VTA, they can damage forage and contribute to channel flow. If solids accumulation within the VTA is observed, first attempt to reduce this problem with improved management of the feedlot surface and settling basin. If solids remain a concern in the VTA, a light tillage operation should redistribute the solids while allowing some grass to survive. If solids accumulation is a severe problem, a more aggressive tillage operation may be necessary followed by replanting of grass.

Vegetation inspection

The health and vigor of vegetation within a VTA or VIB should be checked regularly for potential developing problems. Some common concerns that can be monitored visually include:

- Indications of fertility deficiencies as identified by crop color
- Indications of ponding or solids accumulation causing loss or thinning of forage
- Indications of undesirable plant species
- Indications of high areas where infiltration is not occurring (plants may show signs of low fertility or drought)
- Indications of burrowing animals that would bypass infiltration role of soils

Form 3 of appendix F provides a sample inspection form for inspecting vegetation within a plant treatment system.

Standard operating procedures

When created for a specific, clear reason, written operating procedures save time and reduce the chances of mistakes. These procedures are generally referred to as a standard operating procedure (SOP). For some operation and maintenance, a written procedure may be advantageous if one or more of the following applies:

- The NPDES permit targets specific management expectations.
- The procedure is a condition of an environmental permit compliance.
- The procedure is difficult to commit to memory or is not done frequently enough to commit to memory.
- More than one person will be doing the procedure, and/or it must be done the same way each time.
- There could be serious environmental or safety consequences if the procedure is done incorrectly.
- In the manager's absence, someone else may need to do the procedure (vacations).
- New employees are regularly asked to complete a procedure.

A good SOP is written in simple language (including those languages native to all employees) that everyone can understand, includes all the steps involved in the procedure (even simple or obvious steps should be included, especially if they could have environmental consequences if skipped), is signed and dated, is reviewed, and is revised as needed by the responsible person.

Some key topics to be addressed by SOP for a vegetated treatment system include:

- VTA or VIB soil sampling procedure
- Solids removal from settling basin or other solids collection structure
- Runoff sampling procedures
- Forage harvesting procedures
- Liquid release from solids settling basin or storage (if release is actively controlled)
- Visual inspections for discharges following rainfall events
- Visual inspection of VTS components

- Mass nitrogen and phosphorus balance calculations on a VTA or VIB
- Other management procedures specifically identified within the NPDES permit

Records for monitoring performance

Sample records for VTA systems are provided in appendix F. A discussion of key issues to be addressed by these records follows.

CAFO regulation compliance

The NPDES permit issued to an individual CAFO will define the specific record keeping requirements and should be the final reference for establishing a recordkeeping and reporting program. Table 8–2 summarizes the three primary principles that should be addressed by a recordkeeping program for a conventional and a VTA system. State permitting authorities have the option of expanding the record and reporting requirements beyond those discussed in this section.

Of primary concern are the records and reporting requirements associated with a discharge event. Conventional runoff control systems must demonstrate their ability to limit surface water discharges resulting from a 25-year, 24-hour storm event or less. Larger storm events and possibly chronic (extended) wet periods can produce allowable discharges only if records demonstrate the quantity and timing of rainfall events and proper management of the manure management system prior to and during such events. Records commonly used to document attainment of this objective by a CAFO using a conventional system are summarized in table 8–2.

Alternative technologies such as a VTA system must perform at least as well as the conventional technology. Records will be necessary to verify the same precipitation and management related information. Table 8–2 summarizes a suggested set of records for documenting proper management of a VTA. Suggested records to document a VTA performance are included in appendix F for VTAs.

Releases of water from VTA **must** be observed, sampled, and reported to the permitting authority. To determine when a release occurs, a small reception basin with a spillway should be constructed at the outlet of the last component of the VTS. This small reception basin should be designed to provide a visual means of identifying when a discharge has occurred and a location for collecting a representative sample for later analysis of solids, nutrients, and fecal coliform concentration. An open livestock watering tank buried at ground level at the outlet may serve this purpose.

Table 8–2 Record expectations for a CAFO using a conventional or VTA system. *Suggested records for non-CAFOs are italicized.* [1]

Performance monitoring principle	Recommended records (reports) for a conventional system	Recommended records (reports) for a VTA system (see app. F for sample records)
1) What are the precipitation events that lead to the discharge? If a single storm event or a chronic rainfall period greater than the 25-year, 24-hour storm is the cause of a discharge, then the permitting authority will likely consider such a discharge as an acceptable discharge	– Daily onsite precipitation records	– Daily onsite precipitation records
2) Was good management practiced prior to a discharge? Producers must document key indicators of good (or poor) management	– Animal inventory – Pond liquid level – Pumping start and stop time and dates – Amount pumped – Daily visual inspections of water lines – Runoff effluent nutrient analysis – Weekly inspections of storm water collection/diversion components, runoff storage components, and pond depth readings	– Animal inventory – VTA inspection and maintenance for uniform flow – Crop harvest date and yield – Timing of solids harvest from solids settling system – Daily visual inspections of water lines – Runoff effluent nutrient analysis – Weekly inspections of storm water collection/diversion components – If a settling basin includes storage, follow recommendations for conventional system – VTA and VIB soil samples
3) When does a discharge occur? Any discharge from the runoff holding pond (or last stage of the VTA system) must be reported to the permitting authority within 24 hours by phone and 7 days by written report	– Livestock manure or related process water discharge report (Form 1 or equivalent) – Lab sample report on concentration of solids, nutrients, pH, and fecal coliform in discharge	– Discharge from VTA occurring as feedlot runoff is being applied to VTA (Form 1 or equivalent) [2] – Lab sample report on concentration of solids, nutrients, pH, and fecal coliform in discharge [2]

1 State permitting authorities may add additional requirements to the NPDES program for individual states. The CAFO's NPDES permit will define the specific record and reporting requirements with which the CAFO must comply.

2 Individual permitting authorities will define which releases of runoff from a VTA will qualify as a discharge and require reporting within 24 hours. Ask the permitting authority for this information. The producer also is encouraged to collect and analyze samples from releases from a VTA and create a history as to what releases are primarily clean water and what release contain feedlot runoff.

Example

Standard Operating Procedure (SOP) for
Sampling Open Lot Runoff Nutrient Concentration

Developed by: John Q Owner Revised by: ____________

Date: September 1, 2004 Date Revised: ____________

Filing Location: Clear Creek Feedlot business office

Posting Location: SOP manuals in feedlot office, employee break room, and all feedlot pickups

Purpose: Procedure ensures that runoff is regularly and accurately sampled for concentration of nutrients, solids, and potential contaminants.

Steps

1. Take samples in June and October.
2. Get rubber gloves, dipping can (coffee can on 8 ft pole), and a clean 5-gallon sampling bucket from the scale shed. Put the gloves on.
3. Collect 10 surface samples from perimeter of solids settling basin immediately following a rainfall event of 0.5 or more inches. Pour samples into 5-gallon bucket.
4. Stir the 5-gallon bucket sample in the bucket. Continue to stir until all the sample is mixed completely.
5. Get a clean quart plastic bottle from scale house. Fill the jar leaving 1-inch empty headspace.
6. Add lid and seal lid to jar with electrical tape.
7. Add a large mailing label to the jar. Record the farm name, your initials, and the date on the mailing label using a permanent marker.
8. Empty the remaining runoff from the bucket into settling basin.
9. Dispose of the gloves in the trash can and wash/disinfect hands thoroughly.
10. Take the sample to the office manager for immediate freezing or refrigeration.

Farm Personnel Training Needs

Employee	Training Topic	Date Completed	Dates Update
John Q. Owner	Sampling SOP and mailing to lab	Sept. 1, 2003	
Mary Rider	Sampling SOP	Sept. 4, 2003	9/04
Jim Crewchief	Sampling SOP	Sept. 4, 2003	
Chris Office	Mailing sample to lab	Sept. 10, 2003	

Standard Operating Procedure (SOP) for
____

Developed by: ___________________________ Revised by: __________________________________

Date: _________________________________ Date Revised:______________________________

Filing Location: ____

Posting Location: ______

Purpose: ____
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Steps:
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Farm Personnel Training Needs

Employee	**Training Topic**	**Date Completed**	**Dates Update**

Individual permitting authorities will define which releases of runoff from a VTA will qualify as a discharge and require reporting within 24 hours. **Ask the permitting authority for clarification on reportable discharges.** The producer also is encouraged to collect and analyze samples from releases from a VTA and create a history as to which releases are primarily clean water and which releases contain feedlot runoff. The presence of ammonium, volatile solids, or salts may provide some indication of presence or absence of feedlot runoff in the sample. A comparison sample from a field receiving no manure or feedlot runoff would be helpful in identifying if significant runoff pollutants from the feedlot are escaping the VTA.

Many of these records are essential for proper management of a VTA for all sizes of AFOs (not specifically CAFOs). Regular inspections and records for the VTA site and related components are essential for ensuring proper nutrient management and distributed flow of runoff over the VTA. Records detailing liquid levels in the settling basin and precipitation are essential for avoiding classification of an animal-feeding operation as a CAFO as a result of a discharge.

Ground water protection

Some states may regulate performance of animal production systems relative to their impact on ground water. For VTA systems, excess nitrogen application creates the potential for leaching of nitrate below a crop's root zone and is the primary opportunity for impact on ground water by a VTA. This issue is likely to be of greatest concern in the first 50 feet of a VTA. Possible indicators of ground water risk might include:

- End of growing season deep soil nitrate testing (24 to 36 in). This is only a fair measure because larger rainfall event can flush nitrate beyond sampling depth
- Crop nitrate levels
- Crop nitrogen removal (only estimates removal of nitrogen, not nitrogen additions to field):

$$\text{N removal (lb)} = \frac{\text{Tons of harvested crop} \times \text{\% crop protein} \times 20}{6.25}$$

Records to document at least one of these three indicators of nitrogen utilization by the cropping system (and minimal nitrate leaching) are recommended for situations were ground water contamination is regulated or a priority neighborhood or regional issue.

Vegetation management

Table 8–2 contains a suggested set of records to document efforts to maintain a well-performing vegetation system.

Example:

In section 6, sizing calculations for a 2,000 head feedlot suggested the need for a VTA between 8 and 14 acres based upon the assumptions made the design phase. A 12-acre VTA was installed. In 2004, 4.5 tons per acre of tall fescue was harvested with an average protein content of 12.5 percent. Check the nitrogen balance for the VTA.

$$\text{N removal (lb)} = \frac{4.5 \text{ ton/a} \times 12 \text{ a} \times 0.125 \times 2{,}000 \text{ lb/ton}}{6.25} = 2{,}200 \text{ lbN/a}$$

Discussion: This value compares favorably with the two estimates of nitrogen in feedlot runoff in section 6 (1,600 and 2,800 lb N/yr) and the literature value from section 9 (table 9–4) of 0.68 lb N in runoff per finished animal (2,700 lb total N/yr, about half of which is crop available). Because of challenges with uniform distribution of nitrogen, deep soil sampling should be initiated near the runoff inlet into the VTA.

Record	Headlands (50 ft after effluent inlet)	Remainder of VTA
Soil nutrient profile		
Shallow (top 2 in) soil sample for P and pH	X	X[1]
• Plow layer sample for soil organic matter P, K, EC, and pH	X	X[1]
• Deep soil sample for nitrates (top 3 ft)	X	X[1, 2]
Crop production		
• Harvest timing and conditions	For entire VTA	
• Quantity of forage harvested	For entire VTA	
• Forage protein	For entire VTA	
• Forage nitrate	X	X
• Forage potassium (animal health)	For entire VTA	
• Pesticide application timing, rate, and product	For entire VTA	

1 Remainder of VTA may be divided into one or more zones.
2 Risk will be greatest in upper end of VTA. Sampling may not be warranted until headlands nitrate-nitrogen levels are observed to be high.