Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

DRAINAGE WATER MANAGEMENT

Code 554

(Ac)

DEFINITION

The process of managing the drainage volume and water table elevation by regulating the flow from a surface or subsurface agricultural drainage system.

PURPOSE

The purpose of this practice is to—

- Reduce nutrient, pathogen, and pesticide loading from drainage systems into downstream receiving waters.
- Improve productivity, health, and vigor of plants.
- Reduce oxidation of organic matter in soils.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to agricultural lands with surface or subsurface agricultural drainage systems that can be adapted, or are partially adapted, to allow management of drainage volume and water table by changing the elevation of water level at the outlet(s).

This practice applies where a high natural water table exists or has existed, and the topography is relatively smooth, uniform, and flat to very gently sloping.

The practice applies to saline or sodic soil conditions, but special considerations are required. See Qadir and Oster 2003 in the References section.

This practice does not apply to the management of irrigation water supplied through a subsurface drainage system. For that purpose use NRCS Conservation Practice Standards (CPS), Irrigation System, Surface and Subsurface (Code 443) and Irrigation Water Management (Code 449).

The practice does not apply to the seasonal inundation of fields from overland surface runoff.

CRITERIA

General Criteria Applicable to All Purposes

Manage the drainage discharges and water levels in a manner that does not cause adverse impacts to other properties or drainage systems. Water control structures used in the management system must not cause water to back up into a main or lateral beyond a property line unless the upstream landowner has given written permission.

Manage gravity drainage systems by adjusting the outlet elevations of the water control structure(s) located within the drainage system. Refer to NRCS CPS, Water Control Structure (Code 587) for design criteria. Managed drainage mode is raising the elevation of the control structure outlet above the normal drain elevation to store water in the soil, as opposed to free drainage mode.

Manage pumped drainage outlets by adjusting the on-off elevations for pump cycling throughout the year to provide the required outlet elevation for the drainage system.

Raising the outlet elevation of a water control structure in a flowing drain must result in an elevated free water surface within the soil profile.

Locate structures and pumps where they are convenient to operate and maintain. When operated in free drainage mode, water control structure(s), including any buried in-line control valve(s), must require no more than 0.2 feet of head to maintain the unrestricted flow rate of the drainage system.

Ensure the flow velocity in the drainage system does not exceed acceptable velocities prescribed by NRCS CPSs, Surface Drain, Main or Lateral (Code 608) and Subsurface Drain (Code 606), as applicable. Controlling drain velocities is typically necessary only during the release of drainage water from control structures.

In cold climates, lower the outlet elevation during winter after drain flow has stopped. This will avoid freezing damage to the water control structures. Raise the water to the planned elevation when flow resumes.

Control Elevation. Reference the outlet elevation of each water control structure to a “control elevation” which is defined as the lowest elevation of the soil surface in the area of the field (control zone) impacted by the operation of the water control structure.

To determine the area drained by a single drain use the lateral spacing recommendations specified in the State drainage guide for the predominant soil type in the drained field. The outer boundary of the drained area is a distance of one-half the recommended lateral spacing away from the drain(s).

Where a State drainage guide does not exist, determine the lateral drain spacing using the van Schilfgaarde equation and associated State-accepted time factor.

Control Zone. The control zone (or impacted area) for each water control structure is defined as the drained area upstream of the given control structure. The control zone is bounded on the lower end by the planned control elevation of the given water control structure and on the upper end by the control elevation of the structure immediately upstream or a defined elevation above the given control structure, whichever is less. The defined elevation is a maximum of 2 feet.

Develop a management calendar which specifies the target water control structure outlet elevation throughout the year to meet the intended purpose. Adjust the water levels throughout the year to allow for proper root zone development. Specify conditions where adjusting the outlet elevations may be required, such as significant rainfall events. Describe what those adjustments might be. Provide means for the operator to monitor and record the water levels in the water control structure(s) and the water table within the control zone(s). This information will enable the operator to adapt management to changing weather conditions and minimize adverse effects on crops and soils.

Additional Criteria to Reduce Nutrient, Pathogen, and Pesticide Loading

Drainage Water Management is an ongoing practice implemented throughout all days of the year.

Minimize drainage below that necessary to provide an adequate root zone for the crop.

Maintain each water control structure outlet in managed drainage mode except when the water table must be lowered for trafficability for field work, adverse weather conditions, or system maintenance.

Raise the outlet elevation of the water control structure to within 12 inches or less of the ground surface during noncropped (fallow) periods. Raise the outlet within 2 weeks after final field operations following harvest. Change to free drainage mode no more than 2 weeks before the planned commencement of the next season's field operations, except during system maintenance periods or to provide trafficability when field operations are necessary.

In cold climates, lower the outlet elevation during winter after drain flow has stopped. This will avoid freezing damage to the water control structures. Raise the water to the planned elevation when flow resumes. In fields with winter cover crops, lower the outlet elevation during winter to within 0.5 feet of the expected cover crop rooting depth.

Raise the outlet elevation of the water control structure to within 0.5 feet below the control elevation or just below the root zone of an actively growing crop prior to and during liquid manure applications in order to prevent direct leakage of manure into drainage pipes through soil macro pores (cracks, wormholes, root channels). Maintain the raised outlet elevation for at least 15 days following manure application or until the next precipitation event that produces drain flow. Monitor the control structure(s) for trapped manure. Remove liquid manure trapped in the structure(s) and dispose of it in an appropriate manner.

Additional Criteria to Improve Productivity, Health, and Vigor of Plants

When managing drainage outflow to maintain water in the soil profile for use by crops or other vegetation, specify the water elevation based on root depth and soil type to maintain proper root development and soil aeration.

Raise the outlet elevation after planting to allow the retention and movement of water in the crop root zone.

Additional Criteria to Reduce Oxidation of Organic Matter in Soils

Minimize drainage beyond that necessary to provide an adequate root zone for the crop.

To reduce oxidation of organic matter, set the outlet elevation to enable the water table to rise to the ground surface, or to a designated maximum elevation, for sufficient time to create anaerobic soil conditions. The implementation of this practice must result in a reduced average annual thickness of the aerated layer of the soil.

CONSIDERATIONS

Generally, the same drainage intensity is not required at all times during the year. Consider a management strategy that enhances crop yield while minimizes negative water quality impacts.

For the practice to be economical and practical, each control structure needs to influence a significant amount of the field; therefore, drainage water management is generally limited to nearly flat fields with slopes typically less than 1.0 percent. On moderate slopes design drainage laterals on the contour to maximize the control zone of each structure. Raising the water table during the growing season will generally increase evapotranspiration and may increase crop yield. Take care to maintain a sufficiently aerated crop root zone so as not to damage the crop.

Monitoring of root zone development may be necessary if the free water surface in the soil profile rises close to the soil surface during the growing season.

Because of the increase in water volume stored in the soil profile, drainage water management may affect the water budget, especially volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.

Drainage water management may increase base flow in streams and ditches because of a higher gradient from the fields. A higher field water table may increase lateral and vertical seepage losses. Since this water will likely pass through reduced (low) oxygen zones, seepage water may be denitrified before reaching surface water conduits.

Installing inexpensive water table observation wells can improve management.

Avoid traffic on fine-textured, wet soils to minimize soil compaction.

Reducing mineralization of organic soils may decrease the release of soluble phosphorus, but water table management may increase the release of soluble phosphorus from mineral soils.

Elevated water tables may increase the runoff portion of outflow from fields. Consider conservation measures that control sediment loss and associated agrichemical discharge to waterways.

When using this practice for reduction of pesticide loading or rodent control, apply pesticide in accordance with NRCS CPS Integrated Pest Management (IPM) (Code 595).

If wildlife habitat is a resource concern, design the system so that during the noncropped season, the managed elevation of the drainage outlet is consistent with the habitat management plan for the targeted species.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended purpose(s).

At a minimum, include—

- Farm and field information with a location map.
- The objectives of the landowner.
- A map (or maps) that includes—
    - Field boundaries.
    - Drainage water management project area (drained area) boundaries.
    - A soils map showing the drainage class.
    - A map of the drainage system, including the location of water control structure(s) and the size and location of all mains and laterals.
    - A topographic map with one foot contours or less.
    - A map that shows the location, size, and impacted area (i.e., control zone) of each existing and planned control structure.
- A management plan as described in the Operation and Maintenance section of this standard.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan and review with the landowner or operator responsible for the application of this practice.

- Identify the intended purpose of the practice, safety requirements, and critical dates and target elevations of the water table necessary to meet the intended purpose(s).
- Include instructions for operation and maintenance of critical components of the drainage management system, including instructions necessary to maintain flow velocities within allowable limits when lowering water tables. Address the following management objectives as applicable:

  - Prior to tillage, harvest, and other field operations, set the outlet elevation at a depth to provide trafficability throughout the field (typically the bottom of the drainage outlet).
  - After planting and other necessary field operations, raise the outlet elevation to the planned level. Monitor water elevations to allow capacity to store infiltration from rainfall, as well as subsurface water from up gradient, depending on the soil texture, significant allowance may be required to allow for capillary rise. This will vary, depending on crop, stage of growth, and soil.
  - Operate the outlet elevation in the control structure during the crop season so that prolonged saturation of the root zone does not occur (i.e., as observed in the water table observation wells, if any).
  - During the fallow period, set the outlet elevation in the control structure to allow local groundwater and infiltrated precipitation to elevate the water table to potentially rise to near the soil surface or to an elevation specified by the planner.
  - To prevent leakage of liquid manure applications into drain pipes, specify the elevation of the raised drainage outlet and the number of days prior to and after the application that a raised outlet elevation is to be maintained.
- Replace warped flashboards and damaged seals that cause structure leakage.

REFERENCES

USDA, NRCS. 2001. National Engineering Handbook, Part 624, Sec 10, Water table control and Sec. 16, Drainage of agricultural land.

USDA, NRCS. 2001. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 14, Water management (Drainage).

Qadir, M. and J.D. Oster. 2003. Crop and irrigation management strategies for saline-sodic soils and waters aimed at environmentally sustainable agriculture. Science of The Total Environment. DOI: 10.1016/j.scitotenv.2003.10.012. Volume 323, Issues 1–3, 5 May 2004, Pages 1–19.