Water Resources Division

Drainage Tile Outlet Control Structure

Definition

Outlet controls are structures placed at the ends of drainage tiles. The structures contain adjustable weirs used to control the minimum elevation at which water leaves the drainage tile, which in turn controls the maximum elevation of the groundwater table in the area drained by the tile system to which the outlet control structure is attached.

Description & Purpose

Outlet control structures are used for drainage water management, which is the process of adjusting the timing and amount of discharge from subsurface agricultural drainage tile systems. It's based on the premise that maximum drainage intensity is not required at all times during the year, and that at certain times it's actually beneficial to detain water for the purpose of raising the water table so that the roots of growing plants are in closer proximity to water. Some of the water quality-related benefits of drainage tile outlet control structures include: increased infiltration, reduced pollutant loads associated with reduced tile line discharges, and reduced pollutant loads associated with manure applied to tiled fields.

Pollutants Controlled & Removal Efficiencies

Drainage water management is being increasingly relied upon as a means of minimizing the discharge of pollutants from agricultural sources, including: nutrients, pathogens, pesticides, herbicides, sediment, and flow (NRCS, undated; NRCS, 2010).

Frankenberger et al (2006) report reductions in annual nitrate load in drain flow ranging from ~15 to ~75 percent, depending on location, climate, soil type, and cropping practice. Because drainage tile outlet control structures by themselves don't change the nitrate concentration of drain flow, the nitrate load is reduced by about the same percentage as drain flow is reduced. That is, the load reduction is achieved by reducing flow, not by reducing concentration. In regions where much of the drainage takes place during the winter (such as Illinois, Indiana, and Ohio), the reduction is likely to be greater than where most of the drainage takes place in April or later (such as Iowa and Minnesota).

Companion & Alternate Practices

Subsurface Drain

Advantages & Disadvantages

Additional benefits of using drain tile control structures include:

- Improved productivity, health, and vigor of plants;
- Reduced oxidation of organic matter in soils;
- Reduced wind erosion or particulate matter (dust) emissions; and
- Seasonal wildlife habitat.

Location

Drainage water management is best suited to:

- Flat topography, generally less than 0.5% slope (Frankenberger et al, 2006);
- Intensive tile systems; and
- New systems planned and designed from the outset with drainage water management in mind. That is, starting from scratch is typically easier and cheaper than retrofitting.

Design

Drainage water management is achieved through the use of water control structures with adjustable flow control mechanisms. The structures are placed at drain tile outlets, and can also be placed within drain tile systems when multiple zones of influence (with varying water table levels) are desired. Automated devices are available to aid in management.

Operation

Post-Harvest

For maximum water quality benefit during the period from post-harvest through pre-planting (so, from the fall, through the winter, and into spring), the current recommendation is to set the control structure outlet elevation within six (6) inches of the field surface. Note that this might cause surface ponding in depressional areas of fields (Frankenberger et al, 2006). This is typically the highest setting of the year, of the outlet control structure. Figure 1 depicts the setting of an outlet control structure during the period from post-harvest to pre-planting.

Pre-Planting

Approximately two weeks prior to the start of field operations in the spring, the control structure outlet elevation is lowered enough to allow the affected fields to sufficiently dry out, so that farm equipment can navigate across and operate in the fields, and so that planting can commence. This is typically the lowest setting of the year, of the outlet control structure. Figure 2 depicts the pre-planting setting of an outlet control structure.

Growing Season

During the growing season, the outlet control structure is managed so that the water table in the affected fields stays relatively close to, but below, the roots of growing plants. This typically involves raising the outlet control structure to something above the pre-planting elevation described above, then periodically lowering the elevation through the season, as the roots of the growing plants extend deeper underground.

The optimum growing season outlet control structure elevation has yet to be determined, but the current suggestion is two (2) or more feet below the field surface (Frankenberger et al, 2006). The goal is to provide enough drainage for good aeration and root development, but to capture some of the water that would otherwise drain out under conventionally tiled systems. Note that the drainage outlet setting does not ensure that a water table will be present at the desired depth; sufficient rainfall must occur for the water table to rise to the depth of the outlet setting.

Exercise caution during the growing season, especially during prolonged wet periods, because maintaining water table depths shallower than two (2) feet can potentially increase the risk of excess water causing stress to crops. Pay particular attention to the management of soybeans, since they are less tolerant of wet roots (Frankenberger et al, 2006). So, during the growing season, management can involve temporarily lowering the outlet control structure elevation, to increase drainage during periods of heavy rain or sustained wet periods.

So, the growing season elevation setting of an outlet control structure is typically something between the post-harvest and pre-planting settings (though there can be some variability in this, as described above). Figure 3 depicts a typical growing season setting of an outlet control structure.

Liquid Manure Application

To minimize direct leakage of liquid manure applied to tiled fields through soil macro pores (whether formed by cracks, wormholes, or root channels), into drain pipes, and to receiving streams, establish and adhere to a drainage water management plan which specifies drain tile outlet control structure operation with respect to liquid manure application, including: (a) the elevations to which outlet control structure weirs are to be raised prior to liquid manure application, and (b) the number of days prior to and after liquid manure application that raised elevations are to be maintained (USDA NRCS, 2010).

Maintenance

Maintain outlet control structures as part of the regular upkeep of the associated Subsurface Drains. The major maintenance concerns for such systems are:

- Clogging due to the capture of sediment, vegetation, trash, or other debris;
- Piping of flow around Subsurface Drains, which can cause erosion, or even system failure;
- Cave-in from inadequate support of Subsurface Drains by the surrounding soil;
- Encroachment of tree roots (such as by willows) into Subsurface Drains;
- Adherence to all appropriate safety precautions, such as working in trenches, confined space entry, etc.

Literature Cited

Frankenberger, J., et al. 2006. *Drainage Water Management for the Midwest: Questions and Answers About Drainage Water Management for the Midwest*. Purdue University Cooperative Extension Service. Document number WQ-44.

USDA NRCS. Undated. *Drainage Water Management*. *(The link provided was broken and has been removed)*

USDA NRCS. 2010. *Drainage Water Management*. Electronic Field Office Technical Guide (eFOTG) Conservation Practice #554.

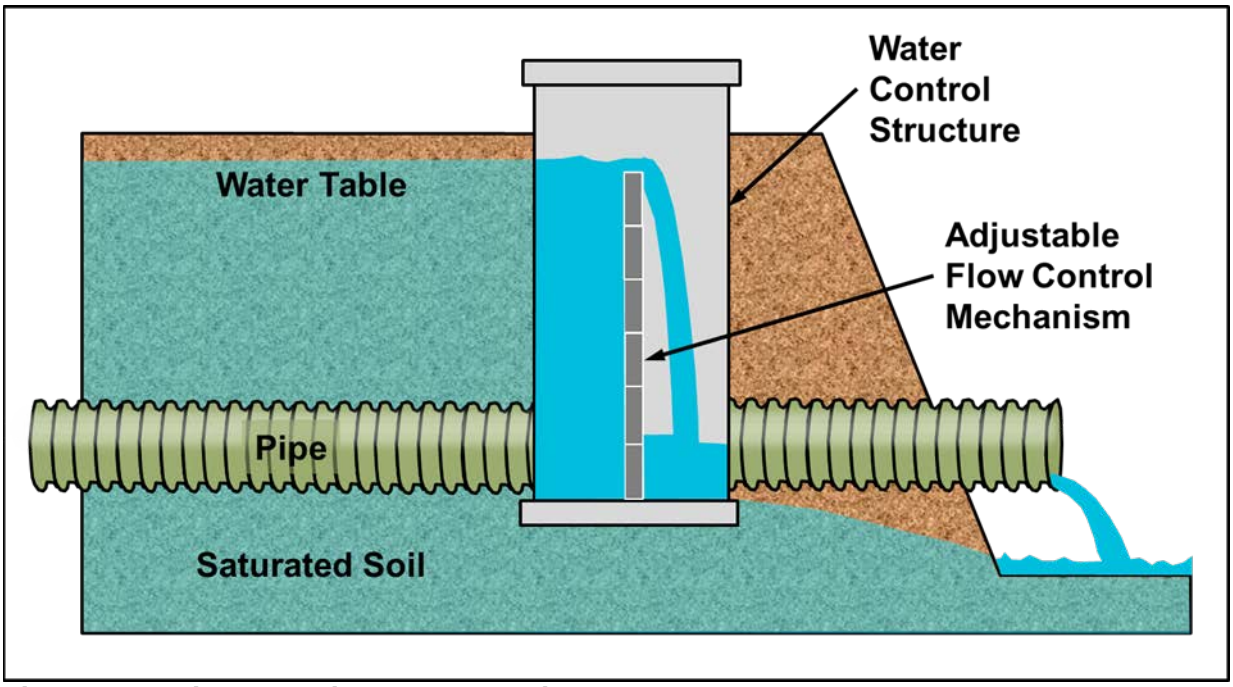

Figure 1. Outlet Control Structure Setting: Post-Harvest

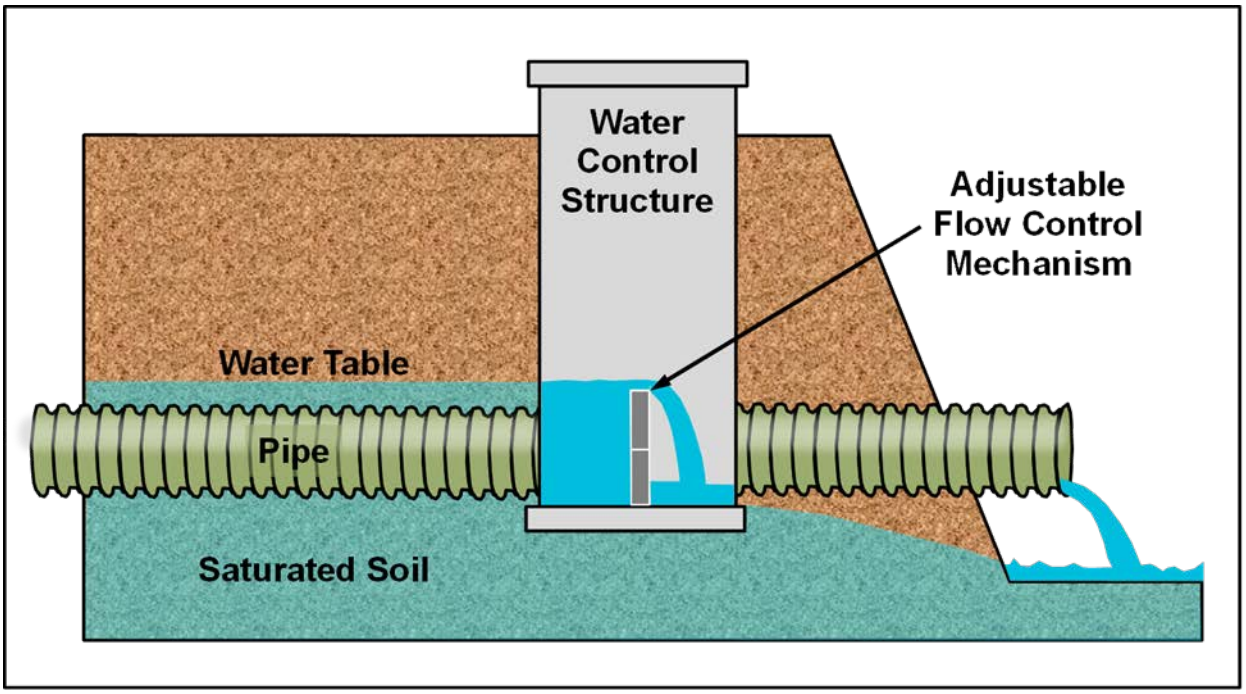

Figure 2. Outlet Control Structure Setting: Pre-Planting

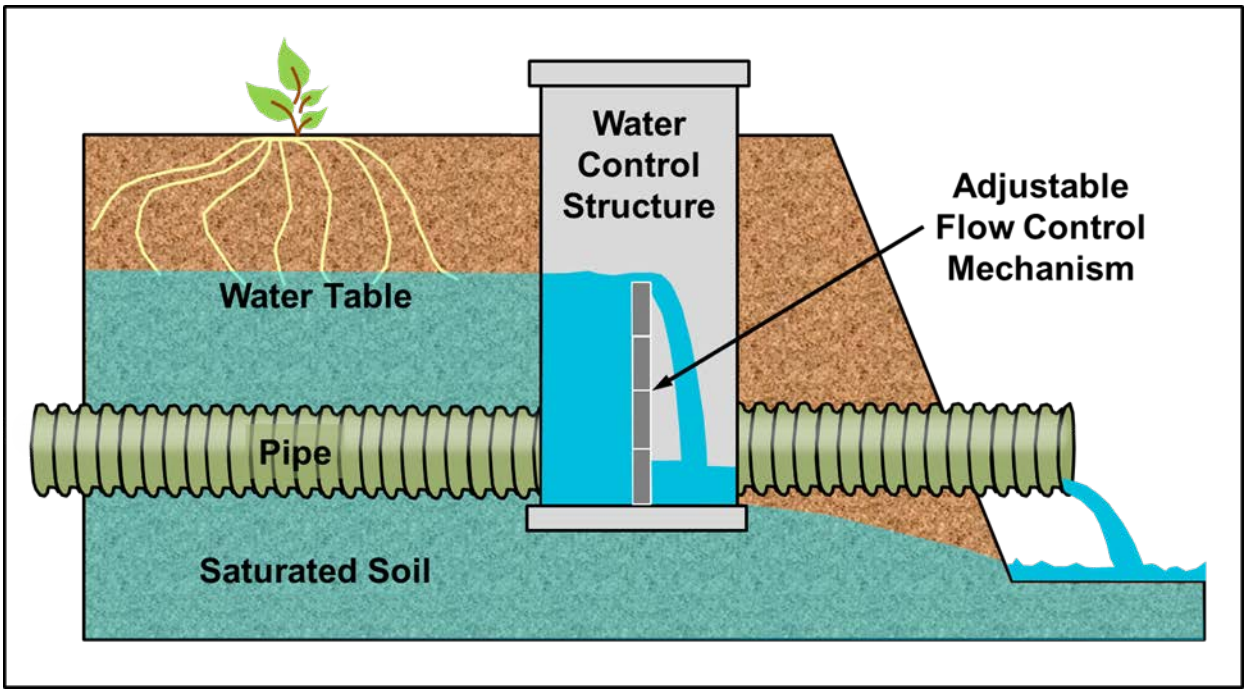

Figure 3. Outlet Control Structure Setting: Growing Season