Wet Detention Basins for Managing Citrus Drainage Waters in South Florida

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INTRODUCTION

Historically, most of Florida's citrus production has been in the upland regions of the central part of the state. Following a series of devastating freezes in the 1980s, there was a major shift in the geographical distribution of citrus acreage (Behr, 1989). Growers seeking to reduce the risk of freeze damage have been locating new groves in south Florida.

There is a concern that the scale of these developments may significantly affect the hydrology and ecosystems of the region, which includes the environmentally sensitive Everglades National Park and the Big Cypress National Preserve. Much of the current and proposed citrus development is occurring in areas occupied by several rare or endangered species. The region has also experienced rapid growth in the coastal urban population. Therefore, concern exists over the availability and quality of water resources to meet these diverse needs.

Because of a seasonally high water table, drainage is required for most of the land to be agriculturally productive. Much of the area currently being developed for citrus was cattle rangeland in native or improved pasture. The drainage requirements significantly differ for rangeland use and citrus groves. Native grasses can tolerate periods of wet and flooded conditions. Therefore, pasture and rangeland areas are typically drained by shallow ditches placed on wide intervals. Citrus is sensitive to excess water, thus requiring grove developments to have more elaborate and responsive drainage systems.

There is concern that the expansion of citrus groves in south Florida may have the following impacts: (1) the drainage impacts on existing wetlands may destroy the habitat for a number of species that are currently endangered and may result in other species becoming endangered; (2) the required pumpage capacities for responsive drainage systems may produce large distortions from the pre-development surface water hydrology of the surrounding area; (3) fertilizers and pesticides used in citrus production may be transported with the drainage water and could possibly contaminate nearby water bodies; and (4) through reduced surface storage, groundwater recharge rates may be affected.

The South Florida Water Management District (SFWMD) has the governmental responsibility and authority to regulate storm water. Given these concerns, the SFWMD has set certain guidelines for the construction of wet detention basins for the impoundment of agricultural drainage water before it can be discharged off-site.

Wet detention areas are defined as water storage areas with a bottom elevation at least 1 ft (30 cm) below the elevation of a controlled discharge structure. Wet detention basins for drainage water from citrus groves are designed to have four primary functions: 1) to maintain off-site discharge peak flows at or below pre-development levels; 2) to provide detention time for sediment removal and enhancement of the quality of the discharged water; 3) to preserve wetland habitats; and (4) to provide groundwater recharge areas.

CITRUS DRAINAGE MANAGEMENT STRATEGY

Conceptual Approach

The conceptual approach to grove design, development and management is to feasibly maintain existing hydrologic conditions with respect to the quantity and quality of off-site water discharge. In addition, the development should not adversely affect overland flow or result in the destruction of viable wetlands (Rodgers, 1982).

Since most developments will have relatively low areas (swamps, marshes and bogs) that can be converted to grove only with extensive land forming, the desired approach is to include those areas into the wet detention basin. Since it is considered more viable to have a few larger wet areas than many small unconnected ones, certain modifications are allowed. Small wet areas, which still exist after designating the wet detention basin, can be replaced by a "tradeoff" with land adjacent to the wet detention basin (Rodgers, 1982).

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Floodplain encroachment must be avoided and should be considered from the aspecta of storage reduction and flow interference. A flow channel cross-section must be maintained to adequately *carry* a three-day, 25-year storm. The post-development hydrography for that same storm event should conform to the pre-development hydrography. To maintain the desired water quality, it is required that the wet detention basin be designed to hold the first **1** in. of runoff in the detention basin and to release it over a five-day period.

Grove Layout and Drainage System

After the proposed site for the grove is surveyed and an elevation grid established on 100-ft interval wet and low areas are identified for possible inclusion in the wet detention area. Natural overland flow paths are located, and a plan is developed to channel this flow through the grove while avoiding floodplain encroachment. Location and size of the wet detention basin is then determined. Effort is made to include and connect existing wet areas. Exterior levees are located and sized to allow passage of off-site flow while protecting the actual grove area. Interior lateral and collector ditches are located, sized and installed to provide drainage. Typically, lateral ditches 5 ft deep are placed at 1300-ft intervals.

Lift pumps are installed in the main collector ditch adjacent to the wet detention basin. Pump stations are typically sized to remove 4 in. of drainage water from the grove area within a 24-hour period. This pumping capacity along with soil storage is intended to provide protection to the citrus trees from a 10-year 24-hour rainfall event.

One of the first steps in actual grove development is landforming. Landforming is performed after consideration of the natural drainage, and the actual grading design attempts to minimize depths of cuts and fills. After grading, tree beds are formed. Bed height (distance from top of bed to bottom of furrow) is usually about 30 in. This bed provides drainage for two tree rows typically planted on 24-ft. centers. Tree spacings usually range from 10 to 22 ft. Finally, 8-in. drainage pipes are installed to convey drainage water from the furrows to the lateral ditches.

Irrigation is required to maintain the trees through the 8-month dry season typical in south Florida Micro-irrigation is the accepted practice with micro-sprinklers and micro-sprayers being most common. This irrigation method has a significant influence on drainage. First, only a portion of the surface area (usually less than 50%) is wetted; therefore, significant soil storage capacity is available for rainfall. In addition, fertigation (fertilizer application through the micro-irrigation system) is commonly practiced with micro-irrigation systems. Since nutrients are delivered on demand through the irrigation system, there is less opportunity for their leaching during rainfall, and the concentration of nutrients in discharge water is expected to be much lower.

Wet Detention Basin Design Procedure

Accepted engineering procedures are followed in the design of the wet detention basins. Runoff volume from the grove area is estimated by the SCS runoff equation (Eq **1**) (**USDA-SCS**, 1972):

$$Q = (P - 0.02S)^2/(P + 0.8S) \qquad \text{Eq [1]}$$

where,

Q = runoff volume,
P = 24-hour rainfall depth,
S = watershed storage parameter depth.

Methods for determining the value of the storage parameter, S, are given by Capece et al. (1987).

The design storm rainfall is based on a 25-year, three-day event. The area of the wet detention area is determined from estimated runoff volume and the maximum design storage water depth for the impoundment area (usually equal to or less than 5 ft). To improve the quality of water discharged off-site, water is held in the detention basin to allow physical and biochemical processes to occur. Only 0.5 in. of the storm runoff is allowed to be discharged off-site in the first 24 hrs after the storm event. This is accomplished by a control structure designed to restrict the discharge flow fate.

Peak discharge through a control structure is limited to the pre-development peak runoff rate that would have occurred from the design storm. Peak pre-development runoff rates are computed from a graphical technique published by the SFWMD (1979). Graphs are presented that were developed from a computer model constructed by Higgins (1976). The model employs the Manning equation combined with an assumed retention depth to estimate peak discharge. The control structure is set at an elevation of 1 ft above the bottom of the wet detention basin to maintain a flooded condition in a significant portion of the basin during the rainy season.

The emergency overflow structure is sized to discharge the entire pumping inflow capacity and rainfall from a 100-year, three-day storm on the detention basin, and the overflow is directed ***on-site.*** Therefore, flood waters from extreme events are controlled and held on the grove site. Finally, the design storm is routed through the wet detention area to insure proper functioning of each component.

Water Quality Enhancement and Wetlands Preservation

Initial studies have indicated significant enhancement in the quality of drainage water leaving the detention basins (Stone et al., 1988; Black, 1990). These studies have indicated a 95 and 64% reduction in the nitrogen and phosphorus, respectively, after the drainage water has passed through the detention basins. There is concern that the long-term effect could be the concentration of nutrients and pesticides in the detention areas, which attract wildlife. Studies have been initiated to evaluate the long-term impact to wildlife (Arnold, 1990).

Work has also been initiated to develop strategies for managing the detention basins to preserve the wetlands and to enhance wildlife habitat. One strategy that is being examined is the manipulation of the control discharge elevation. For example, water levels could be reduced to concentrate food resources for wading birds during critical periods in the reproductive cycle. Another approach that is being investigated is the drawdown of water level and controlled burning to eliminate undesirable flora. Numerous other management techniques will be examined.

SUMMARY

Wet detention basins are water storage areas with bottom elevations at least 1 ft below the elevation of the control discharge structure. The primary functions of these detention basins are as follows: 1) to maintain off-site discharge peak flows at or below pre-development rates, 2) to improve the quality of drainage water, 3) to provide and preserve wetlands habitat and 4) to provide groundwater recharge. Intensive studies are in progress to determine how effectively these detention basins are performing in meeting the above functional objectives.

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