CONSTRUCTED WETLANDS FOR ASSIMILATION OF DAIRY EFFLUENTS: MONITORING STUDIES

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INTRODUCTION

Currently much emphasis is being placed on non-point source (NPS) pollution. In addition to identification and extent of these sources, there also exists the need for targeting best management practices (BMP) and monitoring the success of their implementation. This cooperative, interagency demonstration project in Putnam County, Georgia is an evaluation of a selected BMP (constructed wetlands) utilized to capture discharge from overloaded dairy lagoons. The low cost, yet effective, use of wetlands in assimilating agricultural wastewater has shown much promise (Maddox and Kingsley, 1990; Costello, 1990). The project represents a joint effort by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, Soil Conservation Service, the State Soil and Water Conservation District, the Piedmont Soil and Water Conservation District, Cooperative Extension Service and the Georgia Department of Natural Resources. Pre and post project biological and water chemistry monitoring, which commenced in December 1989, is being conducted jointly by staff of EPA, Environmental Services Division (ESD) in Athens, Georgia and the Georgia Environmental Protection Division (GAEPD). Monitoring efforts, in addition to defining effectiveness of the BMP in pollution abatement, were designed to characterize pre-project water chemistry and biology of receiving waters and subsequent changes following implementation of the BMP.

BACKGROUND

Dairy farming is widespread in the Georgia Piedmont. Water use for a typical dairy (150-200 head) amounts to approximately 10,000 gallons/day for washdown of milking facilities. Wastewater from these operations is captured in lagoons which are intended to be a no discharge system. Although periodic pump-out to prevent solids overload is an integral maintenance feature necessary for lagoons, prohibitive costs (~$6000) for this service has precluded its occurrence. In addition to costs, inadequate pumping procedures have resulted in many lagoons becoming overloaded with solids, and thus, continuously discharging to adjacent water bodies. This consequence has led to elevated nutrient concentrations, total suspended solids load and fecal coliform counts in receiving waters.

An additional concern, non-point source runoff from the feedlot and holding area of these dairy operations, has been identified during the course of ongoing monitoring studies by ESD and GAEPD. Identification of this source, which is of much greater magnitude than discharge from the overloaded lagoons, highlights a need for development of abatement measures for controlling both lagoon discharges and non-point sources.

STUDY AREAS

The site of this demonstration project lies in Putnam County near Eatonton, Georgia. Constructed wetlands have been installed at two dairy operations. The lagoon at the McMichael Dairy is presently being filled by wastewater while constructed wetlands are being sustained by water pumped from an adjacent pond. The Key Farm, approximately 9 miles south of Eatonton, is in close proximity to Lake Sinclair. The Key Dairy has had a lagoon in place for several years. Both dairies have tributaries that drain to Lake Sinclair. Since the McMichael Dairy wetlands and lagoon are still in developmental stages, monitoring efforts are primarily directed toward the Key Dairy. As a result, this report will reflect findings of monitoring efforts related to the Key Dairy.

The Key Dairy, located on the south side of Twin Bridges Road, is approximately 1 mile from Lake Sinclair. Discharge from the wetlands system and non-point sources combine downgradient of the wetlands system and lagoon and enter, via a ditch, a small tributary to the north. This tributary enters an embayment of Lake Sinclair.

METHODS

Water Chemistry

Quarterly water chemistry sampling of the constructed wetland system and lagoon was begun in July 1990. Although not a task for the original plan of study, monitoring of non-point source run-off from the ungrassed feed lots and holding areas has been included as a project task.

Water chemistry parameters are ammonia-N, nitrate-nitrite-N, Total Kjeldahl N, total phosphorus, total organic carbon and total suspended solids.

Hydrology

Water level recorders are employed at weirs to the wetland system influent and effluent.

In the event of discharge from the wetland during a storm event, automatic sequential samplers, configured with stage level actuators, will be utilized for water chemistry sampling. Rainfall records were obtained and enhanced flow from the wetlands were monitored via the water level recorder and weir.

RESULTS

Water Chemistry

Overloaded Dairy Lagoon Effluent. Analysis of water chemistry data prior to installation of the constructed wetlands at the Key Farm revealed elevated nutrient concentrations at KD-1 (discharge point from Key Farm) during active lagoon discharge in December 1989 and January 1990. At this time total nitrogen and phosphorus concentrations exceeded 160.0 and 35.0 mg/L respectively.

Constructed Wetlands Treatment of Lagoon Effluent. The constructed wetlands (completed in June 1990) have dealt effectively with reducing frequency of discharge and solids and nutrient loadings to the receiving water. Water level records from the Key Farm lagoon and wetland effluents indicate discharge from the wetlands occurs during significant rain events (>1.0") during the wet season. Comparison of water chemistry data from the lagoon and wetlands indicate a greater than 90% and 80% removal of total nitrogen and phosphorus, respectively, during sampling of inactive wetland discharge (Table 1). Wetlands discharge, following significant rain events, resulted in slightly lower reductions (>65%) of total nitrogen and phosphorus (Table 1). Both dry and wet season reductions in lagoon effluent total nitrogen and phosphorus attributable to the wetlands system have been comparable or exceeded that reported in the literature.

Non-point sources: Feedlot and holding area runoff. As mentioned in the Background section of this report, ongoing monitoring studies have identified non-point source pollution from the dairy feedlot and holding area to be of greater magnitude than the discharge from the overloaded lagoon. Non-point source discharge from the feedlot and holding area bypasses the dairy lagoon and intercepts the Key Farm wetland discharge downgradient of the lagoon. Water chemistry and flow data collected during an actual runoff event (Figure 1) illustrates both the excessive nutrient concentration of this runoff (KR) and its dominance of the total instantaneous nutrient load to the receiving water (KD-1). Of special concern is the high concentration of

TABLE 1. Total Nitrogen and Phosphorus Concentrations for Key Farm Wetlands and Lagoon Effluents and the Total N & P Reduction @ Key Wetlands Effluent, Putnam County, Georgia

Sample Date	Total N (mg/L)		% Reduct. (TN)	Total P (mg/L)		% Reduct. (TP)
	Lagoon Effl.	Wetland Effl.	@ Wetland Effl.	Lagoon Effl.	Wetland Effl.	@ Wetl. Effl.
7/27/90	211.0	21.05	90	42.0	7.6	82
*11/8/90	210.0	72.23	66	43.0	13.0	70
12/4/90	210.07	9.36	96	39.0	5.0	87
*12/17 - 12/19 (54 hr. composite)	210.0	66.12	69	43.0	14.0	67
*12/20/90	220.0	73.0	67	44.0	15.0	66

*Wetland discharge event

nitrate-nitrite nitrogen in the feedlot and holding area runoff. In this form nitrogen is most readily bioavailable and thus can contribute to the eutrophication potential of the lake.

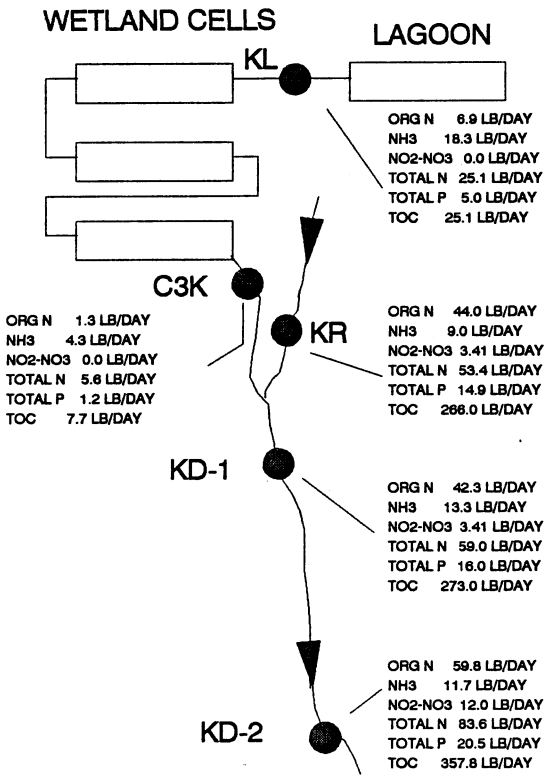

Figure 1. Key Dairy Schematic Instantaneous Loadings, December 20, 1990

Hydrology

Water stage was recorded for the Key Dairy lagoon effluent weir and the effluent weir from the wetlands for the period June 1990 through January 1991. In addition, a rainfall record for this same period has been maintained. The water stage record for the Key Dairy wetland effluent weir indicated that discharge was first released from the wetland cells in late October. With rainfalls commencing in early December, discharge from the lagoon and subsequently from the wetlands have been continuous since the second week of December and has averaged 6500 and 5500 GPD, respectively.

CONCLUSIONS

Constructed wetlands associated with the Key Dairy have contributed to a >90% reduction of total nitrogen and a >80% reduction of total phosphorus during the dry season. During the dry season (warm months) evapotranspiration appears to be a factor curtailing discharge from the wetlands. Although discharge from the wetlands is frequent during the rainy season, reduction rates for total nitrogen and phosphorus exceeds 65%. Recent sampling conducted in January, 1991 indicates a 74%-98% solids (TSS) reduction attributable to the wetlands.

As identified in this paper, non-point sources (pastures, feed lots, and holding areas) represent a much greater nutrient and solids load than does lagoon effluents. Water quality improvements of receiving waters and Lake Sinclair will depend on comprehensive plans for nutrient management.

LITERATURE CITED

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