IMPROVING MANAGEMENT OF OPEN-LOT RUNOFF AND NUTRIENTS ON SOUTHERN HIGH PLAINS FEEDYARDS

Interim Final Report Submitted to the

Texas Cattle Feeders Association (TCFA)
5501 W. Interstate Highway 40
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In fulfillment of the terms of a Memorandum of Agreement between TCFA and the Texas Agricultural Experiment Station (TAES) associated with TAES Account 06-402757

Interim Final Report Submitted By

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Abstract

Comprehensive nutrient management, Total Maximum Daily Loads (TMDLs), and environmental policy and regulations have recently taken front stage as the predominant issues facing production agriculture. Within 150 miles of Amarillo, Texas, over 3.6 million head of cattle are fed in confinement, producing about 500,000 acre-inches of open-lot runoff each year. Because of the variability of the runoff source and large source areas, scientists' confidence in the accuracy and precision of nutrient discharge estimates in rainfall runoff is low relative to most other components of the feedyard mass balance (ration, manure, urine, etc.). In order to meet the increasing challenges of environmental stewardship, agricultural engineers and scientists need more accurate estimates of runoff rate, quality (soluble and suspended solids, N, P, K and pathogens) and total runoff volume are needed. Engineers need improved rainfall-runoff coefficients that account for variables such as differing feedyard surfaces (soil vs. fly ash), manure harvesting practices. Protection of the many cattle feedyards in the Southern Great Plains, clustered within several large watersheds, without sacrificing the agricultural production goals of the region is critical to local, state and regional interests.

The project team has leveraged this TCFA grant with USDA-ARS (Sect. 224) funding with the intent to produce more accurate models of the feedyard's hydrology to facilitate the design and evaluation of nutrient-management strategies and BMPs and improve the design of runoff holding structures based on water budgets. Funding under this proposal has provide the opportunity to verify rainfall-runoff models via experimental data collected at the TAES/USDA-ARS Experimental Feedyard in Bushland, TX. TCFA grant funds have been used to underwrite a portion of the salary of an Assistant Research Engineer/Feedlot Hydrology, co-funded by the Texas Agricultural Experiment Station and West Texas A&M University. With the departure of Arturo Romanillos from TAES employment in January 2003 and the subsequent budget rescission affecting WTAMU's 40% contribution to the salary base for that position, we have yet been unable to re-fill the Feedlot Hydrologist slot. Residual funds totaling over $11,000 from this TCFA grant have been sequestered by the Principal Investigator and will not be spent until a new feedlot hydrologist is hired and the work originally proposed resumes. Filling that position and resuming this work is a high priority of the TAES-Amarillo Environmental Quality Program as we solicit funding through the state agricultural air quality initiative and various competitive grants programs.

Objectives

1. Validate feedyard hydrology (CN, hydrographs) and nutrient (N, P, K, pathogens) models by monitoring and sampling open-lot runoff from an isolated section of one or more commercial cattle feedyards in the northern Texas Panhandle and

2. Develop or improve nutrient management and dust control strategies, BMPs, and TMDLs.

3. Provide updated rainfall runoff data and models, BMPs, TMDLs, nutrient management and dust control strategies for open-lot animal feeding operations (AFOs) and concentrated animal feeding operations (CAFOs) to consulting engineers, USDA-NRCS engineers, industry groups, TAEX specialists, and regulatory agencies.

Experimental Methods

The 18 environmental pens at the TAES/USDA-ARS experimental feedlot at Bushland, TX, have been instrumented with H-type flumes, pressure transducers and dataloggers to collect rainfall/runoff data from storm events. Rainfall events on August 10, 2002, were the first to occur with the data-acquisition systems fully operational on pens 1-9, and although additional rain fell after that, the August 10 storm was the only event for which rainfall/runoff data were processed prior to Mr. Romanillos' departure on January 17, 2003.

Results and Discussion

Data from the August 10, 2002, rainfall event are shown below.

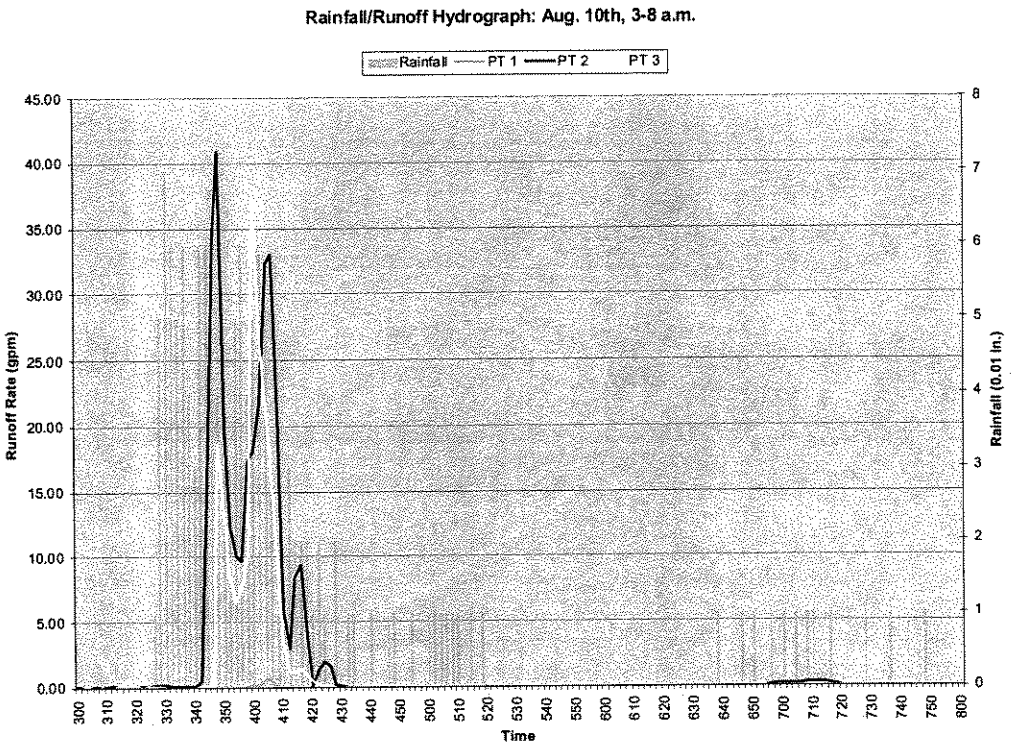

Figure 1. Rainfall and runoff hydrographs, Pens 1-3, August 10, 2002, Bushland, TX.

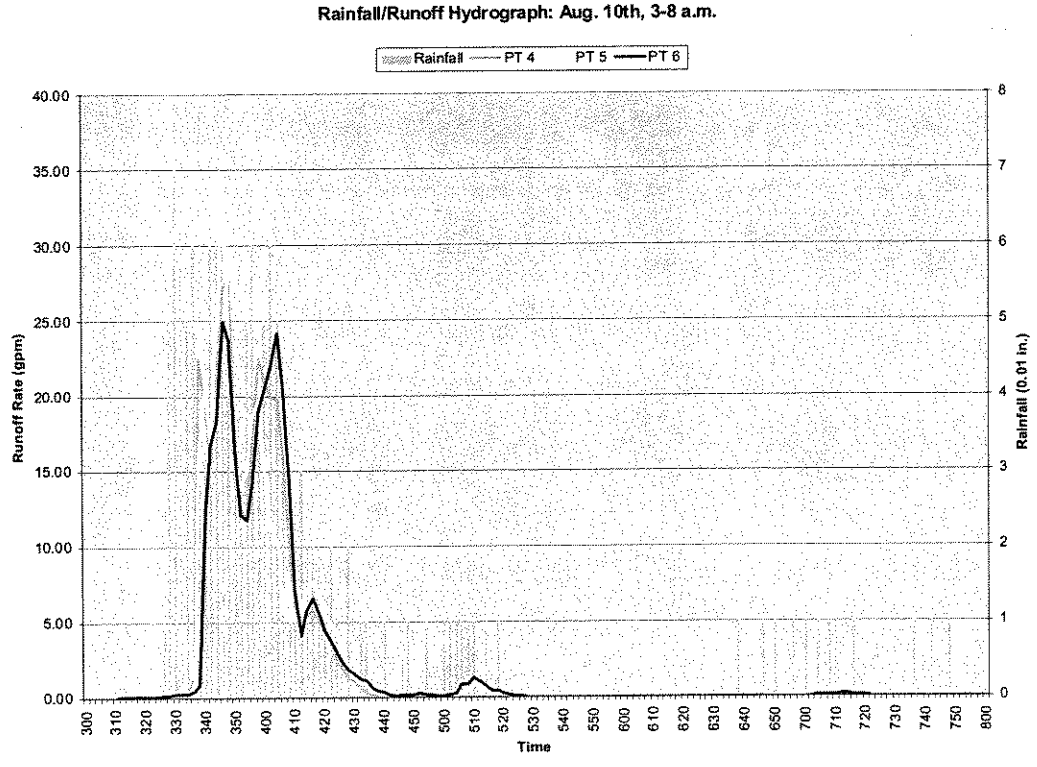

Figure 2. Rainfall and runoff hydrographs, Pens 4-6, August 10, 2002, Bushland, TX.

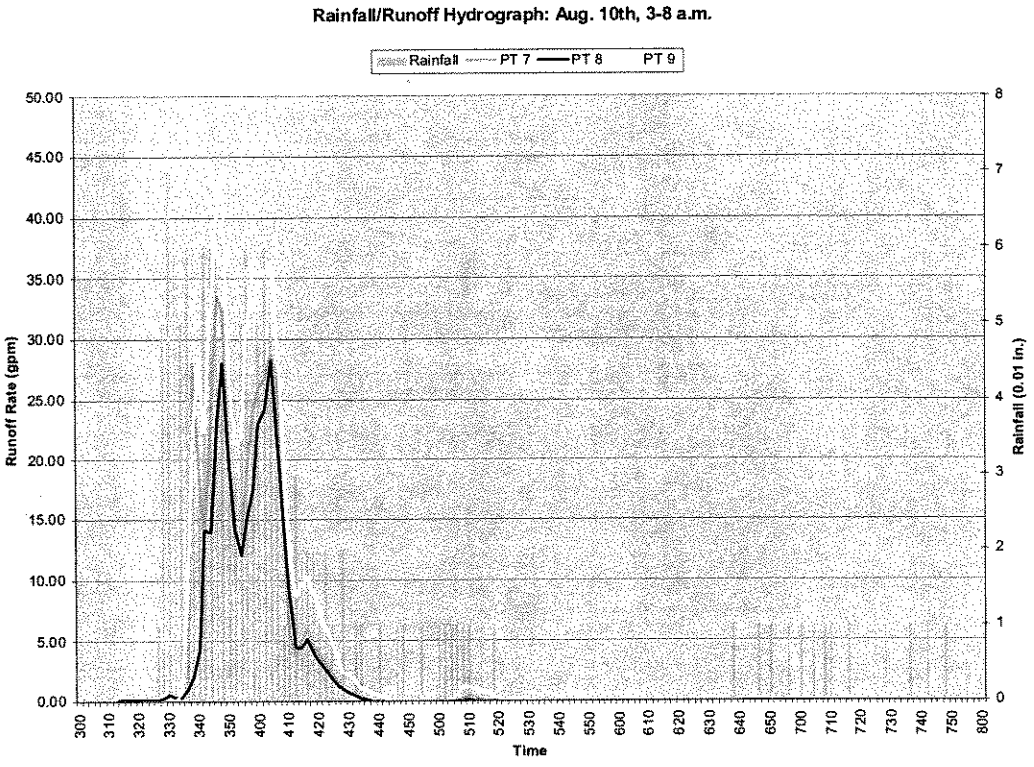

Figure 3. Rainfall and runoff hydrographs, Pens 7-9, August 10, 2002, Bushland, TX.

August 10th Rainfall-Runoff Log

Pen	Peak Flowrate (gpm)	Total Runoff (gal)	Total Runoff (in.)	Calculated CN
1	0.71	3.1	0.02	60.7
2	40.86	648.4	4.32	89.0
3	37.22	368.3	2.46	82.7
4	27.44	686.2	4.57	89.7
5	34.49	674.3	4.50	89.5
6	24.97	663.2	4.42	89.3
7	33.62	800.1	5.33	91.5
8	28.20	633.0	4.22	88.7
9	44.25	1161.4	7.74	96.1

Conclusions

Preliminary indications show a predictable result: runoff from the fly-ash-surfaced pens (Pens 4-9) generated considerably more runoff than soil-surfaced pens (Pens 1-3) having significant regions of poor drainage, especially around the water troughs. The NRCS Runoff Curve Number that seems to fit the fly-ash-surfaced pens most closely is CN=90; for the soil-surfaced pens, CN=80 or 85 is an adequate fit, although the variability in the data from Pens 1-3 does not justify the use of a single value to represent soil-surfaced pens. Additional data analysis from rainfall events following the 8/10/02 storm will be needed to confirm these results, and access to commercial feedyards to install hydrologic monitoring equipment under this TCFA-funded project would allow us to confirm these results at a more realistic scale. Typical design criteria for runoff holding ponds have stipulated a curve number of 90 or 95 for soil-surfaced pens; data collected thus far indicate that those figures may be overly conservative, but further verification is needed. Predicted runoff from the curve number algorithm is very sensitive to the assumed value of CN.

We have determined from the early runoff data that the wetting/drying cycles associated with feedlot runoff monitoring create operational complexities when pressure transducers are used to measure the depth of flow in an H-type flume. When the sensors dry out between events, temperature fluctuations inside the sensor are more significant than when they are submerged by cold runoff water. Those temperature fluctuations cause the calibration of each sensor to drift dramatically, making it more difficult to identify the "zero runoff" baseline in a particular runoff hydrograph. Identifying that baseline is a key step in integrating the hydrograph numerically to generate a cumulative runoff volume; errors in the baseline depth of flow translate directly into errors in runoff rates and the resulting cumulative runoff volume. Using other funds, including Section 224 federal funds and a grant from the Texas Water Resources Institute (TWRI), we have begun to accumulate ISCO model 3230 Bubbler Flow Meters, whose calibrations will not drift as a result of wetting/drying cycles or daily temperature extremes. We now have three of these bubbler flow meters in possession, with plans to install them when a new feedlot hydrologist is hired.