

MONITORING IMPACTS OF ANIMAL RESEARCH CENTER ON SURFACE AND GROUNDWATER QUALITY

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OBJECTIVES:

- 1) To assess the net impact of an integrated animal production system (and construction activities) on surface water leaving the farm.
- 2) To assess groundwater quality at established well nests.
- 3) To determine the relative levels of contribution of the row crop and the pasture areas of the integrated animal production system to water quality constituents.
- 4) To support water quality research efforts at the Center by maintaining a minimum ongoing monitoring program.
- 5) To maintain a GIS historical landuse activity database.
- 6) To maintain a hydrology teaching field laboratory for Biosystems and Agricultural Engineering and Forestry departments.

PARTICIPANTS:

- College of Agriculture
 - Biosystems and Agricultural Engineering
 - Animal Science
 - Forestry
 - Agronomy
- Kentucky Geological Survey - Water Section (Jim Dinger)

UNIVERSITY OF KENTUCKY ANIMAL RESEARCH CENTER:

The basic system concept for the Animal Research Center assumes that animal facilities are designed to meet research goals of the College of Agriculture. These research facilities include confinement structures, pastures, infrastructure and support facilities. Crop production on land at the Center contributes most of the total feed needs of the research herds.

The Animal Research Center must meet the requirements of the Agricultural Water Quality Authority as established by SB 241 which requires that each farm develop a Water Quality Protection Plan. The plan will utilize established Best Management Practices (BMPs) to protect surface and groundwater resources. This does not exclude incorporation of new practices that are not presently recognized by the Agricultural Water Quality Authority as long as the practice has demonstrated the potential to reduce water contamination.

The BMP for animal waste requires that the waste be managed as a no-discharge system in which the nutrients (N, P, and K) and organic matter are to be applied to the land in a manner that does not exceed crop production requirements or soil absorption capacity. Plant nutrients contained in the animal waste produced by the research herds will be used, and supplemented as needed, to sustain the crop production. Plant nutrients in excess of production needs will be exported.

Several soil and water conservation research projects are ongoing or will be conducted on the Animal Research Center. These include:

- site-specific application of animal wastes, fertilizer, and pesticides;
- riparian zone management for beef, dairy and sheep animals;
- storm event nutrient runoff from grazed pasture;
- assessment of off-site contaminant models for agricultural production;
- hydraulic modeling of surface and groundwater systems;
- influence of perched water tables on nitrogen dynamics; and
- influence of artificial wetlands on agricultural chemicals reduction.

The program proposed here will provide base-line and support data for all of these projects as well as others developed in the future.

This program of water quality monitoring will be a long-term project to demonstrate the impacts of the Animal Research Center. Water quality analysis will be conducted by the Ky Geological Survey. College of Agriculture's Biosystems and Agricultural Engineering Department and the Ky Geological Survey's Water Section, in cooperation with the other participants, will supervise the collection and analysis of the data, database maintenance, cooperation with research projects, determination of results and writing of reports and papers.

PROCEDURES:

Stream Water Quality Parameters

Water quality will be assessed by monitoring several parameters that are associated with agricultural production. These are:

- Nitrogen compounds (NO₃-N, NH₃-N, Organic-N)
- Phosphorus compounds (Total-P, PO₄-P)
- Organics (Total Organic Carbon)
- Bacteria (Fecal coliforms, fecal streptococcus and total coliforms)
- Solids (Total solids, Total Suspended Solids, Total Suspended Volatile Solids)
- Pesticides (Atrazine, metolachlor, carbofuran plus others used in crop production)
- Other (pH, Dissolved Oxygen (DO), Temperature, Electrical Conductivity (EC))

In addition, stream flow will be measured so that net yields of the above parameters can be determined. These parameters are not all measured at each proposed monitoring site.

Monitoring Sites

The following is a summary of the proposed monitoring sites and the objective that is being met.

The net impact of cropping and animal research activities at the Animal Research Center on surface water will be determined by monitoring the sites associated with water entering the Center (stream weir sites: Camden Creek - St-8, Pin Oak Spring - St-10 and St-12, storm drain on US-62 - St-13) and surface water leaving the Center (Box Culverts under US-60 - St-1 and St -14).

Groundwater will be monitored at well nests A and C using the three deepest wells at each nest (WA-1, WA-2, WA-3 and WC-1, WC-2, WC-8). These wells monitor deep and shallow water

from a pasture grazing area (Well Nest A) and a row crop area (Well Nest C).

The relative levels of contribution of the row crop and the pasture areas to water quality components associated with production agriculture will be determined by monitoring seven springs that are associated with major drainage areas of both the row crop areas (Sp-6, Sp-1, Sp-3/4) and the pasture areas (Sp-11, Sp-2, Sp-15, Sp-8).

At the present time, the monitoring program outlined above will provide support to 8 research projects, three are funded by EPA 319 and SB-271 funds while four are actively seeking funding from USDA, EPA or KyWRRRI and one is being developed. The baseline data collection will provide continuity for soil and water conservation projects conducted on the Animal Research Center and will be available for use in seeking additional research money.

All the Animal Research Center landuse and geology data will be compiled in a GIS database. This data will also include:

- animal species, populations, weights and location;
- crop type and location, seeding rate, fertilizer nutrient application rates, pesticide type and rate, and yields;
- field activity type and date;
- soil type and measured characteristics;
- depth to rock and topography.

All research and Center operation activities can utilize this historical database.

The maintenance of the monitoring sites and GIS database described above are supportive of a field hydrology laboratory for teaching and training both undergraduate and graduate students from Biosystems and Agricultural Engineering and Forestry departments.

Monitoring Schedule

Monitoring the water quality of the Animal Research Center is proposed to begin June, 1996. This will reestablish baseline water quality data collection. Previous data collection was terminated July, 1995. Three years of data were accumulated prior to that date. Continued data collection is needed before, during, and after the establishment of the full operation of the Animal Research Center which would include the beef, sheep, swine dairy and poultry research units.

Base-line. Six stream sites (St-1, St-8, St-10, St-12, St-13 and St-14) and 2 springs (Sp-1 and Sp-6) will be sampled biweekly. The stream sites will be monitored for all the water quality parameters indicated previously, including continuous measurement of flow volume. Wells will be tested quarterly for the full suite of tests. The remainder of the springs (Sp-2, Sp-3/4, Sp-8, Sp-11, Sp-15) will also be tested monthly for nitrate-N, phosphate-P, bacteria, atrazine, pH, DO, EC and temperature. Flow volume from springs Sp-3/4 and Sp-1 will be recorded.

Storm Events. A significant part of the annual contribution of agriculturally related water quality parameters occur during storm events. Composite storm event sampling for six stream sites (St-1, St-8, St-10, St-12, St-13 and St-14) and 2 springs (Sp-1 and Sp-6) for 10 storm events per year will be collected to assess this contribution and to determine whether the present monitoring strategy would need adjustment. All the water quality parameters indicated earlier will be determined. Limited and focused sequential storm event sampling will be conducted among the sites listed above to assess a storm's timing of the peak concentration.

MONITORING SITE IMPROVEMENT AND REPAIRS

Reestablishment of the monitoring activity will require some repairs to the existing equipment. One spring (Sp-6) needs the drain pipe repaired to prevent water bypassing the pipe. Bypassing is caused by a buried broken section. All nine of the earthen embankments of the stream weirs need reconstruction to prevent muskrat damage which has led to embankment breaching. Two earthen embankments have collapsed and need repair prior to flow volume determinations. Grouting of fractures in the base rock of the upflow pool at St-8 will prevent stream water bypassing the weir.

Construction of a broad crested weir below Sp-2 is needed for the monitoring project for assessing the largest ground water source within the Center.

EQUIPMENT

An inventory of the operational status of the monitoring equipment available from the previous research project was made to determine their applicability for this effort. It was determined that three additional stream flow monitoring systems need to be purchased and one flow sensor needs replacement. Two paper backup units are required for two flow monitoring systems on which the electronic memories have lost data as a result of lightning strikes. A dedicated portable meter for temperature, DO, pH and EC is required for needed field measurements at water monitoring sites.

PERSONNEL

A project manager (60% FTE) would be required to collect data, maintain equipment and the water quality and GIS databases, and manipulate databases for research and impact reports. This position will maintain lines of communication with the Center crop production and waste management system manager and would be under the supervision of the Biosystems and Agricultural Engineering Department.

COSTS

Equipment (one time):

| | | |
|---|-----------------|----------|
| Flow Monitoring Systems (3 needed) (Isco 4220 + 2 batteries ea.) | \$10,875 | |
| Area Flow Sensor + Holding Ring (for Isco 4250) | \$ 1,305 | |
| Glass Composite and Sequential Sample Collection Jars | \$ 2,700 | |
| Flow Monitor Paper Backup (2 needed) (Isco 4250 + 2 batteries ea.) | \$12,250 | |
| Battery Charger - 5 place (Isco 965) | \$ 430 | |
| Isco FlowLink Software Version 3 | \$ 525 | |
| Portable Analyzer/Logger (YSI 3800) | <u>\$ 8,000</u> | |
| Total | | \$36,085 |

Repairs (one time):

| | | |
|-------------------------|-----------------|----------|
| Weirs (9 @ \$1,500 ea.) | \$13,500 | |
| Spring | <u>\$ 1,500</u> | |
| Total | | \$15,000 |

Construction (one time):

| | | |
|-------|-----------------|-----------------|
| Weir | <u>\$ 3,000</u> | |
| Total | | <u>\$ 3,000</u> |

Total one time cost:

\$54,085

Laboratory analysis (per year):

| | | |
|-------------------------------------|-----------------|----------|
| Baseline | \$26,780 | |
| Sequential Sampling of Storm Events | \$ 6,750 | |
| Composite Sampling of Storm Events | <u>\$ 7,500</u> | |
| Total | | \$41,030 |

Personnel (per year):

| | | |
|------------------------|-----------------|-----------------|
| Professional (60% FTE) | <u>\$27,000</u> | |
| Total | | <u>\$27,000</u> |

Total Annual Cost:

\$68,030

SAMPLING DETAILS - Summary

Baseline:

Biweekly, full suite of tests (carbofuran and metalaxyl determined in May and June only).

- Stream sites -- St-1, St-8, St-10, St-12
- Springs sites -- Sp-6, Sp-2
- Well sites -- None

Biweekly, full suite of tests if water present (carbofuran and metalaxyl determined in May and June only).

- Stream sites -- St-13, St-14
- Spring sites -- None
- Well sites -- None

Monthly, full suite of tests (carbofuran and metalaxyl determined in May, June, and July only).

- Stream sites -- None
- Spring sites -- Sp-1, Sp-11, Sp-3/4, Sp-8
- Well sites -- None

Quarterly, full suite of tests.

- Stream sites -- None
- Spring sites -- None
- Well sites -- Nests A and C (deepest three wells)

Composite Storm Events (ten storm events per year):

Full suite of tests (carbofuran and metalaxyl determined in May and June only).

- Stream sites -- St-1, St-8, St-10, St-12
- Springs sites -- Sp-6, Sp-2
- Well sites -- None

Full suite of tests if water present (carbofuran and metalaxyl determined in May and June only).

- Stream sites -- St-13, St-14
- Spring sites -- None
- Well sites -- None

Sequential Sampling of Storm Events:

Full suite of tests for selected sites (limited to 60+ samples depending on budget)