Project Title/Number: **Water Quality Impacts of Feedlot Pollution Control Systems H-21**
Date of Report: **July 1, 1997** **Work Program Amendment**
LCMR Work Program Update

Project Manager: David Wall
Affiliation: MPCA-Water Quality Division
Address: 520 Lafayette Road North, St. Paul, Minnesota 55155-4194
Telephone: (612) 296-8440
E-mail David.Wall@pca.state.mn.us
Fax: (612) 282-6247

I. PROJECT RESULTS:

A. Legal Citation: ML95, Chp. 220, Sec. 19, Subd. 5(I)
Appropriation Language:

This appropriation is from the future resources fund to the Commissioner of the Pollution Control Agency to evaluate earthen manure storage basins and vegetated filter strips for effects on ground and surface water quality by monitoring seepage and runoff. This appropriation must be matched by $267,000 of nonstate contributions, either cash or in-kind. This project must be completed and final products delivered by December 31, 1997, and the appropriation is available until that date.

Legal Citation: ML97, Chp. 216, Sec. 15, Subd. 26(I)
Carryforward

(a) The availability of the appropriations for the following projects is extended to June 30, 1998: Laws 1996, chapter 407, section 8, subdivision 3, paragraph (c), local grants; Laws 1995, chapter 220, section 19, subdivision 4, paragraph (e), local grants, paragraph (1), Wildcat Regional Park; subdivision 5, paragraph (d), blufflands landscape, paragraph (f), atmospheric mercury emissions, deposition and environmental cost evaluation, paragraph (I), water quality impacts of feedlot pollution control systems, and paragraph (r), developing, evaluating, and promoting sustainable farming systems; subdivision 6, paragraph (b), environmental education teacher training, paragraph (g), electronic environmental education network; and paragraph (r), as amended by Laws 1996, chapter 407, section 51, Ney environmental center and paragraph (s), Lawndale Environmental Center; subdivision 7, paragraph (f), completion of statewide land use update, paragraph (g), Fillmore county soil survey update, paragraph (j), microbial deterioration of asphalt materials and prevention, and paragraph (k), analysis of lands enrolled in conservation reserve program; subdivision 8, paragraph (a), urban wildlife habitat program; paragraph (e), Phalen wetland restoration; subdivision 11, paragraph (e), energy improvements in public ice arenas.

Total Biennial Budget: $300,000
Balance: $77,500

B. LMIC Compatible Data Language:

C. Status of Match Requirement:

Match required: $267,000
Amount Committed to Date: $59,700
Match Spent to Date: $207,300

II. PROJECT SUMMARY:

This study will 1) quantify seepage rates below earthen manure-storage basins, and 2) examine the effectiveness of vegetated filter strips for treatment of runoff from feedlots. Given the large number of earthen-basins being constructed in Minnesota and the high concentration of contaminants in the basins, there is great potential for adverse effects on ground water from earthen-basin seepage. Seepage quality and quantity will be monitored below two newly constructed basins by using a monitoring system that intercepts seepage waters over a portion of the basin and routes the seepage to a sump. Perimeter tile water will also be sampled at additional sites. If seepage is found to be minimal, public concern over the use of earthen-basins can be alleviated and implementation of manure storage measures will be accelerated. If seepage is found to pose significant environmental risks, modified design and construction standards will need to be developed.

For the second study component, runoff and seepage waters will be monitored below two vegetated filter strips, including newly constructed filter strips and previously established grass. These filter strips are proposed as low-cost, low-management alternatives to runoff collection. While several studies have shown the potential for trees to remove nutrients, little information is available on ground water quality effects of effectiveness of trees in treating manure contaminated runoff. This study will provide insights and guidance for development of improved filter strips, accelerating their use as pollution abatement systems.

III. SIX-MONTH PROGRAM UPDATE SUMMARY:

January 1, 1996 - The contract between the MPCA and US Geological Survey has been completed and signed. An earthen basin seepage collection system has been designed for a dairy farm in Nicollet County. The necessary contracts are signed and the equipment has been ordered so that installation of the system can proceed following spring thaw. The installation of the monitoring system must coincide with construction of the earthen basin, which was delayed this fall. A second earthen basin site has not yet been selected. Attempts to find a swine producer constructing a lagoon this fall (1995) who would allow construction of the monitoring system were unsuccessful. We are currently examining two swine sites to determine the best site for constructing a monitoring system in the spring. We still anticipate meeting the work plan objectives of this project component by the end date.

Two sites have been instrumented for monitoring runoff and ground water from the vegetated filter strips; a cattle operation in Mille Lacs County with an existing grass filter strip and a dairy operation in Redwood County with a grass/tree filter strip. Most monitoring wells have been installed at the two sites, the surface runoff monitoring system

shave been completely installed and tested in the Mille Lacs County site, and the surface runoff monitoring system in Redwood County is over half completed. The costs to install the surface runoff systems was much greater than originally budgeted. The added costs will prohibit installation of a monitoring system at a third site.

July 1, 1996 - Both manure storage sites have been selected and the engineering plans for the monitoring systems are complete. Equipment has been purchased and several contracts have been arranged for construction of the monitoring systems. The anticipated construction date for the systems is July and August 1996. Delays in construction of the earthen basin correspond with delays in construction of the monitoring system. Both weather and the schedule of the contractor working for the farmers are important variables which affect the date of construction.

The two vegetated filter strip sites have been fully instrumented and are now set to engage during major storm events. Data from two storm events have been collected from the Mille Lacs County site. Pollutant loadings from the feedlot runoff and contaminant transport across the feedlot have been determined. Sampling of other runoff events will continue.

January 1, 1997 - The two manure storage systems and associated monitoring systems were constructed in the late summer, 1996. Both sites are instrumented to collect and measure seepage waters as the earthen basins begin to fill with manure. Liquid or semi-solid manure has not been added to the basins yet. The basins are likely to be filled with manure beginning in late winter.

Ground water and runoff water samples have continued to be collected at the vegetated filter strips. Comparatively few large storms occurred during 1996 at the monitoring sites, limiting data collection activities. Since monitoring has begun, complete hydraulic and geochemical data sets have been collected for one runoff event at each site. Partial data sets were collected for one additional runoff event at each site. An additional variable affecting results has been a large reduction in beef cattle at the Mille Lacs county site.

IV. STATEMENT OF OBJECTIVES:

Objective A - Install and monitor earthen-basin seepage collection systems to determine potential ground water quality impacts from clay-lined earthen-basins.

Objective B - Analyze data from sampled earthen-basin perimeter tile line water and adjacent monitoring well water to determine potential surface water quality impacts from discharging earthen-basin perimeter tiles constructed in clay soils.

Objective C - Monitor vegetated filter strips to determine their effectiveness in treating feedlot runoff and seepage so that greater information is obtained on this relatively low-cost feedlot pollution abatement technique.

Timeline for Completion of Objectives:

	7/95	1/96	6/96	1/97	6/97	12/97
Objective A	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Seepage Monitoring						
Objective B			XXXXXXXXXXXXXXXXX			
Perimeter Tile Analysis						
Objective C	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Vegetative Filter Strips						

V. OBJECTIVES/OUTCOME:

A. Title of Objective/Outcome: Install and monitor earthen-basin seepage collection systems to determine potential ground water quality impacts from clay lined earthen-basins.

A.1. Activity: Select Monitoring Sites

A.1.a. Context Within the Project: Much of this work will be conducted prior to July 1995.

A.1.b. Methods: We will work with County Natural Resource Conservation Service (NRCS) and Soil and Water Conservation District (SWCD) personnel to identify landowners who plan to install earthen manure-storage basins. Two sites will be selected, one hog facility and one dairy operation. Each site will have a natural clay liner and a minimum practical pool level of about one foot.

A.1.c. Materials

A.1.d. Budget: Total Biennial LCMR Budget: $3,700.
LCMR Balance: $0
Match: $1,000
Match Balance: $0

A.1.e. Timeline: to be completed prior to August 1995.

A.1.f. Work Program Update

January 1, 1996 - A medium sized dairy operation in Nicollet County was selected as one of the two sites. The owner is working with the Natural Resources Conservation Service to install the manure storage system. Efforts to find a suitable swine manure storage system where the producer was willing to allow installation of the monitoring system were unsuccessful this fall. The installation of the system requires a one

to two week delay in construction of the basin and potential cooperators could not afford the delays in a tight fall schedule. Potential cooperators have been identified in Dodge and Blue Earth counties and we are optimistic about identifying the second site prior to the spring construction season.

July 1, 1996 - The second site was selected. It is a relatively large swine operation in Dodge County.

A.2. Activity: Install Monitoring Systems

A.2.a. Context within the project: Monitoring systems will be installed at all earthen-basin sites following site selection. The timing of monitoring-system installation must coincide with construction of the earthen-basin.

A.2.b. Methods: The methods used will be similar to those used on a 1993-1994 pilot monitoring project in Morrison County. For that project, a 34-foot by 80-foot sheet of geomembrane was installed two feet below a clay liner in a newly constructed dairy earthen manure storage basin. The synthetic sheet was placed along a portion of the bottom of the basin and along a sidewall. Two feet of sand was placed between the synthetic sheet and the earthen-basin clay liner. Seepage from the overlying clay liner is intercepted by the geomembrane and routed into a nearby vertical culvert that is divided into two sections to receive seepage from 1) the basin bottom and 2) the basin sidewall. The culvert is closed at the bottom with sealed concrete. Pumps in the culvert allow sampling of the quality of seepage water and a meter measures the total volume of seepage that is pumped out of the culvert back into the basin.

Ten monitoring wells will be installed around the basins to further assess the effect of seepage on ground water quality.

Soil samples from the soil used to construct the clay liner will be analyzed for physical and chemical properties.

A.2.c. Materials: For each of the basins, the following materials will be needed:
- 30 mm PVC. geomembrane (5,000 sq. ft.)
- 4-inch PVC pipe boot (2)
- Earthfill, Class C (500 cu yds)
- Coarse drainfill (10 cu yds)
- 4-inch PVC pipe (200 ft.)
- 48-inch manhole w/steps, base and 4-inch riser, top and lid, splitter wall
- electric wiring to sump
- Drainfill, fine (installed)(130 cu yds)
- 2 pumps

A.2.d. Budget

Total Biennial LCMR Budget: $72,000
LCMR Balance: $0
Match: $65,000
Match Balance: $0

A.2.e. Timeline:

	7/95	1/96	6/96	1/97	6/97
System #1 installed		XX			
System #2 installed		XX			

A.2.f. Work Program Update

January 1, 1996 - Progress was made in the construction process of the seepage collection system in Nicollet County. The necessary contracts have been completed and signed, the necessary equipment and materials were ordered, the perimeter tile was installed, and the engineering plans for the monitoring system were completed. The cooperating producer and all other parties were planning to have the project construction completed this fall. However, delays by the excavator, a very high water table soil, and an early fall freeze-up prevented completion of construction this fall. Construction will resume following spring thaw.

Equipment and materials were ordered for the monitoring system at the second site. We anticipate beginning construction of the second system by late spring. The delays in construction will reduce the amount of data available for the final report to LCMR, but will not significantly affect successful completion of long-term project objectives.

July 1, 1996 - A late spring thaw and very wet soils have delayed construction of the earthen basin and the associated monitoring system at the Nicollet County site. Construction of the monitoring system at this site is anticipated for July 1996. The monitoring system must be constructed at the same time as the earthen basin. Delays in construction of the earthen basin correspond with delays in construction of the monitoring system. Both weather and the schedule of the contractor chosen by the producers are important variables which affect the date of construction.

Engineering plans for the monitoring system at the Dodge County site have been completed and much of the equipment and materials have been ordered. The contract between the U.S. Geological Survey and the contractor to construct the system is currently being completed.

Construction of the system will begin when the contractor (who is both working for the farmer on the basin construction and with the U.S. Geological Survey on the monitoring system) is able to fit the project into their tight construction schedule, likely in July or August 1996.

January 1, 1997 - Construction of both earthen basins and the associated underlying seepage collection system occurred in August and September 1996. All meters and instrumentation to measure seepage quantity were installed in September, October and November at each of the two sites. A shallow monitoring well was installed at each site.

July 1, 1997 - All electrical lines have been installed and all monitoring systems are now in operation. A clog in a tile drain draining water from one of the two sites is in the process of being removed.

A.3. Activity - Monitor Seepage Quantity and Quality and Ground Water Quality

A.3.a. Context within Project: Seepage water quality measurements and sampling will produce the data that will be analyzed.

A.3.b. Methods: To determine total seepage volume, meters will be installed to measure the seepage water volume pumped from the basin bottom and the amount of basin sidewall seepage on a continuous basis. Seepage samples will be taken and analyzed twice monthly during the first two months of flow, monthly during months 3-6 and every other month from month 7 until the last sampling date. Samples are to be analyzed for the following parameters during each sampling event:

Ammonium-N
Total Kjeldahl-N
nitrate + nitrite-N
chloride

Field measurements will be taken for specific conductance, pH, temperature, dissolved oxygen and oxidation-reduction (redox) potential during all sampling events.

The following additional parameters will be analyzed during months 2,8, and 12: sulfate, alkalinity, calcium, magnesium, sodium, potassium, phosphorus and fecal coliform.

The quality assurance procedures documented in "Integrating Quality Assurance in Project Work Plans of the U.S. Geological Survey" by Shampaine, Pope and Koterba, U.S. Geological Survey open file report 92-162-1992 will be used for this study.

During each sampling event, the following additional information shall be recorded: the physical condition of sidewalls, manure level in the basin and the volume of seepage flow into sumps between sampling events.

Monitoring wells will be sampled five times for ammonium, nitrate, chloride, fecal coliform and field parameters.

A.3.c. Materials - Field equipment for measuring pH, dissolved oxygen, redox potential, temperature and specific conductance will be provided by the U.S. Geological Survey (USGS).

A.3.d. Budget

Total Biennial LCMR Budget: $34,500
LCMR Balance: $17,000
Match: $32,000
Match Balance: 15,000

A.3.e. Timeline:

	7/95	1/96	6/96	1/97	6/97	12/97
System #1		XXXXXXXXXXXXXXXXXXXX				
System #2			XXXXXXXXXXXXXXXXXX			

A.3.f. Work Program Update - Very little work was accomplished for this activity. Monitoring will begin following construction of the monitoring systems.

January 1, 1997 - Water samples have been taken and analyzed from the perimeter tile lines surrounding the earthen basins. No seepage water samples have been taken yet, since manure is just now beginning to be added to the basins. Soil core samples at the site have been taken and analyzed.

July 1, 1997 - Sampling of perimeter tile line water has continued. Five rounds of samples have been collected from the seepage collection sumps.

A.4. Activity: Data Analysis and Reporting

A.4.a. Context within the project: An interim and final LCMR report will be written for objective A.

A.4.b. Methods: An initial report will be produced after construction of the basins that documents the characteristics of each site. Information in the initial reports will include site locations, monitoring system designs, livestock operations, soil conditions, and engineering test results. A final report will be written following the analysis of all seepage-quantity and -quality information. Computer modeling will be used to aid in determining potential ground water quality impacts from basin seepage.

A.4.c. Materials: Print materials to assemble ten initial reports and 100 final reports.

A.4.d. Budget

Total Biennial LCMR Budget: $33,000
LCMR Balance: $20,500
Match: $30,000
Match Balance: 17,500

A.4.e. Timeline

	7/95	1/96	6/96	1/97	6/97
System Installation Report		XXX			
Final Report					XXX

A.4.f. Work Program Update: No data analysis or reporting.

The initial construction report will be completed following construction of the monitoring systems.

January 1, 1997 - The monitoring system construction report is currently being prepared.

July 1, 1997 - A rough draft of the monitoring system construction report is complete. The report will be refined for presentation at a national conference.

B. Title of Objective/outcome: Analyze data from sampled earthen-basin perimeter tile line water and adjacent monitoring well water to determine potential surface water quality impacts from discharging earthen-basin perimeter tiles constructed in clay soils.

B.1. Activity: Select Perimeter Tile Sampling Sites and Compile Existing Data

B.1.a. Context within the project: High water table soils are common in Minnesota. Perimeter tiles are typically installed around earthen basins constructed in these high water table soils. Monitoring wells have been installed around several of these sites as required by MPCA permit. Additionally, the Natural Resource Conservation Service has collected initial water quality information from one perimeter tile. Other potential perimeter tile monitoring sites will be identified to supplement the existing perimeter tile information.

B.1.b. Methods: Discussions with local NRCS and SWCD offices and reviews of feedlot permits will be used to identify three sites that have a perimeter tile which discharges near the barnyard or is non-perforated between the barnyard and discharge point. All other perimeter tile monitoring results in the state will be incorporated into this study by reviewing the laboratory analytical results.

B.1.c. Materials: none

B.1.d. Budget

Total Biennial Budget: $500
LCMR Balance: $0
Match: 0
Match Balance: $0

B.1.e. Timeline - Most sites shall be selected prior to July 1995. The remaining sites shall be selected prior to September 1995.

B.1.f. Work Program Update

January 1, 1996 - The new perimeter tile monitoring sites have not been selected, yet potential cooperators have been identified. Site selection priority was given for objectives A and C. We do not anticipate any problems in completing the work plan activities for objective B within the allotted time frame.

July 1, 1996 - All sites have been selected. Compilation of existing perimeter tile information is currently underway and will be continually updated throughout the project duration. Literature reviews of tile drain water quality is also in progress.

B.2. Activity: Analyze perimeter tile water-quality data.

B.2.a. Context within project: Samples from perimeter tiles will be collected, analyzed at the laboratory, and evaluated to determine the relative risks to surface water quality from earthen basin perimeter tile lines.

B.2.b. Methods:

Sampling frequency - samples will be collected during early fall, winter, spring and summer at each site for a total of four samples per site.

Parameters to be analyzed - samples from two primary sites will be analyzed for all major cations, anions, and field parameters. All remaining sites will be sampled for nitrate, ammonium, total Kjeldahl nitrogen, phosphorus, chloride and field parameters including dissolved oxygen, redox, pH, specific conductance and temperature.

Data analysis - Water quality results from perimeter tile samples will be compared to the water quality results taken from cropland tiles reported in the literature. A determination will be made of the potential for surface water quality impacts from discharging perimeter tile lines.

B.2.c. Materials: Field parameter equipment will be needed to conduct this work. Existing USGS equipment will be used.

B.2.d. Budget:

Total Biennial LCMR Budget: $3,500
LCMR Balance: $1,200
Match: $3,000
Match Balance: $1,200

B.2.e. Timeline

	7/95	1/96	6/96	1/97	6/97
Collect Samples		XXXXXXXXXXX			
Analyze data			XXXXXXXX		

B.2.f. Work Program Update

July 1, 1996 - Efforts have begun in assembling the existing perimeter tile line water quality data in the state. The first samples will be collected in July from all sites where water is flowing in the perimeter tile lines.

January 1, 1997 - Water samples were obtained and analyzed from two existing perimeter tiles in July and October 1996. At a third existing site, no water was flowing in the perimeter tile line during the July and October 1996 sampling events. New perimeter tile lines were sampled at two sites in conjunction with Objective A.

July 1, 1997 - Sampling at perimeter tiles at two sites continued. Deep snows prevented winter sampling at three other sites.

B.3. Activity: Reporting

B.3.a. Context within the project: The report for Objective B will represent one of four reports written for this project.

B.3.b. Methods: A separate report about the perimeter tile line sampling will describe all methods, results and conclusions of that part of the study.

B.3.c. Materials: Enough materials are needed to print 50 copies of the report.

B.3.d. Budget
Total Biennial LCMR budget: $2,800
LCMR Balance: $2,500
Match: $2,500
Match Balance: $2,200

B.3.e. Timeline

	7/95	1/96	6/96	1/97	6/97
Report Writing				XXX	

B.3.f. Work Program Update - No reporting has begun.

C. Objective/Outcome: Monitor vegetated filter strips to determine their effectiveness in treating feedlot runoff and runoff seepage so that greater information is obtained on this relatively low-cost feedlot pollution abatement technique.

C.1. Activity: Select Vegetated Filter Strip Sampling Sites

C.1.a. Context within the project: Specific criteria are needed to obtain those data that will allow determination of various vegetated filter effectiveness for improving the quality of runoff and seepage from feedlot runoff effluent.

C.1.b. Methods: In cooperation with federal and local agencies and the feedlot permitting program, the following information will be compiled for potential sites:

- Landscape geomorphology, soil type and composition, geologic origin and geographic location.
- Type of feedlot operation and runoff characteristics.
- Presence and type of existing vegetation.
- Willingness of land owner to allow monitoring equipment installation.
- Depth to ground water table.

One new site will be selected for intensive study of water movement and biogeochemical treatment. The feedlot area shall be unroofed and less than one acre. The sites will need to have an area for solids settling prior to application on the vegetated site. One existing site in Redwood County that is already set up for ground water monitoring will be instrumented for surface runoff monitoring and sampled the second year of the project.

C.1.c. Materials: None

C.1.d. Budget

Total Biennial LCMR Budget: $3,000
LCMR Balance: $0
Match: $1,000
Match Balance: $0

C.1.e. Timeline: Sites will be selected during summer 1995.

C.1.f. Work Program Update

January 1, 1996 - Three sites were selected for monitoring. Construction priority was given for an existing grass filter strip in Mille Lacs County and a grass/tree filter strip in Redwood County. A monitoring system will not be installed at the third site due to much greater than anticipated construction costs at the first two sites.

C.2. Activity: Install Runoff and Ground Water Monitoring Systems at Vegetated Filter Strip Sites

C.2.a. Context with project: Monitoring equipment will be installed to sample surface runoff and ground water at the vegetated filter sites.

C.2.b. Methods:

Ground Water Monitoring: A network of monitoring wells will be installed at two of the sites. The network will provide ground water samples hydrologically upgradient and downgradient of the treatment area. An additional well will be installed to represent background conditions. Wells will be installed from 0.5 and 2.5 meters below the water table.

Surface Runoff Sampling: A gravel trench will be installed upslope of each vegetated strip sampling site to allow sampling of surface runoff prior to entering the vegetation. Another gravel trench will be installed on the downslope side of the vegetation to monitor the change in runoff volume and quality as it passes through the vegetated filter. If site conditions are suitable, a third gravel trench will be installed halfway between the upslope and downslope trenches. Automatic samplers and pressure transducers will be installed for collection of and measurement of flow volume through the monitoring sites during runoff events.

C.2.c. Materials: Standard materials for construction of eight monitoring wells will be needed. Six flumes, six automatic samplers, six pressure transducers, and six data loggers will also be needed for surface runoff monitoring. Existing automatic samplers, pressure transducers and data loggers from MPCA and USGS will be used.

C.2.d. Budget

Total Biennial LCMR Budget: $57,000
LCMR Balance: $0
Match: $49,500
Match Balance: $0

C.2.e. Timeline

	7/95	1/96	6/96	6/97
First site installation	XXX			
Second site installation		XXX		
Third site installation			XXX	

C.2.f. Work Program Update

January 1, 1996 - The runoff collection and monitoring systems on the upslope and downslope sides of the Mille Lacs County filter strip were constructed and instrumented. Five ground water monitoring wells were also installed at this site. Construction costs were much greater than anticipated. This type of monitoring system has not been previously installed at this site.

July 1, 1996 - The surface runoff monitoring system was completed at the Redwood County Site. Both sites are now fully instrumented and information from runoff events is being collected. The second plantings of poplar trees at the Redwood County site died, and the monitoring will now determine the effectiveness of the grass filter strip. Cattle numbers at the Mille Lacs County site are very low now due to high corn prices.

C.3. Activity: Collect Runoff and Ground Water Samples

C.3.a. Context within the project: Ground water samples will be collected from the monitoring wells periodically and surface runoff sampling will be conducted during runoff events.

C.3.b. Ground water samples: Ground water samples will be collected from each well at least five times. The times will include a pre-snowmelt sample in March, a post-snowmelt sample in April, a summer sample in July, and a fall sample in September. In addition, a more intensive sampling will be conducted during one four-day period that includes at least one storm event. Samples will be collected from each well every day during the intensive sampling period. Ground water samples will be analyzed for the following field parameters: 1) dissolved oxygen, 2) pH, 3) specific conductance, 4) redox potential, and 5) temperature. Samples will be taken to a laboratory and analyzed for: nitrate, phosphorus, ammonium, chloride and sulfate. A more complete list of chemical analyses will be analyzed during one sampling event, including the following additional parameters: iron, total Kjeldahl nitrogen, total organic carbon, potassium, alkalinity, calcium and magnesium.

Quality Assurance procedures will be followed as referenced under Objective A.

Surface water samples: Samples collected during five storm events will be collected every 15 minutes during the first hour of runoff and every 30 minutes during the remaining hours of runoff. All samples will be analyzed for total phosphorus, total dissolved phosphorus, nitrate, ammonium, total Kjeldahl nitrogen, chloride, sulfate and fecal coliform. Incoming and outgoing flows will also be measured so that a phosphorus mass balance can be obtained for surface water flows.

C.3.c. Materials: all equipment for determination of field parameters will be from existing USGS equipment.

C.3.d. Budget

Total Biennial LCMR Budget: $66,800
LCMR Balance: $26,000
Match: $62,800
Match Balance: $10,700

C.3.e. Timeline

	7/95	1/96		6/96		1/97		6/97		12/97
Ground water samples		X	X	X	X	X	X	X		
Surface runoff samples			X	X	X	X	X	X		

C.3.f. Work Program Update

January 1, 1996 - A fall storm event produced runoff from the Mille Lacs County site, which triggered the upslope monitoring system, and water samples were collected throughout the storm. Instrumentation problems in the downslope monitoring system prevented collection of samples on the downslope side. These problems have been fixed and we expect to be able to obtain complete and accurate data from spring snowmelt runoff and spring storms at this site.

July 1, 1996 - Two storm events have been monitored successfully at the Mille Lacs County site. Hydrologic and pollutant loading information was obtained from both storms. Monitoring wells have also been sampled in accordance with the work plan. No storms have yet triggered the monitoring equipment at the Redwood County site.

January 1, 1997 - Complete hydraulic and geochemical data sets were collected at the Redwood County Site on October 17, 1996. A partial sampling of an earlier storm was also conducted. No new storm events were monitored at the Mille Lacs County site since the July 1, 1996, report. We plan to monitor two additional runoff events at each site during the spring and early summer of 1997.

We had hoped to have sampled more storm events during 1996. However, 1996 was a comparatively dry year at the research sites, and few large storms occurred that produced discharge at both the upslope and downslope ends of the filter strips. Equipment malfunctions also affected monitoring on a couple of occasions earlier in the year.

June 30, 1997 - In March and April, the feedlot-runoff monitoring installations at the Mille Lacs County and Redwood County sites were reconditioned and brought up to operating condition after being turned off for the winter. Frost heave had moved the flume at the MilleLacs County site, so this flume had to be reinstalled in the ground. The computerized logging unit at the Redwood County site was found to be

inoperative upon testing, so it was sent back to the manufacturer for repair. New batteries were installed at the sites to power the autosamplers, logging units, and pressure transducers. At this writing, the MilleLacs County and Redwood County sites are fully functional and are ready to collect runoff samples and measure runoff volumes. Presently, we are waiting on rain to provide runoff for sampling. No spring storm events have occurred at the sites.

Ground water was sampled in late May from five wells at the MilleLacs County site and seven wells at the Redwood County site. Water samples were sent to the laboratory for analysis of concentrations of fecal coliform bacteria, nitrate, nitrite, ammonium, organic nitrogen, dissolved phosphorous, chloride and sulfate. This round of ground water sampling is the last one planned for the project.

C.4. Data Analysis and Reporting (for Vegetated Filter Strip)

C.4.a. Context within the project: a separate report will be produced for the feedlot runoff vegetated filter strip monitoring results.

C.4.b. Methods: Graphical plots of the data will be examined to identify patterns in ground water chemistry that reflects the effects of the treatment system. The contaminant loading measured at upslope, mid-slope and down-slope locations will be compared to determine the effectiveness of the filter strips in reducing contamination in feedlot runoff. Both graphical and statistical comparisons will be made. The final report will include a complete description of site characteristics, monitoring design, water chemistry results, conclusions and recommendations.

C.4.c. Materials: Materials are needed to print 100 copies of the final report.

C.4.d. Budget
Total Biennial LCMR Budget: $23,200
LCMR Balance: $10,700
Match: $20,200
Match Balance: $8,200

C.4.e. Timeline

	7/95	1/96	6/96	1/97	6/97	12/97
Data analysis					XXXX	
Report writing						XXXXXXX

C.4.f. Work Program Update

January 1, 1996 - Water quality data from the first runoff event in Mille Lacs County has been analyzed. Contaminant concentrations of runoff coming off of the feedlot were very high.

July 1, 1996 - Data are being analyzed following each storm event to determine reductions in contaminant concentrations as runoff flows across the filter strip.

January 1, 1997 - Data analysis following all runoff events has continued.

July 1, 1997 - With the lack of storms, the primary data analysis has been from the monitoring wells information.

VI. EVALUATION:

The monitoring data collected for all three objectives as described under Section V will allow for in-depth evaluation of the effectiveness of the feedlot pollution abatement systems to prevent both surface and ground water quality degradation.

VII. CONTEXT WITHIN FIELD:

Earthen-basin Seepage - Research in Wisconsin has suggested that leakage from clay-lined earthen manure storage basins can pose a significant threat to underlying ground water quality, but the quantity of seepage was not determined. Other studies using monitoring wells have indicated that seepage from earthen-basins, including some without clay liners, do not pose a threat to ground water quality. Until 1993, no studies had been indicated to determine the quantity and quality of seepage below earthen-basin clay liners. During 1993-94, a unique monitoring system was installed in Morrison County through the teamwork of Morrison County, the MPCA, the Natural Resource Conservation Service and the University of Minnesota. The installation of the Morrison County system is complete, demonstrating the feasibility of constructing this new type of monitoring system. This study will use a similar approach to examine seepage under different livestock and soil conditions.

Vegetated Filter Strip Monitoring -

Grassed filter strips have been used for over a decade to reduce surface water pollution from feedlot runoff. Limited monitoring of the effectiveness of grassed buffers has shown that they can significantly reduce biological oxygen demand and nutrients from the surface runoff. However, little work has been conducted to determine if the attenuation of surface runoff is leading to increased ground water nitrate contamination at the filter strip sites.

In the past five years, several research projects have concluded that certain trees can remove tremendous amounts of nitrogen from soil and shallow ground water. In Iowa, multispecies buffers using trees and grasses have shown promise as being effective at minimizing nutrient transport to surface and ground water in riparian areas. The effectiveness of the multispecies vegetated filter strips has not been determined for feedlot runoff areas. Currently, the MPCA, in cooperation with the NRCS and USGS are setting up a study site in Redwood County to monitor the effectiveness of grass/tree filter strips. Monitoring at additional sites are needed to draw conclusions about the effectiveness of grass and tree filter strips in attenuating feedlot surface runoff contaminants without contributing to ground water contamination.

VIII. BUDGET CONTEXT:

(a) A related earthen-basin monitoring project is being funded by Morrison County, with in-kind support from several organizations. A vegetated filter strip seepage monitoring project that is currently being conducted by the USGS is funded ($34,000) by the MPCA through the EPA (Section 319 of the Clean Water Act). (b) No other MPCA monies are planned to be spent on activities related to this project during the two-year period beginning July 1, 1995.

IX. DISSEMINATION:

The results of this study will be of great interest to people at the local, state and national level. The primary means of information dissemination at the local level will be tours at the monitoring sites. The LCMR reports and presentations at state and regional meetings will be the primary means of disseminating information at the state level. The USGS reports and national conferences will be the primary means of disseminating this information throughout the country and world. The raw data will be kept on a computer data tape accessible at the Twin Cities USGS office.

X. TIME:

Monitoring should be long-term since: 1) initial filling of the storage basins and establishment of vegetation may take 6 to 12 months; and 2) adequate time is needed to reach conditions representative of long-term operation. Long-term monitoring will also allow determination of performance under a variety of climatic and runoff conditions. The following study results will be available within the two-year funding cycle: 1) tile line water quality surrounding unlined earthen basins; 2) seepage quantity and quality during the first two years of newly constructed clay-lined earthen manure storage basins; 3) older growth vegetated filter strip treatment of feedlot runoff; and 4) initial treatment of feedlot runoff from newly-planted vegetated filter strips. Continued monitoring beyond December 1997 of the clay-lined earthen basins and newly-planted vegetated filter strips will be needed. Long-term monitoring of these sites will be low in cost relative to this initial

LCMR grant. Funding for continued monitoring will be sought from EPA and various research organizations. Two of the four LCMR reports will be completed before July 1, 1996, and the other two will be completed by June 30, 1998. The additional time for two of the reports is needed to meet the USGS national standards for report review.

XI. COOPERATION:

MPCA: The MPCA project manager (Dave Wall) and technical support staff (Randy Ellingboe, Joe Magner) will be very involved with project planning, project oversight, and project review, spending 400 to 500 hours on this project.

USGS: The USGS will be the principal investigating agency responsible for planning, construction, monitoring, data collection, data analysis, interpretation and reporting. The equivalent of 1.5 full-time staff will be working on the project for the two-year period. Steve Komor will be the principal investigator for Objective C and Jim Ruhl will manage objectives A and B.

Natural Resource Conservation Service (NRCS): The NRCS (John Brach, Scott Swanberg and Jeff St. Ores) will assist with site selection, engineering design of earthen basin monitoring system, and inspections during construction of earthen basins. The NRCS will spend approximately 300 hours on the project, mostly during the first few months of the project.

University of Minnesota: Staff from the University of Minnesota Agricultural Engineering Department (Chuck Clanton and Brian Hetchler) will assist with project planning, construction of monitoring systems, inspections, sampling and report review. Total hours spent by University of Minnesota will be 300 to 350.

XII. REPORTING REQUIREMENTS:

Semiannual six-month work program update reports will be submitted not later than January 1, 1996, July 1, 1996, January 1, 1997, June 30, 1997, a final six-month work program update by December 31, 1997 and a final report by June 30, 1998.

XIII. REQUIRED ATTACHMENT

1. Qualifications
2. Project Summary