STRATFORD/AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT

DEMONSTRATION OF IMPROVED LIVESTOCK AND MANURE MANAGEMENT TECHNIQUES IN A SWINE OPERATION

Technical Report R-3

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PREFACE

This report is one of a series of technical reports resulting from work undertaken as part of the Stratford-Avon River Environmental Management Project (S.A.R.E.M.P.).

This two-year project was initiated in April 1980, at the request of the City of Stratford. The S.A.R.E.M.P. is funded entirely by the Ontario Ministry of the Environment. The purpose of the project is to provide a comprehensive water quality management strategy for the Avon River Basin. In order to accomplish this, considerable investigation, monitoring and analysis has taken place. The outcome of these investigations and field demonstrations will be a documented strategy outlining the program and implementation mechanisms most effective in resolving the water quality problems now facing residents of the basin. The project is assessing urban, rural and in-stream management mechanisms for improving water quality.

This report results directly from the aforementioned investigations. It is meant to be technical in nature and not a statement of policy or program direction. Observations and conclusions are those of the authors and do not necessarily reflect the attitudes or philosophy of all agencies and individuals affiliated with the project. In certain cases the results presented are interim in nature and should not be taken as definitive until such time as additional support data is collected.

Reference to equipment, brand names or supplies in this publication is not to be interpreted as an endorsement of that particular product or supplier.

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This report has been prepared using Imperial measures, as were the plans and specifications attached hereto. This was done purposely for ease of interpretation by contractors, the landowner, and project staff. A metric conversion table has been included in the Appendix.

ABSTRACT

Staff associated with the Stratford/Avon River Environmental Management Project worked with a private landowner in mitigating two very common sources of water quality impairment associated with livestock operations throughout the Avon River Basin. One project dealt with restricting livestock access to a watercourse through fencing and a culvert installation. Details of this project are contained in Technical Report R-7. The second demonstration was aimed at preventing manure-contaminated runoff from entering the same nearby watercourse. This was accomplished by the construction of a concrete retention wall and accompanying system which pumped the runoff into a liquid manure tank where it could be stored for use in land application. The purpose of the project was to demonstrate that nutrient and sedimentation problems often associated with livestock enterprises can be controlled successfully by commonly applied management and conservation practices.

Landowner approval and local reaction have been very favourable since completion of the work in the summer of 1981.

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1.0 INTRODUCTION

Pollution hazards can arise from the mismanagement of manure from livestock operations[1]. Manure and its constituents can be carried overland in surface runoff and can create adverse effects in receiving waters. These include nitrate poisoning of animals and humans that drink contaminated water, the transmission of certain diseases if disease-producing organisms are present in the manure, nutrient enrichment of water courses, the resultant growth of nuisance algae (eutrophication), and occasional fish kills, due to the presence of toxic ammonia and the depletion of the dissolved oxygen as organic material decays. Sane of these pollution problems have been experienced in the Avon River Basin and are a major concern to the Stratford/Avon River Environmental Management Project.

The owner and operator of a farm property in the upper portion of the Avon River watershed, Robert Lantz, was approached by project staff in mid-July of 1981 to discuss the management of a water quality problem thought to originate on his farm. The water in an open drain running through the farm was often very turbid, a condition caused by uncontrolled livestock access to a stretch of the drain, and manure runoff from a concrete pad around the farm buildings (see Figure 1). Mr. Lantz was already aware of the Stratford/Avon Project through his involvement in a conservation tillage demonstration partially funded by the Project (see Technical Report R-11). The farm is situated in the Stratford/Avon Project's "Demonstration Sub-Watershed" (see Technical Report R-13).

The livestock access problem was corrected as a separate project, and is reported in Technical Report R-7. This report covers only the demonstration of improved manure handling practices on Mr. Lantz's farm.

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[1] Canada Animal Waste Management Guide, Publication 1423. 1976 Agriculture Canada.

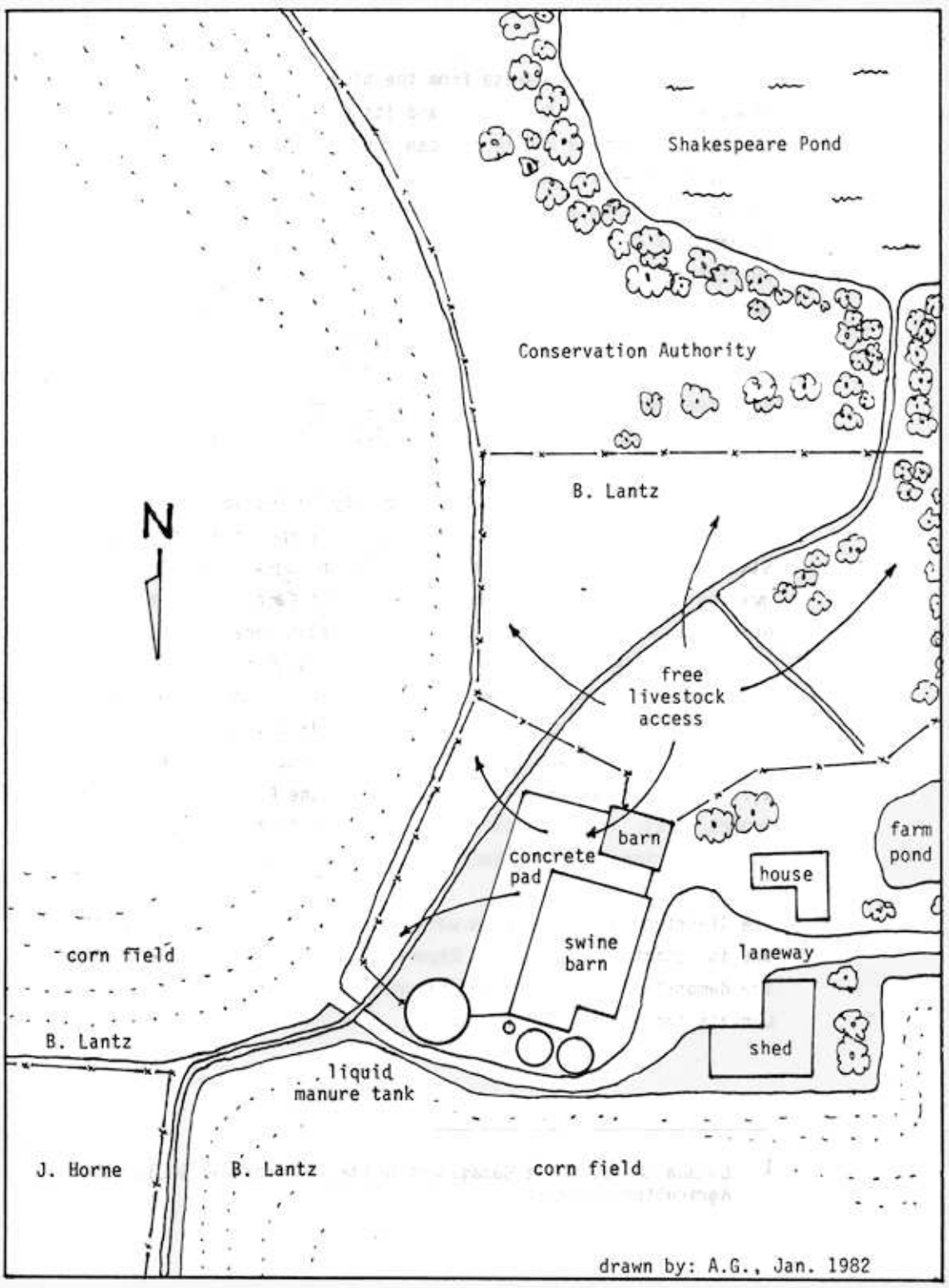


FIGURE 1: Site Plan Before Demonstration Work

2.0 METHODS

2.1 Existing Structures

As noted above, some of the increased turbidity observed in the drain was attributable to runoff from a concrete pad around the farm buildings. The pad, which covered about 7000 square feet, had been poured several years previously on a raised area of the yard between the barn and the drain (Figure 1). This area is also accessible to pigs and is used seasonally as a feeding yard. The pad had no retaining wall around it, allowing rainfall to flush any collected manure from the pad directly into the open watercourse. However, the concrete used for the pad had been poured over a fill material of broken concrete, stone and gravel, which provided sub-surface drainage and assured minimal frost heaving. In addition to the concrete pad, a liquid manure tank had been built previously to handle manure from the housed swine. This gave the operator the opportunity to store valuable nutrients until such time as they could be applied to the cropland. This system, however, handled only the manure from the barn and offered no storage for the waste from the concrete yard.

2.2 Demonstration Structures

To retain manure on the pad itself and to prevent external runoff from entering the collection area, project staff proposed that a concrete retention wall be constructed around the concrete pad (see Figure 2). Eavestroughs had previously been placed on the barns, and the roof leaders were directed beneath or away from the concrete pad; this run-off would not be contaminated so it could be discharged directly into the drain.

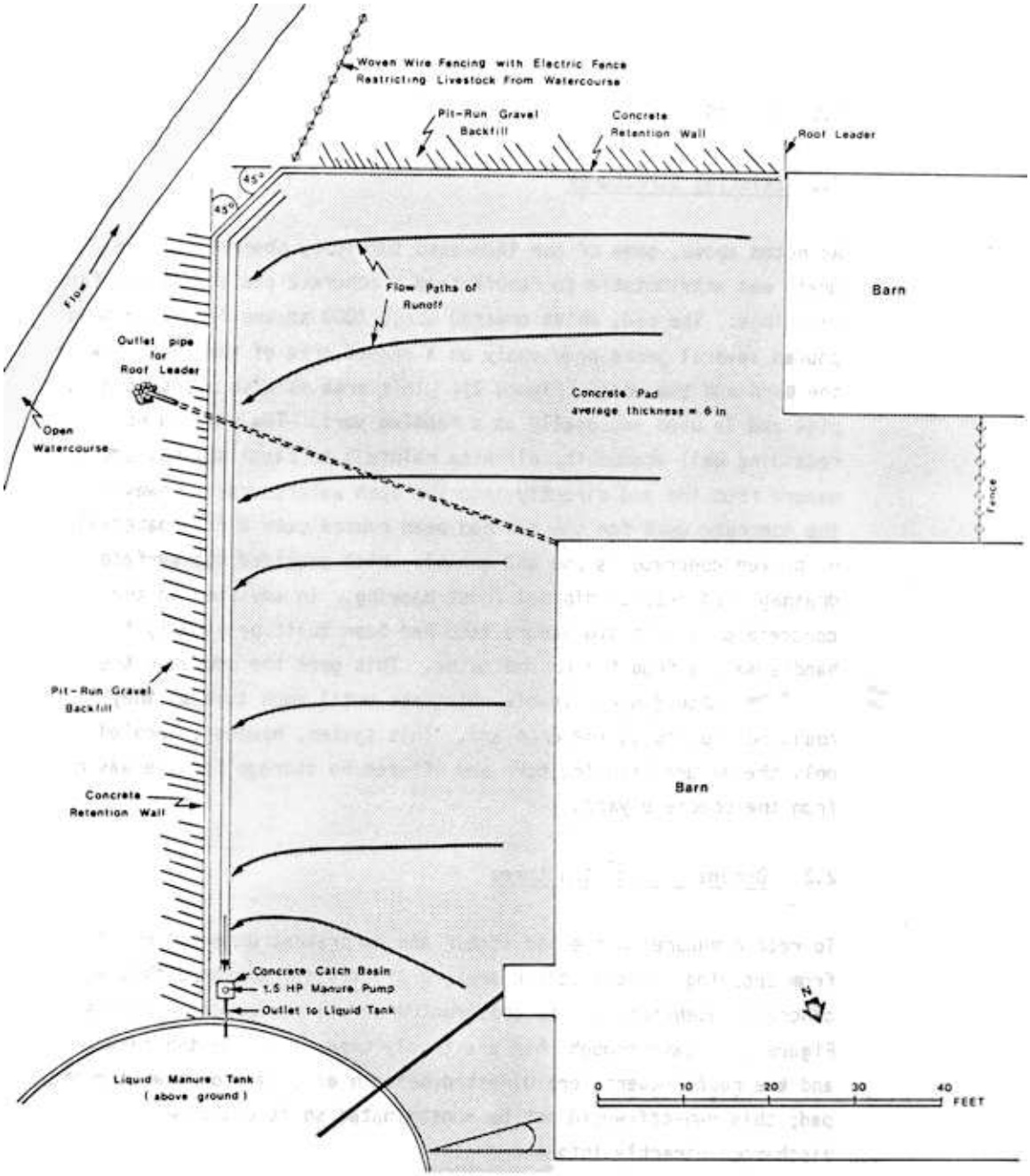


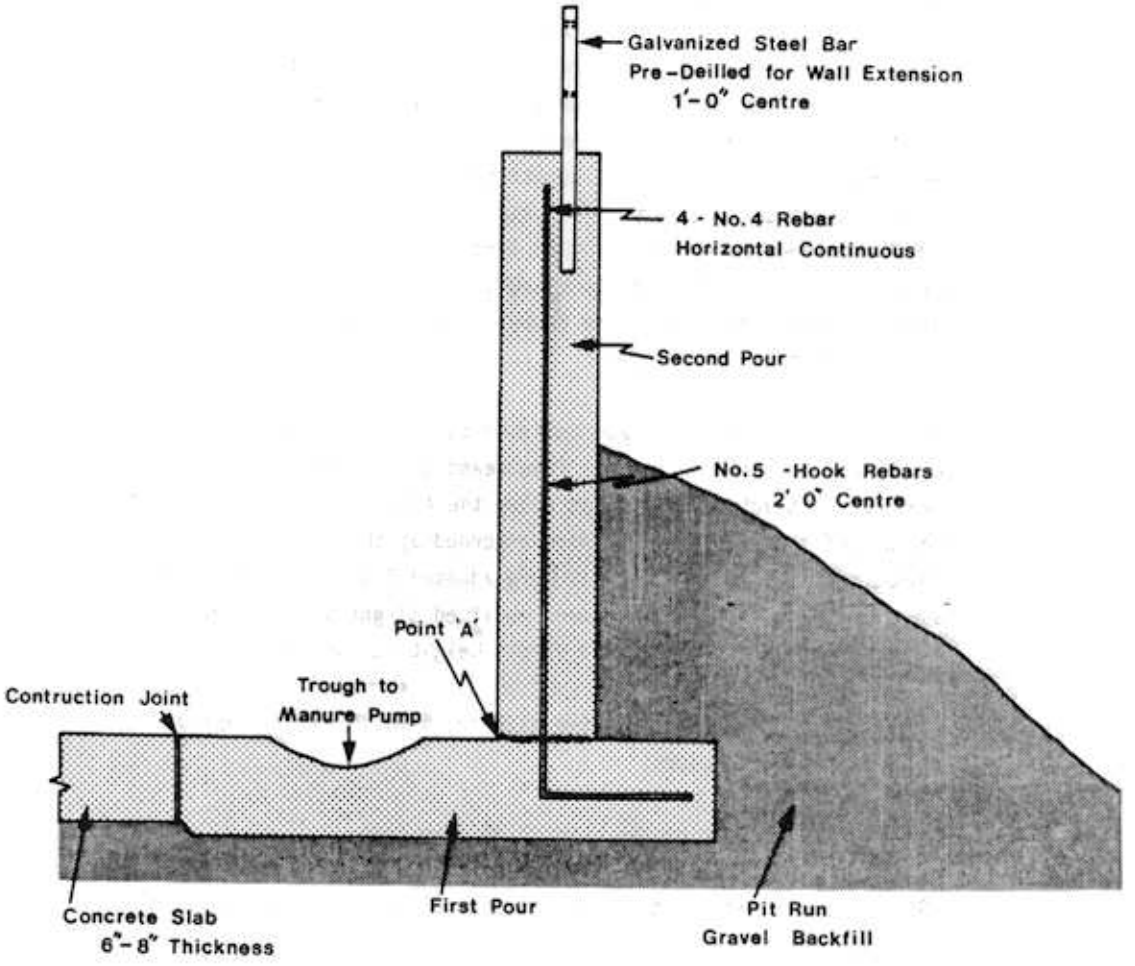
FIGURE 2: Site Plan For The Manure Handling Facilities

The runoff which would be collected by the retention wall could then be pumped into the existing liquid manure tank where it would be stored and later used for land application. The capacity of the liquid tank and the potential runoff from the pad were used to calculate the probable performance of the system under average rainfall conditions. It was concluded that collected runoff could be stored in the tank without upsetting the 6-month storage capability of the tank even if excessive rains did occur (N. Bird, O.M.A.F., 1981, pers. comm.). The landowner could simply delay pumping the runoff into the tank and allow it to pond on the concrete pad. This would also promote evaporation which would reduce the volume of runoff.

The retention wall itself was designed to 'float' adjacent to the concrete slab (see Figure 3). This meant that there would be no need to construct wall footings below the frost level in the ground because of the excellent drainage afforded by the existing foundation. Plans for the wall were adapted from the Canada Plan Service's Plan No. 2703, and were modified slightly to accommodate a 4-foot high concrete wall. The 4-foot height was preferred because:

(1) it would be more effective as a "buck wall" when scraping the concrete pad clean;
(2) it would offer better control of livestock;
(3) it would facilitate future structural or functional changes to the concrete pad or retention wall.

The first pour of concrete was finished July 24 and some of the reinforcing bar installed. The concrete slab was extended in both directions in order to square up the proposed wall. A shallow depression was formed in front of the north-south running wall and sloped towards the liquid tank. This trench would serve to drain the runoff into a sealed concrete catch basin where it could be collected and lifted by means of a sump pump into the liquid manure tank.



NOTES

1. Retention wall will be completed by two continuous pours. Maintain a rough surface at Point 'A' to assure a good bond.
2. 3600 P.S.I. concrete to be used for both pours.
3. Adapted from: Canada Plan Service Plan 2703.

Cross Section Through Retention Wall

FIGURE 3:

The remainder of the reinforcing bar was tied in and the wall forms erected by July 19. The retention structure was essentially a continuous wall 165 feet in total length. Galvanized steel posts were sunk into the concrete at seven-foot spacings to allow for a heightening of the retention wall if required in the future.

Once the concrete was sufficiently dry, the wall was backfilled on the outer side with pit-run gravel. This would provide good support and drainage around the wall. Backfilling was done using a backhoe and a blade on the back of the landowner's tractor. The manure pump was then installed and connected by qualified electricians.

Details relating to the drain work on Mr. Lantz's farm, as well as the restricted livestock access constructed through cost-sharing by the SAREMP, are found in Technical Report R-7.

3.0 CAPITAL COSTS

The entire project required less than a month to complete. Project staff were on site at all times assisting the landowner in all stages of design and construction. Contractors were required only as stated in this report to perform work which neither the landowner nor the project staff had the expertise or the equipment to perform. As outlined in the Engineering Practice Agreement (Appendix 2), the labour, equipment and technical resources offered by the co-operator and the Stratford/Avon Project are not included in estimates of the capital costs of the demonstration project. The costs totalling $3828.57 for the construction of the retention wall project was shared 60% by the Stratford/Avon Project and 40% by the Co-operator, as stated in the Engineering Practice Agreement. Materials and equipment costs are detailed in Table 1.

TABLE 1: Material And Equipment Costs

Qty.	Materials and Equipment	Unit	Unit Cost	Total Cost
7	Carl Zehr Backhoe Excavation	HR	$ 35.00	$ 25.00
10	Corrugated Steel Culvert	FT	17.43	186.03
70	Pit Run Gravel	YD^3	3.00	210.00
1	Concrete Catch Basin	UNIT	47.40	47.40
38.5	Ready Mix Concrete (3600 P.S.I.)	M^3	58.75	2262.87
4	Brian Bell Backhoe Rental	HR	15.00	60.00
	2' x 4' Form Rental & Hardware			160.00
100	No. 5 Rebar 5' Lengths			137.50
36	No. 4 Rebar 20' Lengths			118.80
	Drop-off & Pick-up Forms			35.00
1	1 ½ HP Manure Pump	UNIT	320.00	32.00
1	1 ½ HP Motor	UNIT	175.00	175.00
	Wiring of Pump			324.00

Stratford/Avon River Environmental Management Project (60% Cost)	$2078.16
Co-Operator (40% Cost)	$1385.44

4.0 RESULTS

4.1 Function

The retention wall has proven effective in collecting contaminated runoff from the concrete yard. The pumping system works efficiently in lifting the barnyard runoff into the storage tank. Although an increased runoff volume is being added to the liquid manure tank during periods of heavy rain, it is not expected that the 6-month holding capacity of the liquid tank will be exceeded except under extreme conditions.

The system was at full capacity in the early spring of 1982 due to snowfall accumulation and heavy rains, however, the landowner was attentive to the potential problem and managed to time the liquid spreading with drier field conditions.

The retention wall and pumping system seem to be effective in protecting the quality of surf ace and groundwater sources, while storing a valuable manure nutrient source for crop production. There have not been any problems with excessive odour levels from the retained runoff.

4.2 Acceptability

The landowner has been very enthusiastic about both the livestock fencing (Report R-7) and the retention wall since work began in July of 1981. He now feels that he has upgraded his farming operation tremendously, not only in terms of reduced nutrient and sediment pollution to the watercourse, but also in terms of his farmstead's appearance. The overall cost of the project, particularily the retention wall , was quite high, but was this anticipated and was discussed with the operator before the project was initiated. The assistance which was given to the landowner both technically and financially was an important factor in implementing the improvements.

5.0 CONCLUSIONS

1. The fencing used in this demonstration to restrict swine from the open watercourse has proven to be very effective over the short time since it was erected. The Project and the Co-operator are in agreement that anything less than the combination of woven wire and electric fencing would have been ineffective in restricting this type of livestock from the water.

2. The open drain as it now passes through this portion of the property no longer receives excessive sediment or nutrient loadings associated with livestock access problems.

   It was not the intention of the Project to undertake any detailed water sampling on this property to assess the effectiveness of the remedial measures. Technical Report R-7 contains a more complete discussion of livestock access to watercourses.

3. The concrete retention wall constructed to prevent contaminated runoff from the concrete yard from entering ground and surface waters has proven effective. The manure runoff can now be utilized by the farmer for crop production. If properly spread, the wastes will not adversely affect surface or ground water quality. The farmer must watch his tank levels, particularly in the spring in order to avert potential spills and pollution problems. Snow accumulations in the retention area may have to be removed periodically.

6.0 RECOMMENDATIONS

1. The landowner must be fully convinced that any conservation or management practices being promoted or advised will give both short and particularly long-term benefits not only to him, but also to downstream landowners.

2. The design of a permanent structure such as a retention wall must accommodate both the immediate and future needs of the landowner. In some cases these projects will demand substantial time and capital resources, and care should therefore be taken in the planning stage to ensure that initial objectives are met.

3. The type of technical and financial assistance which was offered to the landowner was essential to the overall success of the project. The 'hands-on' approach taken by project staff was important in building a good working relationship with the co-operator and ensuring mutually satisfactory results. The same project staff were continually involved from the initial contact and design stages to the final construction phase, and have since carried out periodic visits to the site since construction to monitor the project and to pass along additional information to the landowner. This procedure has proved invaluable in building trust and a positive reputation with other landowners in the area, as well as with governmental agencies involved with the Stratford/Avon Project. It may, on the other hand, prove to be a disadvantage in the wide-scale application of similar extension effort unless support is available to farmers from other agencies such as conservation authorities or the Ministry of Agriculture and Food.

4. The Stratford/Avon Project was able to draw directly on the expertise of professionals of the Ontario Ministry of Agriculture and Food, who gave assistance in the design and construction details of this project. This was important in allowing a constant flow of ideas and information between the agencies and the co-operator.

APPENDIX 1

METRIC EQUIVALENTS

LENGTH

inch	= 2.54 cm	millimetre	= 0.039 in.
foot	= 0.3048 m	centimetre	= 0.394 in.
yard	= 0.914 m	decimetre	= 3.937 in.
mile	= 1.609 km	metre	= 3.28 ft

AREA

square inch	= 6.452 cm^2	cm^2	= 0.155 sq in.
square foot	= 0.093 m^2	m^2	= 1.196 sq yd
square yard	= 0.836 m^2	km^2	= 0.386 sq mile
square mile	= 2.59 km^2	ha	= 2.471ac

VOLUME (DRY)

cubic inch	= 16.387 cm^3	cm^3	= 0.061 cu in.
cubic foot	= 0.028 m^3	m^3	= 31.338 cu ft
cubic yard	= 0.765 m^3	hectolitre	= 2.8 bu
bushel	= 36.368 litres	m^3	= 1.308 cu yd
board foot	= 0.0024 m^3		

VOLUME(LIQUID)

fluid ounce(imp)	= 28.412 ml	litre	= 35.2 fluid oz
pint	= 0.568 litre	hectolitre	= 22 gal
gallon	= 4.546 litres		

WEIGHT

ounce	= 28.349 g	gram	= 0.035 oz avdp
pound	= 453.592g	kilogram	= 2.205 lb avdp
hundredweight(imp)	= 45.359 kg	tonne	= 1.102 short ton
ton	= 0.907 tonne		

PROPORTION

1 gal/acre	= 11.232 litres/ha	1 litre/ha	= 14.24 fluid oz/acre
1 lb/acre	= 1.120 kg/ha	1kg/ha	= 14.5 oz avdp/acre
1 lb/sq in.	= 0.0702 kg/cm^2	1 kg/cm^2	= 14.227lb/sq in.
1 bu/acre	= 0.898 hl/ha	1 hl/ha	= 1.112 bu/acre

APPENDIX 2: ENGINEERING PRACTICE AGREEMENT

This agreement between:

Stratford-Avon Environmental Management Project (SAREMP)

and

Robert Lantz (Co-operator)

1. The Co-operator agrees to assist the with implementation of the following soil conservation practices on his property as noted below:

    1. **Drain improvement & Restricted Livestock Access to Watercourse**
    2. **Retaining Wall to Control Barnyard Runoff**

2. The Co-operator agrees that for the purposes of demonstration, practices shall be accessible for viewing by others, that photographs may be taken for documenting the success of the practice, and that a sign may be installed identifying the practice as part of a Project.
3. The **SAREMP** and the Co-operator. jointly agree to undertake the above-noted demonstration in accordance with this Agreement and the plans and specifications attached hereto.
4. Modifications to the demonstration specifications and/or Agreement may be made in the future, subject to the approval of both Co-operator and **SAREMP**
5. The **SAREMP** agrees to have a staff member or representative at the site to oversee the implementation of the demonstration, according to the demonstration specifications. If none are available, the Co-operator agrees to keep detailed records on all activities at the site during that period.
6. The Co-operator agrees to have at the demonstration site, in working order, those machines to be provided by him, as stated in the demonstration specifications. The Co-operator should be available to operate such tractors and/or machinery.
7. The **SAREMP** agrees to document changes in each project (eg. grass establishment on grassed waterways), throughout the life of the demonstration.
8. The Co-operator agrees to maintain the demonstration according to the specifications, for at least 3 years from the time of installation.
9. Should the **SAREMP** staff or the Co- operator note any problems that could jeopardize the success of the demonstration, both parties will be notified, and mutually acceptable, appropriate, corrective measures undertaken.
10. The Co-operator agrees not to undertake any cultural practices in the demonstration area without the consent of the **SAREMP** staff.
11. The **SAREMP** agrees to inform the Co-operator when a tour stop is to be made at the site, and will invite, on occasion, the Co-operator to attend the site while the tour is being conducted.
12. The **SAREMP** agrees to pay 60% of the total cost (exclusive of project staff and Co-operator labour), of the engineering practices noted above, subject to the satisfactory completion of the project and the provision of acceptable invoices.
13. Financial assistance will be made available by **SAREMP** in the following manner:

    - **All Capital Expenditures will be initially paid by the SAREMP**
    - **Once completion of the Demonstration Project, the Co-operator will pay the SAREMP 40% of the TOTAL Capital cost .**

14. The Co-operator agrees to release the project, its staff and associated agencies from all liability which might arise as a result of the activity proposed.

_____ _____

Co-operator Program Co-ordinator

Date: _____

STRATFORD-AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT
LIST OF TECHNICAL REPORTS

S-1 Impact of Stratford City Impoundments on Water Quality in the Avon River
S-2 Physical Characteristics of the Avon River
S-3 Water Quality Monitoring of the Avon River - 1980, 1981
S-4 Experimental Efforts to Inject Pure Oxygen into the Avon River
S-5 Experimental Efforts to Aerate the Avon River with Small In-stream Dams
S-6 Growth of Aquatic Plants in the Avon River
S-7 Alternative Methods of Reducing Aquatic Plant Growth in the Avon River
S-8 Dispersion of the Stratford Sewage Treatment Plant Effluent into the Avon River
S-9 Avon River In-stream Water Quality Modelling
S-10 Fisheries of the Avon River
S-11 Comparison of Avon River Water Quality During Wet and Dry Weather Conditions
S-12 Phosphorus Bioavailability of the Avon River
S-13 A Feasibility Study for Augmenting Avon River Flow by Ground Water
S-14 Experiments to Control Aquatic Plant Growth by Shading
S-15 Design of an Arboreal Shade Project to Control Aquatic Plant Growth

U-1 Urban Pollution Control Strategy for Stratford, Ontario - An Overview
U-2 Inflow/Infiltration Isolation Analysis
U-3 Characterization of Urban Dry Weather Loadings
U-4 Advanced Phosphorus Control at the Stratford WPCP
U-5 Municipal Experience in Inflow Control Through Removal of Household Roof Leaders
U-6 Analysis and Control of Wet Weather Sanitary Flows
U-7 Characterization and Control of Urban Runoff
U-8 Analysis of Disinfection Alternatives

R-1 Agricultural Impacts on the Avon River - An Overview
R-2 Earth Berms and Drop Inlet Structures
R-3 Demonstration of Improved Livestock and Manure Management Techniques in a Swine operation
R-4 Identification of Priority Management Areas in the Avon River
R-5 Occurrence and Control of Soil Erosion and Fluvial Sedimentation in Selected Basins of the Thames River Watershed
R-6 Open Drain Improvement
R-7 Grassed Waterway Demonstration Projects
R-8 The Controlled Access of Livestock to Open Water Courses
R-9 Physical Characteristics and Land Uses of the Avon River Drainage Basin
R-10 Strip cropping Demonstration Project
R-11 Water Quality Monitoring of Agricultural Diffuse Sources
R-12 Comparative Tillage Trials
R-13 Sediment Basin Demonstration Project
R-14 Evaluation of Tillage Demonstration Using Sediment Traps
R-15 Statistical Modelling of In-stream Phosphorus
R-16 Gully Erosion Control Demonstration Project
R-17 Institutional Framework for the Control of Diffuse Agricultural Sources of Water Pollution
R-18 Cropping-Income Impacts of Management Measures to Control Soil Loss
R-19 An Intensive Water Quality Survey of Stream Cattle Access Sites