STRATFORD/AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT

THE CONTROLLED ACCESS OF LIVESTOCK TO OPEN WATERCOURSES

Technical Report R-8

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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 0ntario 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 supply 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 three farming landowners in the Upper Avon Basin to demonstrate cost-effective means of controlling or restricting livestock from open watercourses. This technical report deals with the identification of each problem situation and recommendations to be considered in the design of the remedial measure. Two projects demonstrated controlled access of livestock to an open drain; the third project involved restricting livestock from the drain altogether. Various crossing designs and fencing alternatives were used in the projects. The landowners concerned, proved to be receptive to the approaches used to control or prevent access of livestock to open watercourses. Further monitoring of these demonstrations will give better indication of their effectiveness in reducing sediment and nutrient loadings to downstream areas.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1.0 INTRODUCTION

Uncontrolled livestock access to open watercourses is very common to livestock operations in the Avon River watershed. Pasturing of beef and dairy cattle provide the major impacts, although the same problem exists with other types of animal operations. The direct discharge of animal wastes into the stream can cause a water pollution problem, as can the severe trampling and consequent erosion of the streambanks and channel sedimentation which occurs where livestock enter streams for watering.

An individual farm may not in itself be a significant source of pollution, hut a number of farms along a single tributary which do not utilize controls on access can pose a major water quality problem. Of primary concern in such situations are elevated concentrations of bacteria, suspended solids and nutrients in stream waters.

Staff of the Stratford/Avon River Environmental Management Project undertook remedial programs in co-operation with three farming landowners in the upper portion of the Avon River watershed who had previously allowed livestock uncontrolled access to an open watercourse on their property. The remedial measures were undertaken to demonstrate that bank slumping and direct waste discharge to the river could be controlled through the provision of improved facilities. The different conditions existing at each farm dictated the types of crossing and fencing alternatives used for each demonstration.

This report details construction methods for limiting livestock access to a watercourse, thereby reducing bank erosion and sedimentation problems. The impact of controlled livestock access points on nutrient loadings to the Avon River is the subject of a separate report by the Stratford/Avon Project (SARFEMP Technical Report R-19).

2.0 METHODS

2.1. Description of Demonstration Sites

Mr. Ron Hyde, owner of the first farm studied, approached the Stratford/Avon Project and requested assistance to improve a 1400 foot section of the Avon Municipal Drain which passed through his property. The banks of the drain in many places were very unstable and actively eroding. This condition was partially caused by cattle which had been allowed free access to this portion of the watercourse.

A second farm, operated by Mr. Ken Scheerer, supported a sizeable number of dairy herd which crossed the Avon Municipal Drain several times daily as they travelled from the barn to the pasture. No improved crossing had been provided, and as a result the drain banks were very unstable and subject to severe erosion.

A third landowner, Mr. Bob Lantz, was approached by project staff and was offered technical and financial assistance to remedy a livestock access problem on a private drain. Approximately forty to fifty sows had free access to 450 feet of open drain where it flowed through the yard adjacent to the barn structures.

In all three cases, the unrestricted livestock access to the drains had led to severe trampling of the banks; in some areas virtually no vegetative cover was left on any ground adjacent to the drain. Sediment washed from the exposed soil and eroding banks, and nutrients from the livestock wastes, could freely enter the watercourses.

2.2 Remedial Measures

2.2.1 The Hyde Farm

Extensive demonstration projects were undertaken on Mr. Hyde's farm over the three year period 1980-82. The work included livestock control, bank stabilization, a grassed waterway, drain cleanouts, protected tile outlets and a sediment basin. These measures are fully detailed in Technical Reports prepared by project staff (SARFEMP Technical Reports R-6, R-7, R-13 and R-16).

Once the ditch banks had been re-shaped to a desired side-slope and seeded down with a grass/legume mixture, a permanent fence was constructed on one side of the drain to restrict the cattle from the watercourse except for one access point. This point would serve as a watering facility as well as a crossing for livestock and machinery.

The crossing was constructed using a hydraulic hoe. A 5:1 (horizontal:vertical) side-slope was cut into both banks for a width of 20 feet, and excavated to a depth of about 10 inches. Rounded stone ranging in size from 4 to 9 inches in diameter was dumped onto the entry and exit ramps, as well as into the channel bottom. The stone was then levelled and firmed into place by the hydraulic hoe. The stone protection would serve to resist the trampling caused by the cattle, yet allow their safe passage. Any exposed banks were then seeded down with a grass/legume mixture.

Suspension fencing was chosen because of its practicality, simple construction, relatively low costs and minimal upkeep. The fence reportedly has a lifespan comparable to woven page wire fencing. Four strands of barbed wire were fastened to cedar line posts, spaced at a maximum distance of 100 feet. Twisted wire stays were then used every 16 feet along the fence to maintain the proper distance between the strands of barbed wire. Further details on suspension fencing can be found in an Ontario Ministry of Agriculture and Food Fact Sheet entitled "Suspension Fencing", Agdex 400/724, March 1976.

Following the preference of the landowner, brace panels were installed and line post holes drilled by a contractor. The posts were then installed and the fence erected by the landowner with assistance from project staff. Gates were positioned across the drain to prevent cattle from moving upstream or downstream in the channel at the crossing.

The fencing somewhat reduced the pasture area accessible to the cattle, but the landowner did not forsee any problems. Future drain cleanouts could be performed easily since fencing was installed on one side of the drain only. A laneway was left along the bank adjacent to the sediment basin to allow periodic basin cleanouts. A gate was also installed to allow machine access.

Figure 1 gives a site plan of the project and details of the crossing. Associated costs for the crossing and the fencing are included in Table 1.

2.2.2 The Scheerer Farm

The work on Mr. Scheerer's farm was almost fully designed and carried out by the landowner himself using his own farm labour and available resources. Because a culvert or similar dry crossing would have proven very expensive, it was decided to improve on the existing channel crossing. Entry and exit ramps 12 feet in width were excavated from opposite banks at about 5:1 slopes. Concrete slabs measuring 6 feet square and 6 inches thick were laid down and butted up against each other to form the ramps. The rough surface on the concrete slabs would prevent the cattle from slipping when the ramps were wet. The channel bed had been excavated at the crossing and then filled with several loads of gravel. This gravel would resist the impact of the cattle hooves, while providing a firm surface for crossing.

Field stone and broken concrete were then used to protect the sidewalls of the ramps from eroding. On numerous occasions spring flows in the drain greatly exceeded the drain's capacity at this point. To guard against potential scouring and to hold the banks in place, stone walls were built along the stream banks adjacent to the ramps. The walls were backfilled with soil and the surrounding area seeded down with a grass/legume mixture. An electric fence was erected to keep the cattle away from the banks and to limit their

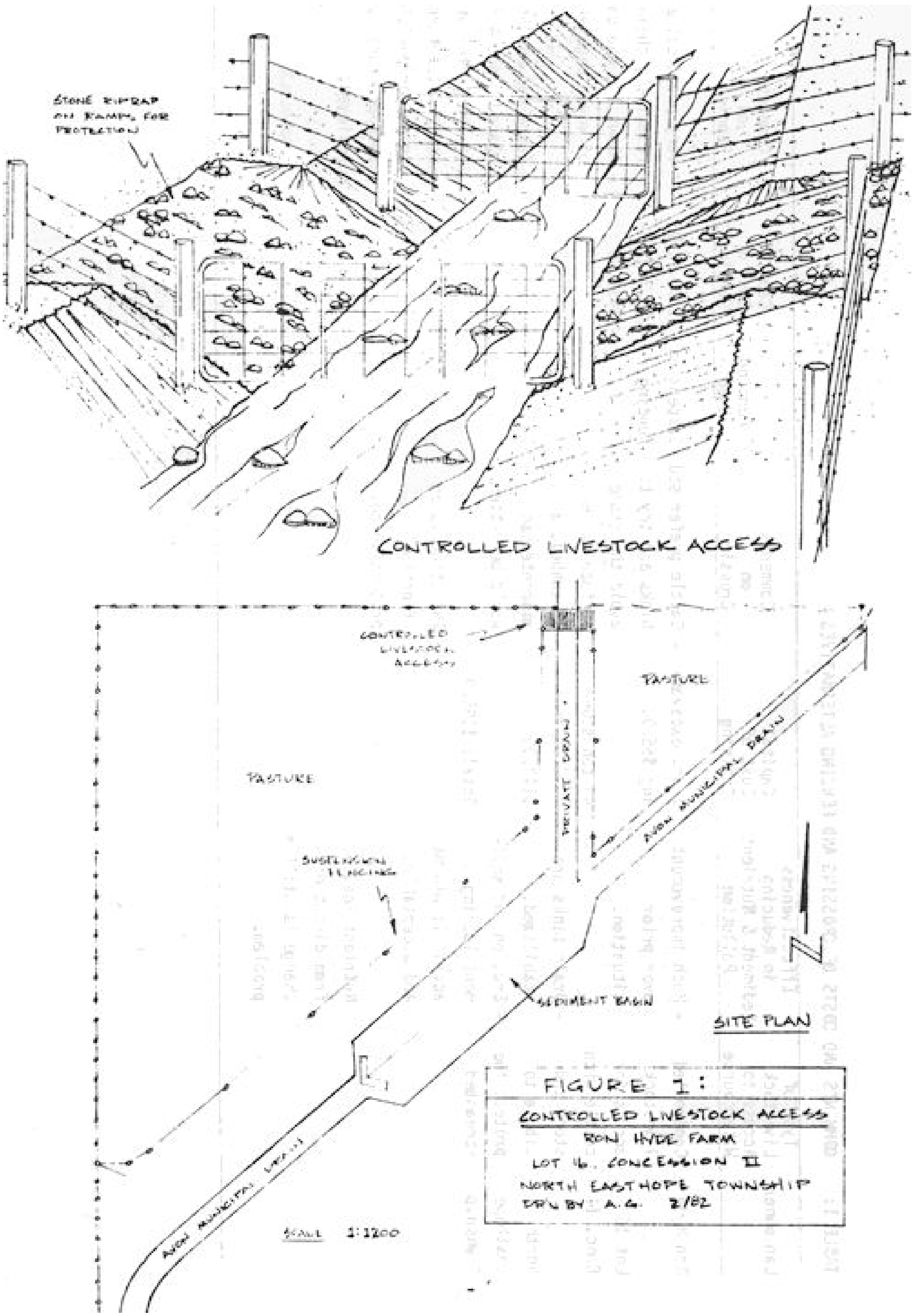

STONE RIPRAP ON RAMPS FOR PROTECTION
CONTROLLED LIVESTOCK ACCESS
CONTROLLED LIVESTOCK ACCESS
PASTURE
PASTURE
PRIVATE DRAIN
AVON MUNICIPAL DRAIN
SUSPENSION FENCING
SEDIMENT BASIN
SITE PLAN
FIGURE 1:
CONTROLLED LIVESTOCK ACCESS
RON HYDE FARM
LOT 16, CONCESSION II
NORTH EASTHOPE TOWNSHIP
DRN BY: A.G. 2/82
SCALE 1:1200
AVON MUNICIPAL DRAIN

TABLE 1: COMMENTS AND C0STS CF CROSSING AND FENCING ALTERNATIVES

Landowner	Type of Livestock Access to Watercourse	Effectiveness in Reducing Sediment & Nutrient Pollution	Capital Cost of Crossing	Comments on Crossing	Fencing Used	Capital Cost of Fencing	Comments on Fencing
Ron Hyde Lot 16 Conc. II North Easthope Township	Controlled livestock access for cattle with stone and cobble to protect the streambed	- Much improvement over prior situation. - Drain banks are stabilized. - Erosion and sediment loading at access is minimal and acceptable. - Nutrient loading from direct discharge is still a problem.	1 Hr. excavating $55.00 44 ton stone @ $3.18/ton $140.00 Total: $195.00	- Cattle prefer sod banks and try to avoid the stone surface of the stream-bed; a concrete pad would be better. - The stone is an effective protective cover.	Suspension fencing	1200 ft @ $0.36/ft - $432.00	- Very practical and relatively cheap. - About ⅓ the cost of woven page wire. - Fence can be displaced about 4 ft. in the centre of a span, but returns to proper position when pressure is relieved.

TABLE 1: Cont'd

Landowner	Type of Livestock Access to Watercourse	Effectiveness in Reducing Sediment & Nutrient Pollution	Capital Cost of Crossing	Comments on Crossing	Fencing Used	Capital Cost of Fencing	Comments on Fencing
Ken Sheerer Lot 31 Conc. II North Easthope Township	Controlled Livestock Access for Dairy Cattle	- Bank trampling is under control - Crossing is on a heavily used corridor between barn and pasture, where a vegetative cover cannot develop. - Continuing problem with sediment laden surface runoff. - Nutrient loading via direct fecal discharge has not been reduced.	2-½ Hrs. Trucking $55.00 2-½ Hrs. Loader $75.00 Concrete Slabs $10.00 Hired Labour 70 Hrs. $280.00 Total: $420.00	- Animals have adjusted to concrete ramps. - Surface Runoff concentrated down ramps is a definite problem. Berms would be advantageous. - Improved, but not an ideal solution for this particular situation.	Electric Fencing	No Record	- Can be an effective means of seasonal or temporary control. - Cheap and easily installed. - Fencing was not kept up so is somewhat ineffective.

TABLE 1: Cont'd

Landowner	Type of Livestock Access to Watercourse	Effectiveness in Reducing Sediment & Nutrient Pollution	Capital Cost of Crossing	Comments on Crossing	Fencing Used	Capital Cost of Fencing (#/ft.)	Comments on Fencing
Bob Lantz Lot 20 Conc. II North Easthope Township	Restricted Livestock Access for Pigs	- Vast improvement over prior situation. - Drain banks are vegetated and quite stable. - Buffer strips act as filter for both sediment and nutrient carried in surface runoff. - No direct discharge by animals into watercourse	28 Yd^3 Pit Run Gravel $84.00 1-½ Hr. Backhoe $52.50 10'x36" Diam. C .S. Culvert $186.00 Total: $322.50	- Animals have adjusted well. - Excellent alternative to controlled access. - Could be increased in size to allow machine crossings if required.	Woven Page Wire with an Electric Fence Strand supported on 2 x 4 braces in site of the fence.	884 ft. @ $1.00/ft. $884	- Very effective alternative under these circumstances. - Recommended that the electric strand be supported by steel posts rather than 2 x 4 braces.

crossing to the ramps. Fencing was strung across the drain to prevent the cows from moving upstream or downstream in the channel This work was completed in early summer of 1981.

Figure 2 gives a site plan of the project and details of the crossing. Associated costs for the crossing are included in Table 1.

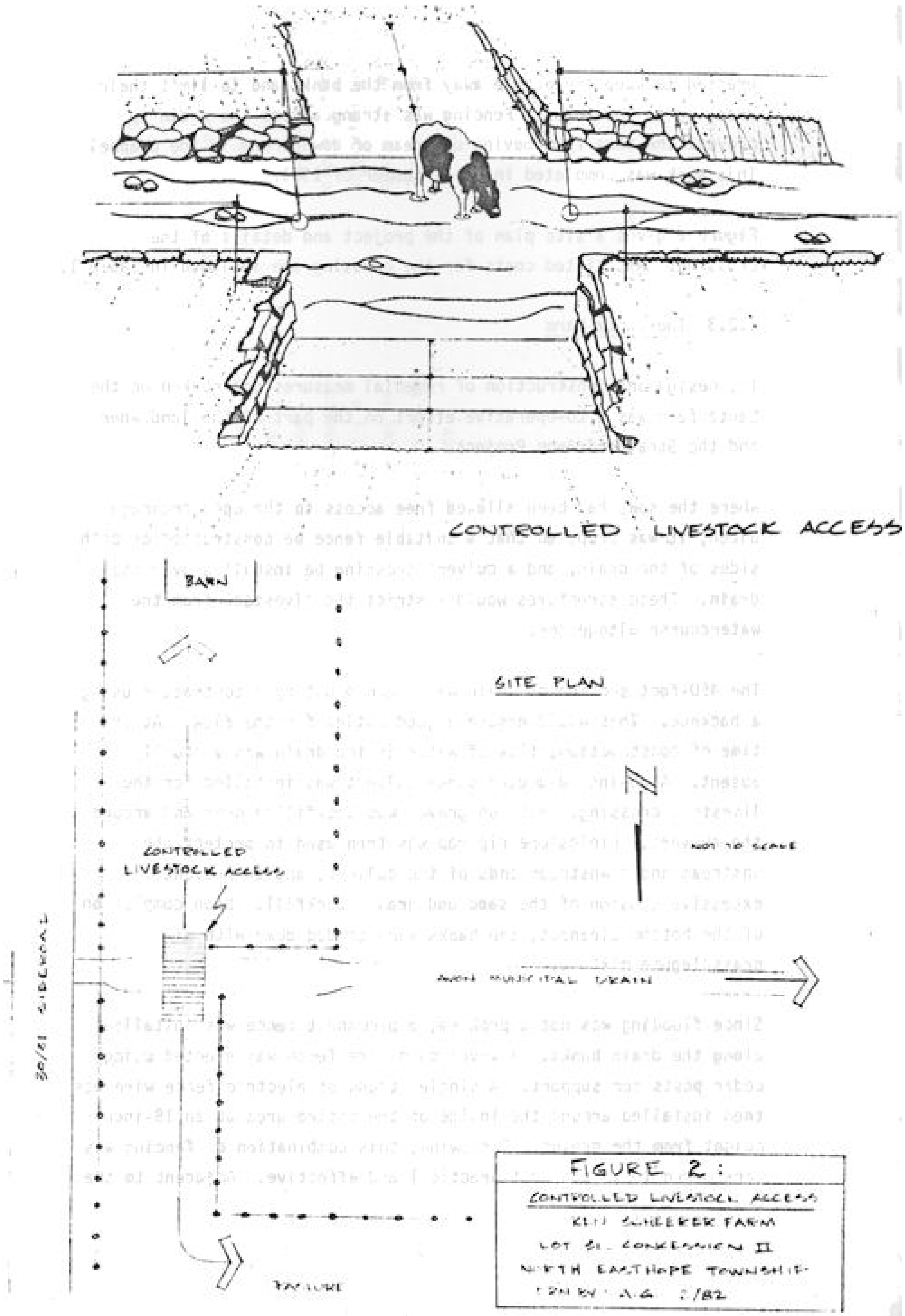
2.2.3 The Lantz Farm

The design and construction of remedial measures undertaken on the Lantz farm was a co-operative effort on the part of the landowner and the Stratford/Avon Project.

Where the sows had been allowed free access to the open drainage ditch, it was proposed that a suitable fence be constructed on both sides of the drain, and a culvert crossing be installed over the drain. These structures would restrict the livestock from the watercourse altogether.

The 450-foot section of drain was cleaned out by a contractor using a backhoe. This would ensure a good outlet for the flow. At the time of construction, flow of water in the drain was virtually absent. A 36-inch diameter steel culvert was installed for the livestock crossing. Pit run gravel was backfilled over and around the culvert. Fieldstone rip rap was then used to protect the upstream and downstream ends of the culvert, and to prevent excessive erosion of the sand and gravel backfill. Upon completion of the bottom cleanout, the banks were seeded down with a grass/legume mixture.

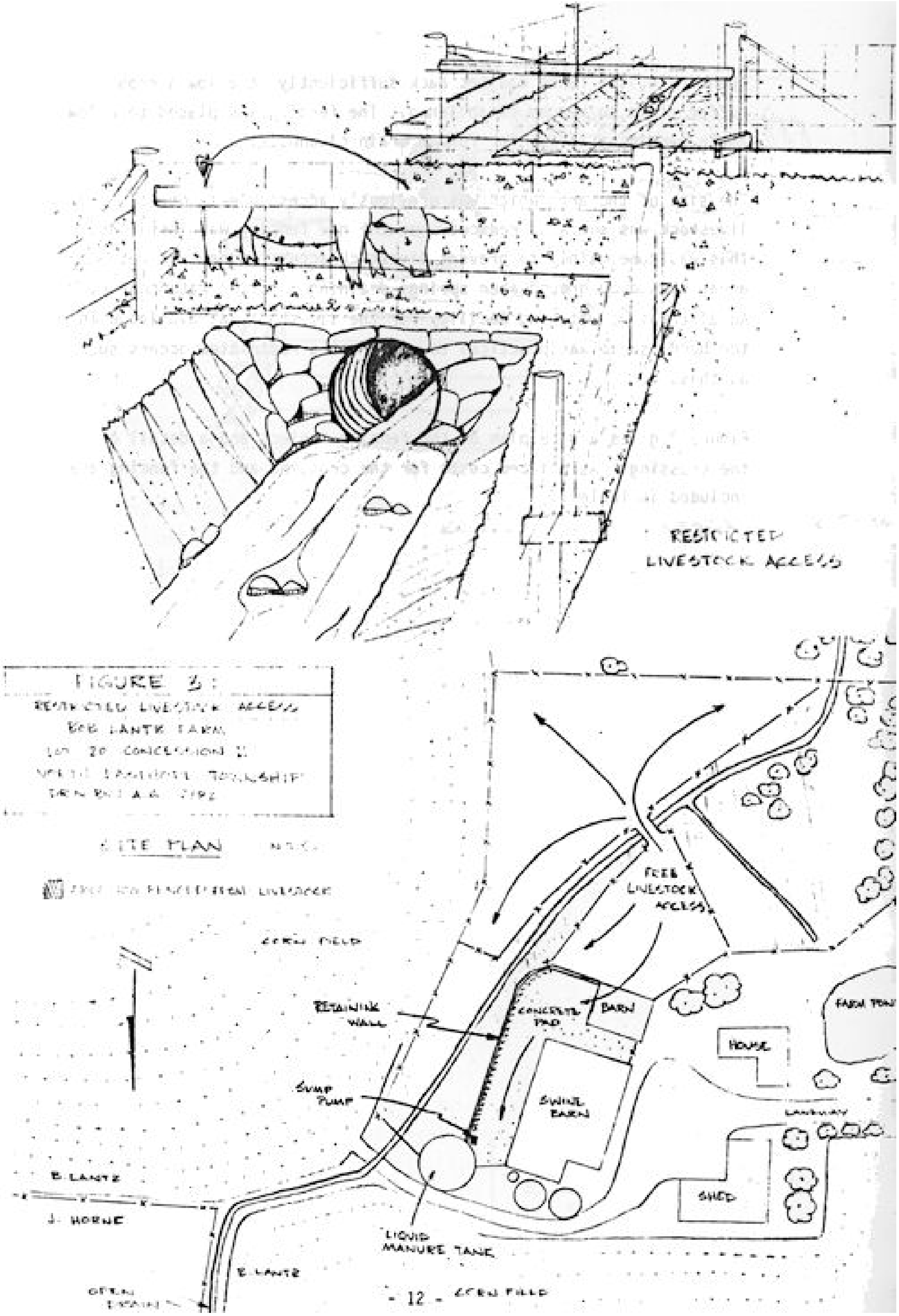
Since flooding was not a problem, a permanent fence was installed along the drain banks. A woven page wire fence was erected using cedar posts for support. A single strand of electric fence wire was then installed around the inside of the entire area at an 18-inch height from the ground. For swine, this combination of fencing was considered to be the most practical and effective. Adjacent to the open drain, the fence was set back sufficiently


CONTROLLED LIVESTOCK ACCESS
BARN
SITE PLAN
NOT TO SCALE
CONTROLLED
LIVESTOCK ACCESS
AVON MUNICIPAL DRAIN
PASTURE
FIGURE 2:
CONTROLLED LIVESTOCK ACCESS
NORTH EASTHOPE TOWNSHIP

to allow a good buffer strip to become established. The fencing was placed to allow ample machinery access for future drain cleanouts.

The size of the area which was previously accessible to the livestock was somewhat reduced when the new fencing was installed. This was done mainly to prevent livestock access to several wet areas caused by groundwater springs draining into the watercourse. An alternative watering facility for the livestock was available in the barn, so it was practical to construct a restricted access such as this.

Figure 3 gives a site plan of the fencing project and a detail of the crossing. Associated costs for the crossing and the fencing are included in Table 1.


RESTRICTED LIVESTOCK ACCESS
FIGURE 3:
SITE PLAN
CORN FIELD
FREE LIVESTOCK ACCESS
RETAINING WALL
CONCRETE PAD
BARN
HOUSE
SWINE BARN
SUMP PUMP
LIQUID MANURE TANK
SHED
B. LANTZ
J. HORNE
OPEN DRAIN
- 12 -

3.0 RESULTS AND DISCUSSI0N

Table 1 compares the effectiveness and costs of the three crossing and fencing alternatives discussed here.

The capital costs listed in Table 1 cover the material and equipment costs used to complete each project. These capital costs were shared according to the Engineering Practice Agreement: 40% paid by the co-operating landowner and 60% covered by the Stratford/Avon Project. Any labour, materials or equipment offered by either the landowner or the project staff were considered "free resources" and were not included in the capital cost.

This type of construction and the costs involved are very site specific. The design and expenditures depend on a number of considerations such as the intended function of the crossing or fencing and the resources available to any given individual to complete the job.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

There are obvious water quality benefits common to each of the alternatives which were demonstrated for the control of access of livestock to the Avon Municipal Drain and its tributaries. Although the best resolution of streambank erosion problems was realized at the Lantz site with complete restriction of livestock from the drain, well-constructed access points with adequate fencing can also dramatically reduce sediment loadings caused by trampling of banks.

In general, bank stability was improved at each of the demonstration projects described above, though there is a need for continuing surveillance and maintenance. It is safe to conclude that bank scouring and the resulting sediment loading to the stream has been reduced. This cannot be conclusively demonstrated however since overall sediment loadings during high flow periods will not be significantly impacted by these demonstration projects at limited sites along the stream*.

In addition to general water quality benefits, farmers also derive direct benefits from controlling or restricting cattle access to a watercourse:

1. A properly constructed crossing can prevent serious injury to livestock.

2. Controlling or eliminating access may help to keep livestock clean and thus improve sanitation.

3. A practical watering facility can be provided on a seasonal basis by a controlled access.

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* Intensive water quality monitoring to quantify nutrient, sediment and bacteriological loading at cattle access sites was undertaken and is documented in the SAREMP Technical Report, R-19, "An Intensive Water Quality Survey of Stream Cattle Access Site".

4. The appearance of the farm property is improved when drain banks are stabilized by the control of livestock access.

5. Bank stabilization makes for an efficient drain requiring fewer cleanouts.

6. Elimination or reduction of fecal contamination of water courses reduces bacterial contamination and may thus reduce livestock illness (there is evidence in the Avon River of livestock related bacterial contamination that violates Provincial Water Quality Objectives, see SAREMP Technical Report R-19).

There are a number of factors which may be used to determine the magnitude of water quality problems caused by livestock access:

1. Intensity of livestock:
   (i) number and type of livestock;
   (ii) area available per animal;
   (iii) behavioural patterns.
2. Length of stream accessible and number of access points on property.
3. Height and steepness of streambanks.
4. Size of stream channel and expected flows.
5. Soil type.
6. Duration of access (long-term or short-term)
7. Frequency of access (times crossed daily).
8. Bottom characteristics of stream (muck, gravel, etc.).
9. Fishery potential in stream.
10. Pasture locations relative to the stream.

4.2 Recommendations

The following recommendations are intended as a guideline for landowners considering the control or elimination of livestock access to streams. If it has been determined that a controlled livestock access is the best alternative, the following recommendations should be considered during the design phase:

1. A practical location for the access point should be chosen. Areas where the livestock are presently concentrating should be examined and the fencing layout considered. If possible, locations where natural drains enter the watercourses should be avoided.

2. Gently sloping entry and exit ramps should be designed to allow safe movement of livestock and possibly machinery if crossing is necessary.

3. The ramps and stream bottom should be protected with an erosion resistant material which is also safe and comfortable for the livestock.

4. Livestock must be restricted from walking upstream or downstream from the crossing. This can be done using removable gates or electric fencing across the channel.

5. Care must be taken not to impede the flow of the stream with the access ramp structure. Interfering with the flow may result in streambank erosion or undesired ponding.

6. Diversion berms may be required to direct surface flows away from the ramps, or to temporarily pond contaminated overland runoff.

7. Depending on the life expectancy of the pastured area, permanent or temporary fencing may be required above and below the access point. Seasonally high flood and ice conditions are a consideration in designing and locating fencing.

8. Fencing design will depend on site specific conditions. Fencing alternatives are:

(i) woven page wire;
(ii) suspension fencing;
(iii) electric fencing;
(iv) a combination of the above.

9. If fencing is required on both sides of the watercourse, ample machinery access must be allowed to facilitate future maintenance and cleanout operations. This will also assure that good buffer strips are established. A set back of at least 2-3 meters from the top of the bank was used in Stratford/Avon Project demonstrations.

In addition to the preceding recommendations, the design of a restricted livestock access requires the following considerations:

1. The crossing must be cost-effective and durable. The type of crossing required will depend on its intended function. Examples are:

    (i) corrugated steel culvert;
    (ii) concrete conduit;
    (iii) post and beam bridge.

2. The crossing must be able to handle flood flow volumes without impeding the flow. This may call for some simple engineering calculations.

3. A practical alternate watering facility should be chosen if one is required:

    (i) electric pump;
    (ii) mechanical nose pump;
    (iii) artesian or spring water and trough;
    (iv) excavated pond.

APPENDIX

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

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