THE UPPER EAST SYDENHAM RIVER WATERSHED
WATER QUALITY STUDY, 1988

Ontario

St. Clair Region Conservation Authority
and the
Ministry of the Environment

THE UPPER EAST SYDENHAM RIVER WATERSHED WATER QUALITY STUDY

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St. Clair Region Conservation Authority

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1. SUMMARY

1.1 Water Quality

During the fall and winter of 1987/1988, the microbiological and chemical quality of the water in the Sydenham River upstream of Coldstream was assessed. This was in response to expressed concerns over degraded water quality in the river and Coldstream Reservoir. Water samples were collected weekly from eight stations along the watercourse and analyzed at the Ministry of the Environment Lab in London. The elevated fecal coliform and fecal *Streptococci* levels recorded fairly routinely throughout the study period as well as high Phosphorus, Nitrate and Total Kjeldahl Nitrogen loadings indicate a water quality problem exists in the upper East Sydenham River watershed.

There was a great deal of variability in the data over space and time which made data interpretation somewhat difficult. Overall, however, the highest bacterial readings were coming from the upstream stations in the upper-east part of the watershed. Over 70% of the samples at Stations 4, 6 and 7 exceeded the objective for fecal coliform concentration compared with about 50% in the other stations. Pollution loadings were also highest following heavy rain and winter thaw events.

A walking survey of the drainage network combined with sampling of suspected tile outlets was undertaken in an attempt to isolate the possible sources of the fecal bacteria. In a couple of cases obvious localized contamination was found. These included tiles at Lot 26, Concession 12 and Lot 31, Concession 10 in London Township and the Ilderton Storm Sewer Outlet. The affected landowners and the Abatement Section of MOE were notified.

A number of other field tiles were also found to be sporadically releasing poor quality water. In some cases, particularly in the north part of London Township, pollution from winter manure spreading was suspected. Human wastes were occasionally entering the watercourse as well based on the presence of *Pseudomonas aeruginosa*. This is most probably from faulty septic systems in the rural areas and in the Town of Ilderton.

Thirty-two landowners were interviewed and questioned about their farm practices. Reception was good as most landowners were also concerned about water quality. The results indicate that there is still a lack of: vegetative buffers along drains, conservation tillage techniques, structures to catch runoff from solid manure piles, fencing to prevent cattle access to streams, and manure testing for nutrient content. Some winter spreading is still being carried out as well. Most landowners stated a lack of finances as the biggest factor in not improving their practices, although many felt that their present systems were adequate.

In summary, aside from the few point sources isolated, the bulk of the fecal bacteria and nutrient load to the river appears to be originating from numerous, diffuse sources throughout the watershed.

1.2 Summary of Recommendations

The sites where pollution sources were positively identified should be corrected by the landowners. The abatement section of the MOE should be called to enforce compliance of regulations.

Additional monitoring should be carried out on: 1) the eight regular stations, 2) the additional sampling sites where inconclusive results were found, and 3) sections of the watercourse where samples were not taken previously.

An information package or flyer summarizing information on the causes and solutions to rural water pollution should be sent to each landowner in the basin. Also, a flyer on water conservation in the home should be sent to the homeowners in Ilderton to reduce the load on their septic systems which is causing overflows into the storm sewer outlet.

BACKGROUND

This study was initiated by the St. Clair Region Conservation Authority (SCRCA) in 1987 in response to expressed concerns regarding water quality problems in the upper East Sydenham River watershed (Figures 1 and 2). Degraded water quality for recreational use at Coldstream Conservation Area, decreased biological productivity, loss of sport fishing, and occasional fish kills resulting from manure spills prompted the Authority to approach the Ministry of the Environment (MOE) for assistance. The result was a seven month study to monitor the quality of the upper East Sydenham River watershed and to locate the possible sources of the pollution. Funding and technical support were provided by the MOE. This study is the first in a potential series of studies to examine water quality problems throughout the St. Clair Region watersheds.

METHODOLOGY

To determine the nature and location of the pollution problem, water samples were collected weekly from eight MOE approved stations along the upper East Sydenham River and its tributaries. Two sterilized bottles were filled at each station, one for chemical analysis and the other for bacteriological analysis. The samples were generally taken in the middle of the river or drain where flow was greatest. Since the water depth was often shallow, the bottles were submerged only a few inches below the water's surface.

Six stations were originally set up, but this was soon expanded to eight to cover all of the major tributaries. The samples were sent to the MOE lab in London, Ontario where they were tested for various chemical and bacteriological parameters (MOE, 1983).

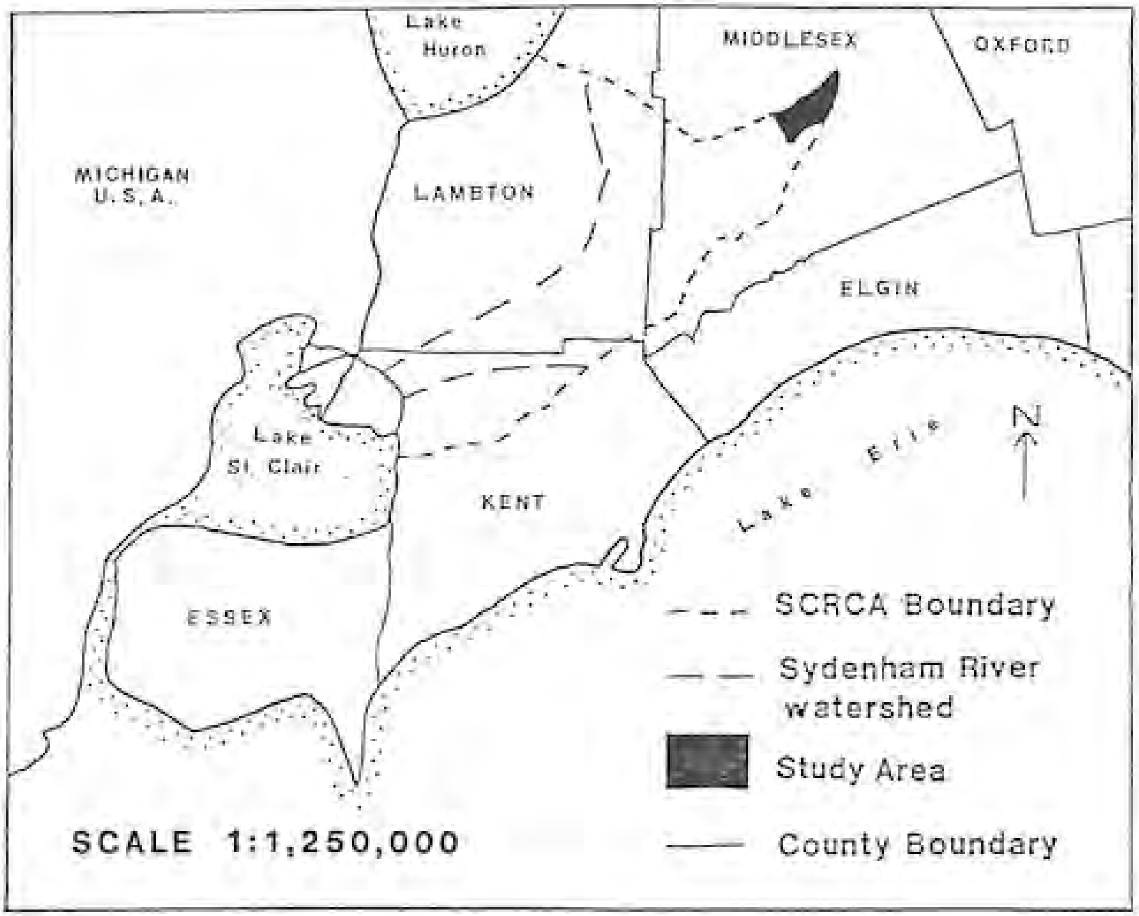


FIGURE 1. Location of the St. Clair Region Conservation Authority and the Study Area

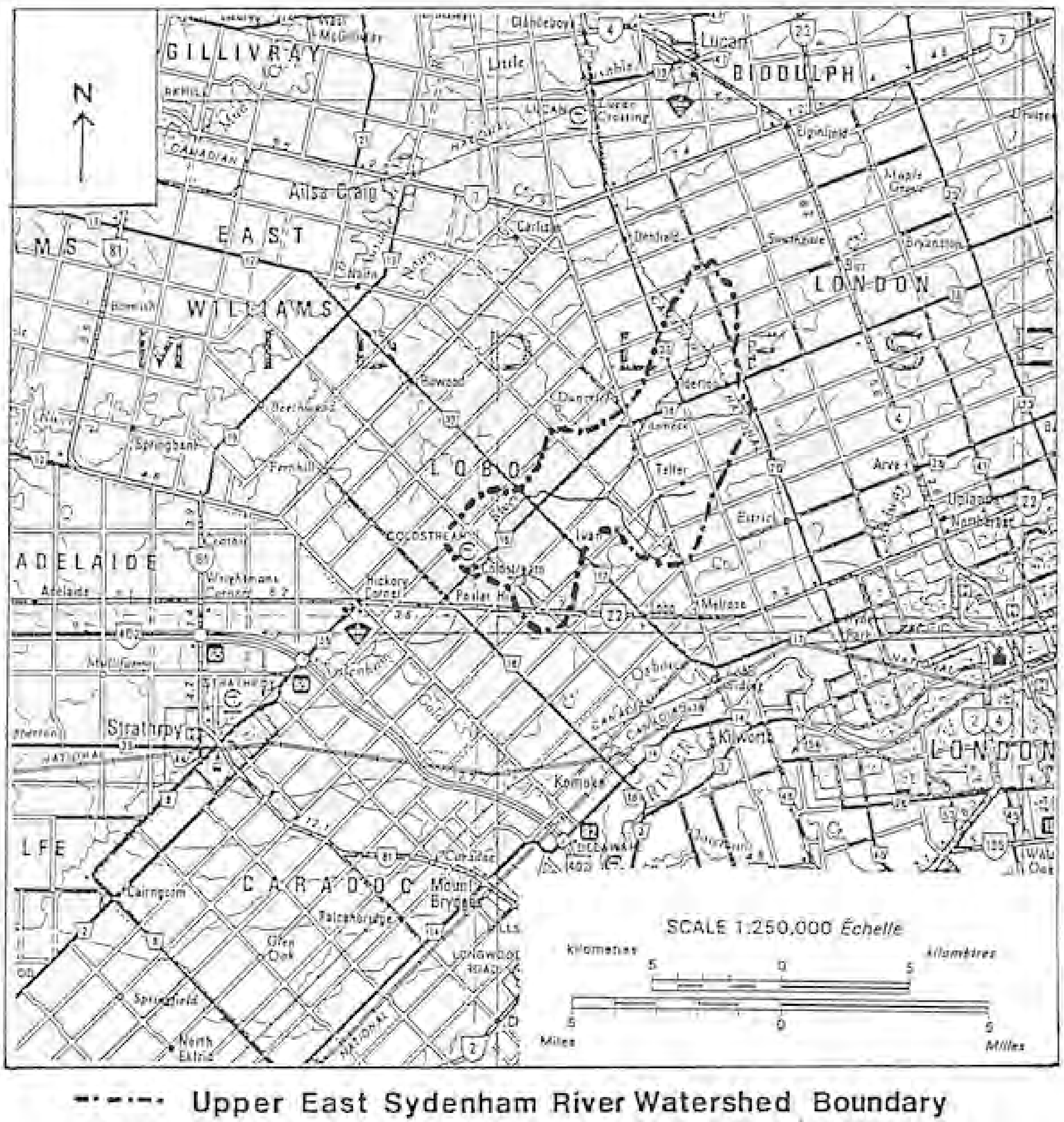


FIGURE 2. Situation of the Study Area in Middlesex County

The parameters tested for in the lab included the following:

<u>Chemical</u>	<u>Bacterial</u>
Biological Oxygen Demand	fecal coliform
Suspended Solids	fecal *Streptococci*
Free Ammonia	*Pseudomonas aeruginosa*
Total Kjeldahl Nitrogen	*Escherichia coli*
Nitrite	
Nitrate	
Total Phosphorus	
Soluble Phosphorus	
pH	
Chloride	
Conductivity	

Provincial Water Quality Objectives are set by MOE and were used to assess the quality of the water (MOE, 1984b). These standards are set to ensure that surface waters in the province are of a satisfactory quality for recreation usage and aquatic life.

The location of all farmsteads and current crop cover were mapped using topographic maps, aerial photographs and field observations.

All open sections of the watercourse were surveyed on foot except for one natural stretch of the Sydenham River in Concession 8, Lobo Township which proved to be treacherous walking and predominantly untiled. The locations of all of the drainage outlets were mapped and other visual observations such as the presence of algae were made and recorded. Aerial photographs from 1972 at a scale of 1:15,840 were used in the field to map and record the information. Additional water samples were collected at sites suspected of having contaminated water. In total, 44 samples were taken from an additional 25 locations.

A four page questionnaire directed towards the local landowners was prepared to solicit their concerns and understanding about the water quality problem (Appendix A). There were also questions to determine specific information relating to crop types, livestock populations, manure spreading and handling techniques and septic systems on the farm and in the homestead. Letters explaining the pollution problem and the purpose of the questionnaires were delivered to approximately 50 homes. Landowners were then contacted by telephone to arrange for a meeting time. Thirty-two interviews were completed in total.

Upon completion of the interviews, a Water Quality Information Day was held to further educate the public on the causes, effects and solutions of water pollution in the rural environment. Five speakers presented information on various topics related to agricultural practices and water quality problems (Appendix B).

Weather records consisting of daily precipitation and mean daily temperature were also collected from the London Weather Office to give an indication of the correlation between weather and water quality.

4. THE UPPER EAST SYDENHAM RIVER SUB-BASIN

4.1 Land Use

The upper East Sydenham River watershed is located roughly between the villages of Coldstream and Ilderton in Lobo and London Townships, Middlesex County (Figure 2). It is approximately 59 square kilometers in size. This watershed functions as one of the headwaters for the Sydenham River which travels southwest through Middlesex and Lambton Counties until it eventually empties into Lake St. Clair near Wallaceburg.

Most of the Coldstream basin is agricultural. Approximately 48% of the 124 farmsteads are livestock operations based on field observations of barn types (Figure 3). The predominant field crops include corn, soybeans, hay and winter wheat as well as some oats and barley. Portions of the villages of Coldstream and Ilderton are also located within the watershed. These are nonindustrial towns which serve as community and agricultural service centres as well as suburban areas for London.

In addition to conventional agricultural operations, there are several hobby farms, raising predominantly horses as well as several non-farming residential homes scattered about. There is also a quarry operation and a concrete company located close to the Conservation Area. The remnant woodlots also provide a small local maple syrup industry. Middlesex County overall has only 7.3% forest cover left. Figure 4 depicts the forest cover of the Upper East Sydenham River Watershed.

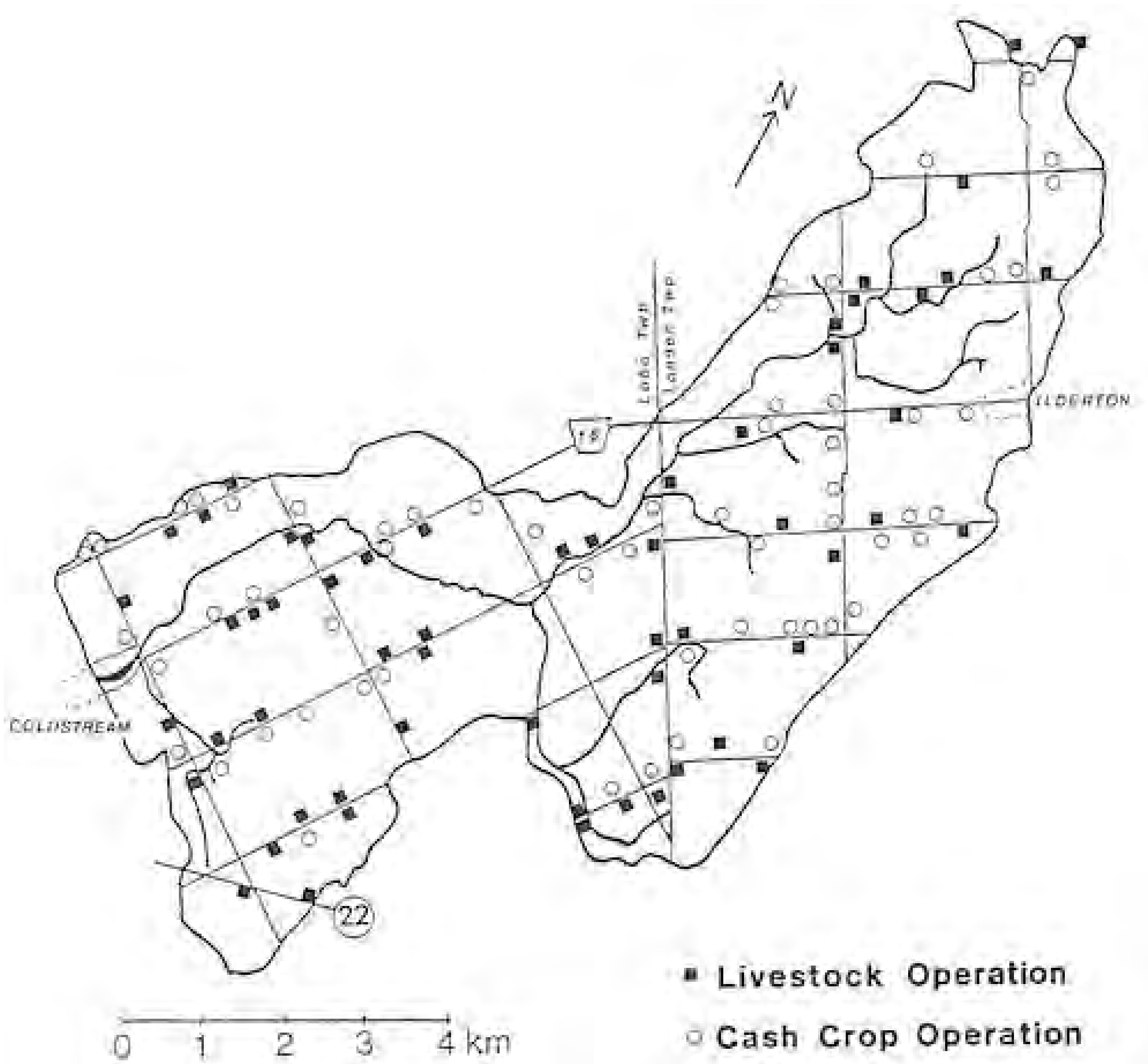
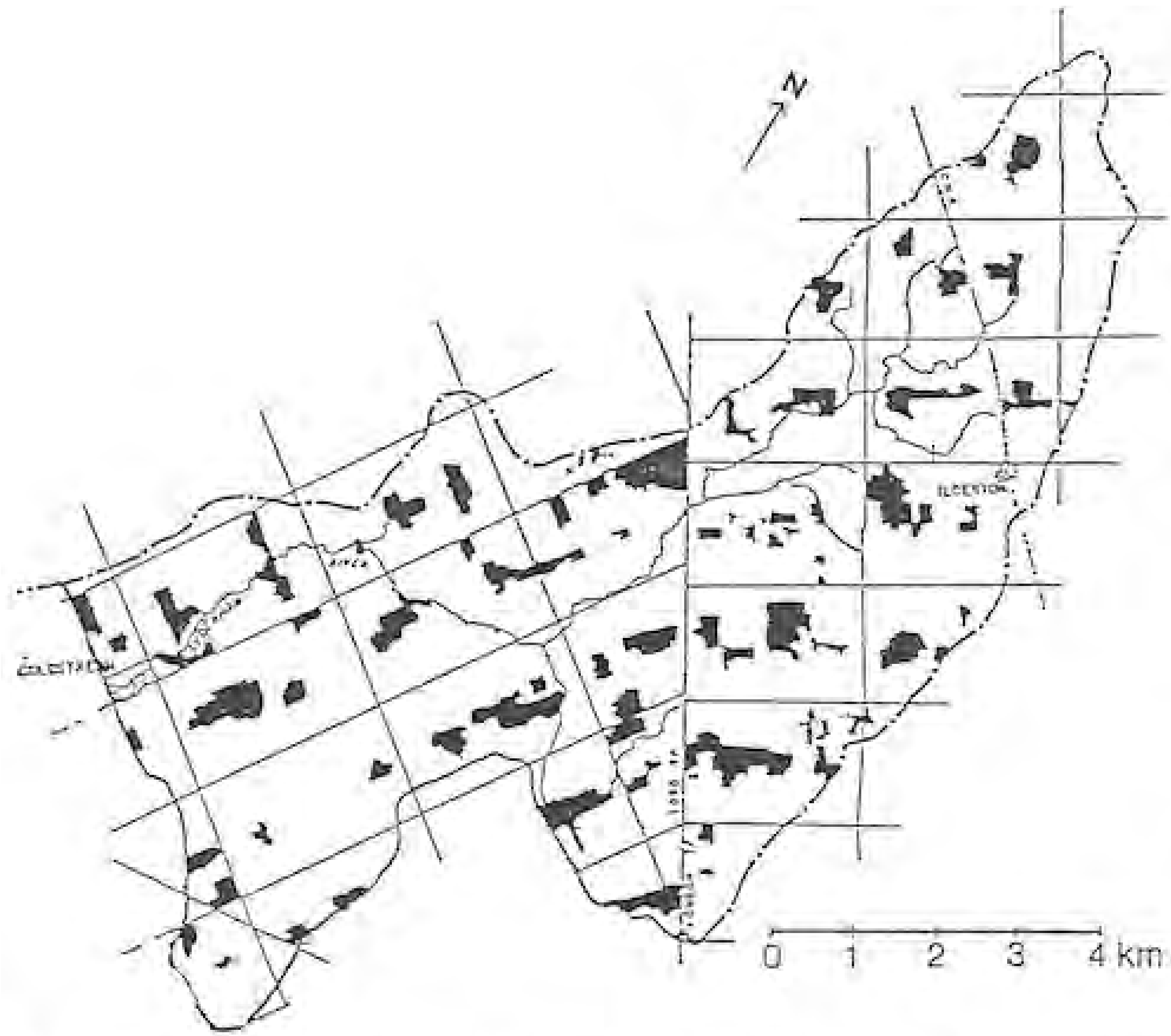


FIGURE 3. Location of the Crop and Livestock Operations in the upper East Sydenham watershed



Dept. of Lands and Forests, Conservation Authorities Branch, 1963.

FIGURE 4. The upper East Sydenham River Showing Existing Woodland in 1963.

4.2 Geology and Soils

As the glacier receded from the London area some 11,000 years ago, the ice sheet split into 2 lobes. The Huron lobe and its associated meltwater left several significant topographical features in the Coldstream area including glacial Lake Warren. Other features which are obvious today include the Seaforth and Lucan moraines which fringe the north-western and eastern corners of the study basin as well as sand plains and clay plains (Figure 5). The till moraines are composed largely of unsorted glacial material primarily brown clayey till. The till plain is a fairly uniform brown, calcareous, silty clay. A small segment of the Caradoc Sand Plain is also present.

The superficial materials are composed of primarily four different soil groups (Figure 6). The Huron Clay Loam covers almost half of the basin with the Perth Clay Loam occupying another 13%. The Huron Silt Loam and Perth Silt Loams each occupy another 15% of the area. Other soil types making up less than 3% of the area include the Guelph Loams, muck, Burford Gravelly Loam, bottom lands along the watercourse and eroded land. The natural drainage of the major soil groups varies from poor to good. The Huron soils which occupy almost two-thirds of the watershed have fair to good drainage. The Perth soils are fair to poorly drained. The agricultural capabilities of these major soil groups is high with no major limitations to cropping activities.

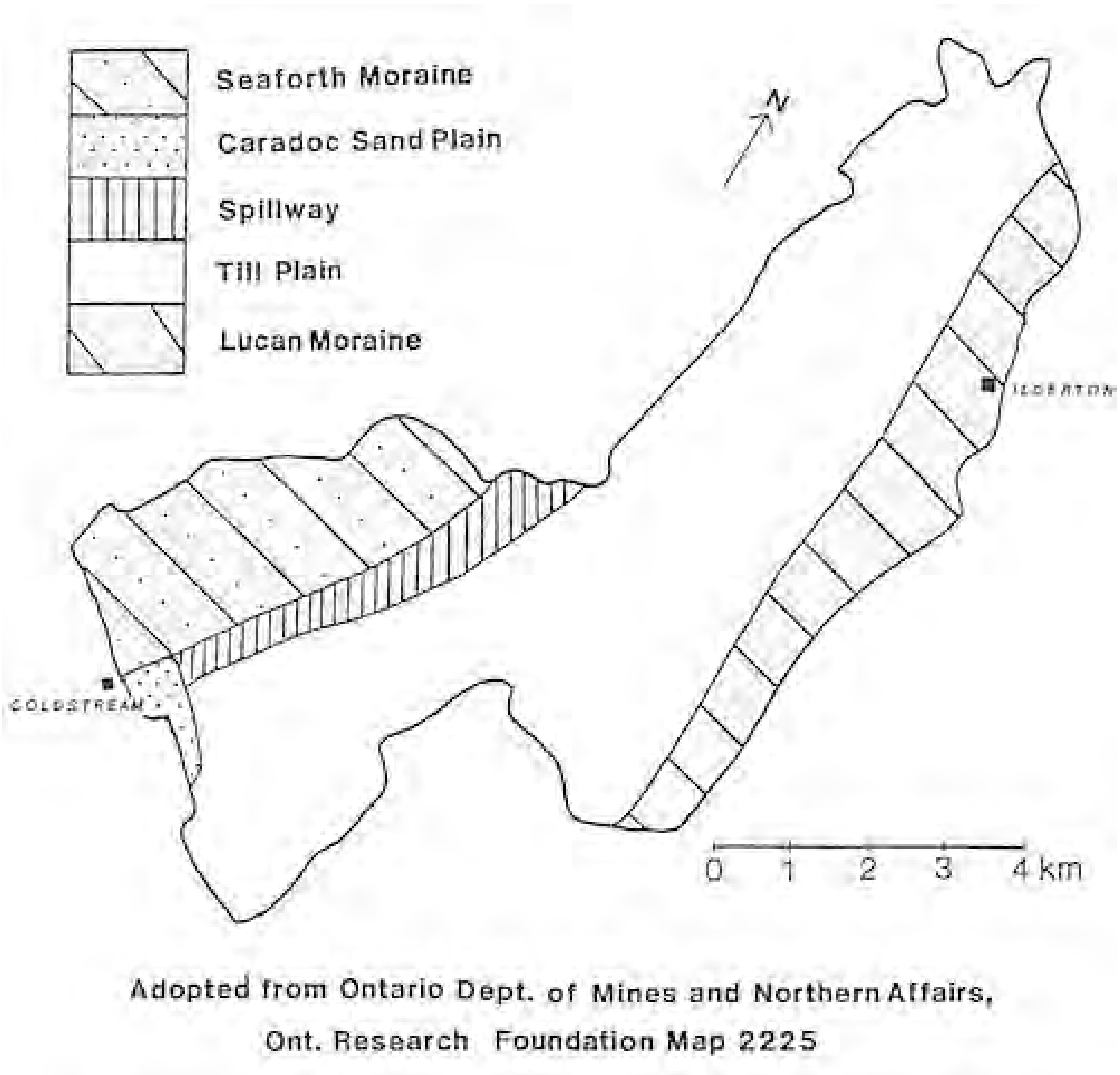
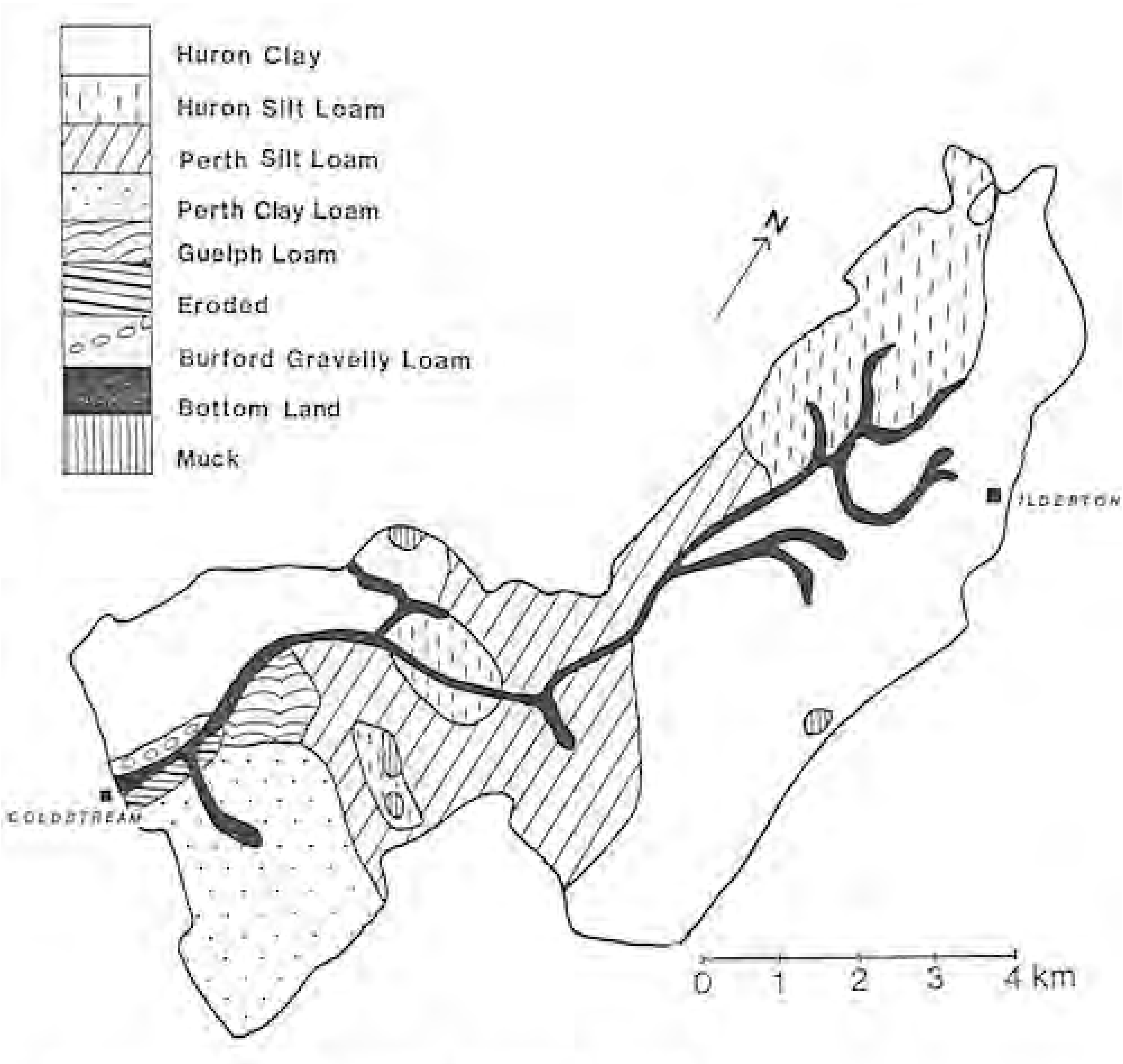


FIGURE 5. The Physiography of the upper East Sydenham River watershed.



Taken from Middlesex County Soils Map, 1929.

FIGURE 6. The Soils of the upper East Sydenham River watershed

4.3 Drainage

The upper East Sydenham River passes through a relatively flat clay plain with resulting low stream gradients. The elevation difference is only 30 meters from source to mouth. The headwaters of the upper East Sydenham River originate in the western portion of London Township just north of the Town of Ilderton. The river flows south-southwest towards Lobo Township and then south and west towards the Town of Coldstream where it empties into the Coldstream Reservoir (Figure 7).

Aside from the 3-4 kilometers of the old Sydenham River channel, most of the open watercourses in this basin have been channelized, buried, created or are presently maintained as municipal drains. All of the original Sydenham River channel east of Taylor Drain has been altered and is now referred to as the Bear Creek Drain. Several subsurface municipal drains have been added to the network as well. The Colvin and Taylor Drains are two major open drains which have been added over the years. They flow northward to the Sydenham.

There are approximately 230 tile outlets present over the entire open watercourse (Figure 8). The highest density of tile outlets occurs along Bear Creek Drain and its tributaries.

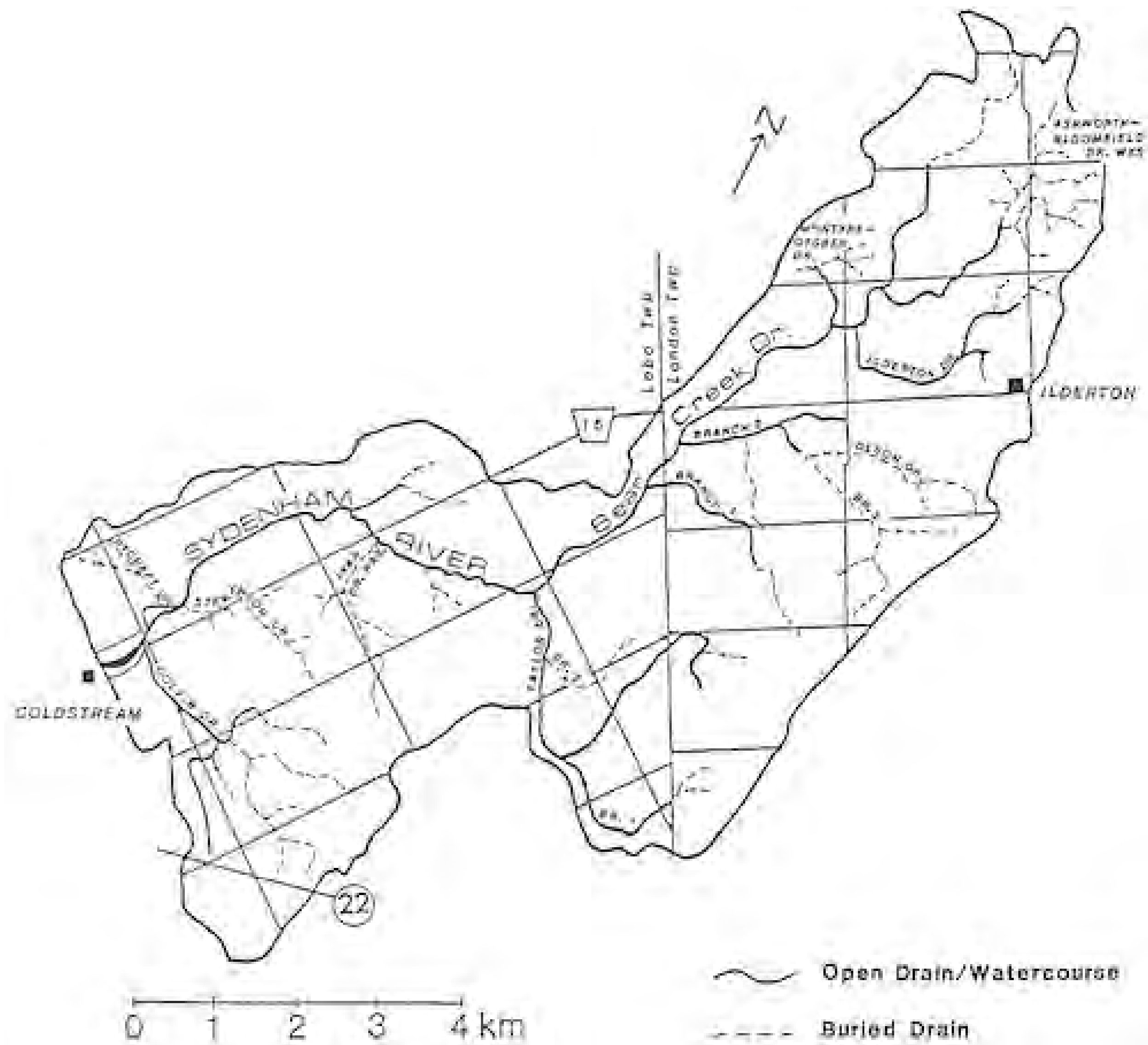


FIGURE 7. The Drainage Network of the upper East Sydenham River watershed

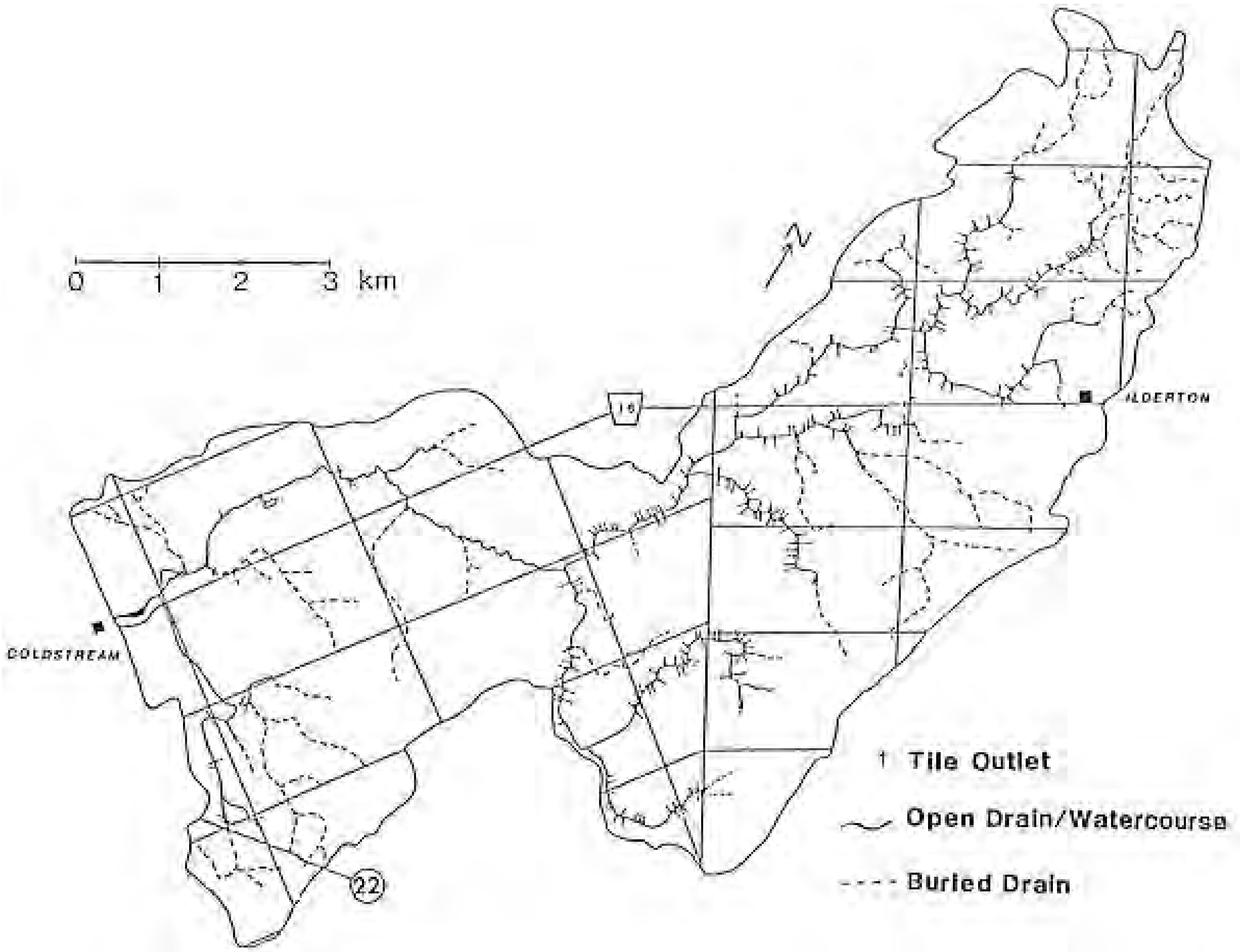


FIGURE 8. Location of the Tile Outlets along the upper East Sydenham River watercourse

5. RESULTS

Water samples were collected weekly from eight stations along the watercourse from September 24, 1987 to March 28, 1988. The location of the eight stations is illustrated in Figure 9.

Over the six month sampling period, approximately 20 samples per station were collected and analyzed. The number of samples varied from 12 to 23 per station due to the late date at which Station 8 was added to the network and freeze-ups at various stations over the winter months. Three additional samples per station were collected but the results were not available at the time this report was written. The results for all of the samples collected are contained in Appendix C.

5.1 Method of Data Presentation

Geometric means have been calculated and are used to summarize the data instead of simple averages. Because of the uneven distribution of bacteria in space and over time, occasional samples may be far above or below the average. For example, the number of fecal coliform bacteria ranged from 8 bacteria per 100 ml of water to 4300/100 ml at Station 5 but most the data were in the 50 to 250/100 ml range. A simple average yields a value of 420/100 ml because of two very high values, but the geometric mean yields a value of 121/100 ml which is much closer to the normal range of levels recorded.

Geometric means are thus used to get a more accurate estimate of the water quality. The results from a number of samples are combined in such a way that occasional unrepresentative samples will not unduly influence the average. Bacterial standards and objectives are set to require that the geometric mean (GM) of all samples fall below such a maximum.

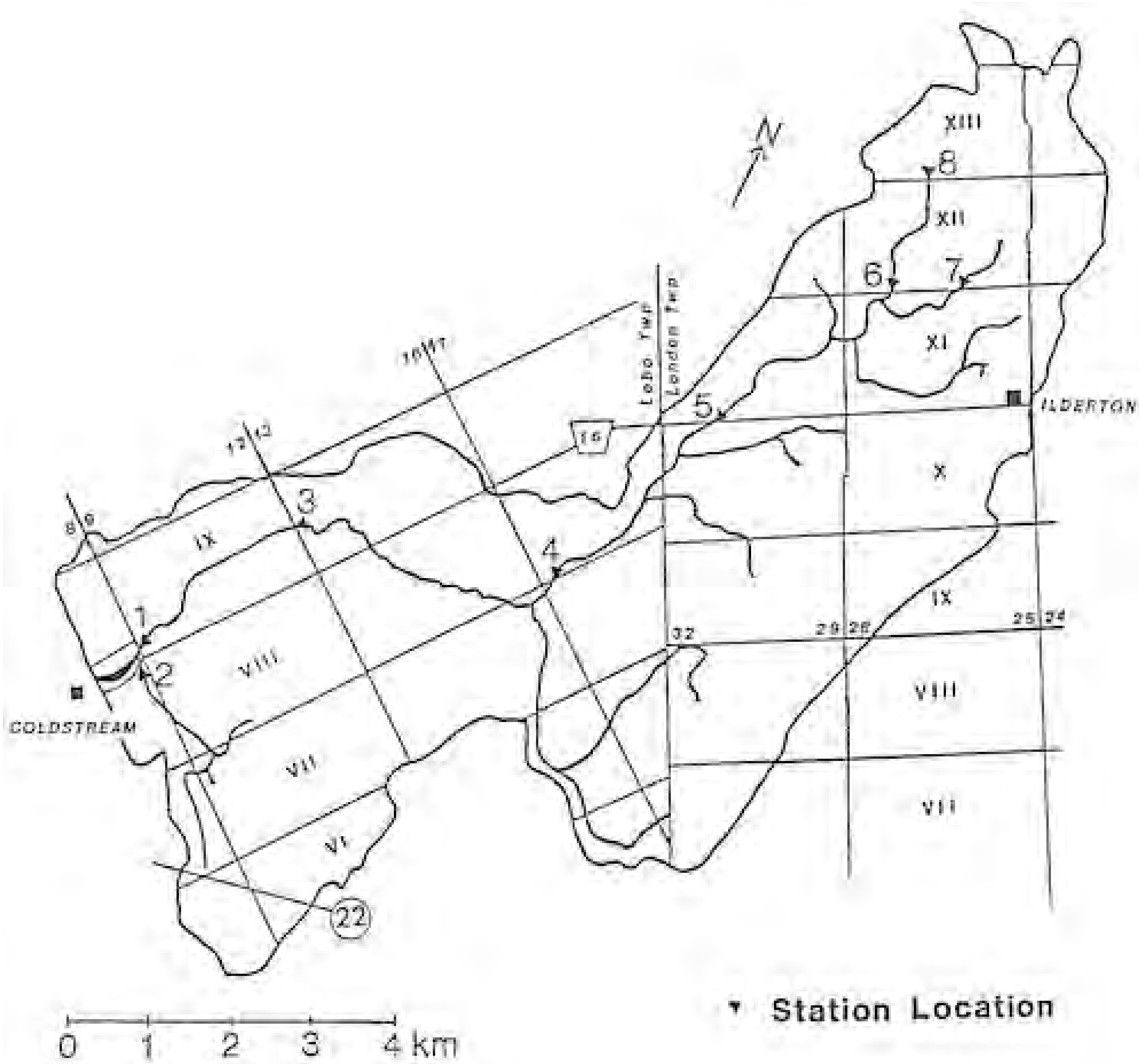


FIGURE 9. Location of the Weekly Water Sampling Stations

The formula for GM is:

$$\sqrt[4]{w.x.y.z}$$

where w,x,y,z are individual sample values, multiplied together and taken to the 4^{th} root. In this case, 4 is the number of samples (Freund, 1979).

5.2 Bacterial Analysis and Results

All of the four bacterial groups analyzed are found in the feces of warm blooded animals and are used as indicators of pollution from sewage or fecal matter. There is a health risk to swimmers and bathers when the geometric mean density of these bacteria exceeds the MOE objectives for a series of water samples taken from a beach or bathing area. Table 1 summarizes the results of the bacterial analysis for the eight stations. Table 2 describes each of the bacterial groups, the MOE Objective associated with them, their effects on the environment and a brief summary of the findings from this study.

The geometric mean for each of the eight stations exceeded the MOE objective for fecal coliform and fecal *Streptococci* bacteria. Half of the stations exceeded the standard for fecal coliform by more than 2 times and Station 7 exceeded this limit by more than 21 times. Station 6 recorded the highest fecal *Streptococci* level with a geometric mean of 714.

Sixty one percent of all of the 154 samples collected were over the acceptable limit for fecal coliform bacteria and 57% were over the limit for fecal *Streptococci.* The Station closest to the Coldstream Reservoir, Station 1, exceeded the standard for these two bacterial groups half of the time.

TABLE 1. Summary Of The Bacterial Analysis

i) GEOMETRIC MEANS

	F.c.	F.s.	P.a.*	E.coli	# samples
Objectives	100	100	4	1000	
Station 1	109	177	6	89	20
Station 2	117	127	5	90	21
Station 3	216	131	5	173	21
Station 4	183	124	5	118	23
Station 5	121	114	6	91	19
Station 6	292	714	6	341	17
Station 7	2178	302	14	1529	21
Station 8	223	657	7	206	12

ii) AVERAGES

	F.c.	F.s.	P.a.*	E.coli	# samples
Objectives	100	100	4	1000	
Station 1	470	990	11	441	20
Station 2	710	807	5	696	21
Station 3	717	888	8	605	21
Station 4	396	646	9	271	23
Station 5	420	999	12	363	19
Station 6	959	2595	538	550	17
Station 7	20545	3062	71	13151	21
Station 8	1741	10058	14	1363	12

Note: F.c. is fecal coliform, F.s. is fecal *streptococci*,

P.a. is *Pseudomonas aeruginosa*, E.c. is *Escherichia coli*.

* Values for P.a. are accurate to within plus or minus 2/100 ml.

TABLE 2. Description of Bacteriological Parameters

Parameter	Moe Objective	What It Measures	Affects	Results
Fecal Coliform	100/100 ml	- intestinal bacteria found primarily in the intestines and feces of warm blooded animals, usually human	- can cause disease transmission to swimmers either directly or through the other bacteria associated with it	- all Stations were above acceptable levels - Station 7 very high
Fecal *Streptococci*	100/100 ml	- a resistant, intestinal bacteria found primarily in the intestines and feces of warm blooded animals - more numerous in animal feces than human	- as above	- all Stations were above acceptable levels - Stations 6,7 + 8 were highest
Pseudomonas Aeruginosa	4-20/100 ml	- a pathogenic bacterium usually of human origin - indicates presence of other infectious bacteria - concentrations20/100 ml are somewhat common and may indicate back-ground levels; over 20/100 ml may indicate human waste contamination	- can cause eye, ear, nose, throat and skin infections to swimmers	- only excessive 12-24% of the time - Stn 7 highest
Escherichia Coli	1000/100 ml	- group of bacteria generally-found in the intestines of warm blooded animals but may have non-animal sources - indicates potential for disease transmission	causes illness to swimmers at high concentrations	- all Stations were within the acceptable range except Stn 7

Figures 10 and 11 graphically illustrate and summarize the results of the analysis for fecal coliform and fecal *Streptococci*. The three curves indicate the maximum and minimum limits of the individual sample readings and the geometric mean (heavy line). The MOE objective for surface water quality acceptability is also indicated as a basis of comparison (dashed line). The stations are listed in a downstream to upstream order (see Figure 9).

The highest bacterial contamination is occurring in the upstream stations, that is, Stations 6, 7 and 8. The max and min curves also follow this trend. This is a common finding in most water quality studies since the downstream stations receive more water and the pollution is therefore diluted to some degree. The max and min curves also illustrate the high degree of variability in bacterial levels for individual samples. Standard deviations for fecal coliform at the eight stations ranged from 500 to 37000 which is extremely high considering the maximum permissible limit is 100/100 ml. Fecal *Streptococci* was also variable with standard deviations ranging from 1400 to 2300.

Pseudomonas aeruginosa was present at levels above the MOE objective of 4/100 ml approximately three to five times per station or 24 percent of the time. Approximately half of these were over 20 bacteria per 100 ml of water. The Ausable Bayfield Conservation Authority's 1985 Study found 10% exceeded.

The geometric means for the pathogenic bacterium *Pseudomonas aeruginosa* are somewhat misleading due to the fact that the laboratory reports levels which fall within the guidelines as simply "less than 4". These are entered into the computer as 4 even though values could have been anywhere between 0 and 4. The geometric means are thus somewhat elevated and are only accurate to within plus or minus 2/100 ml.

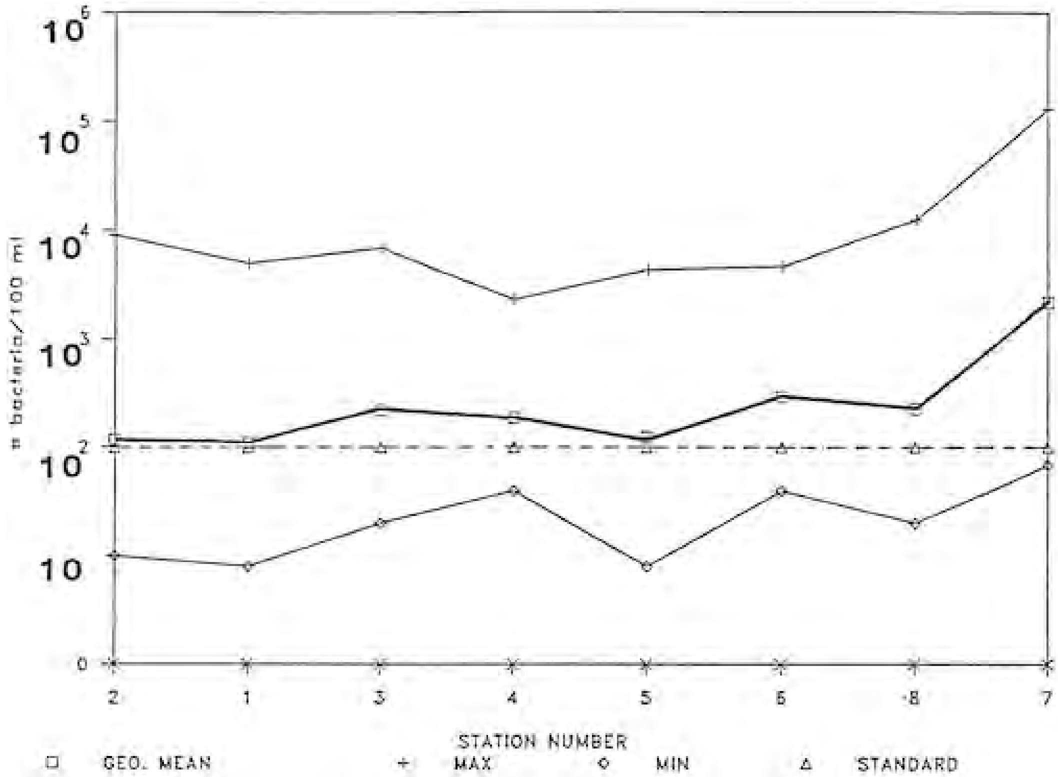


Figure 10. Fecal Coliform Levels

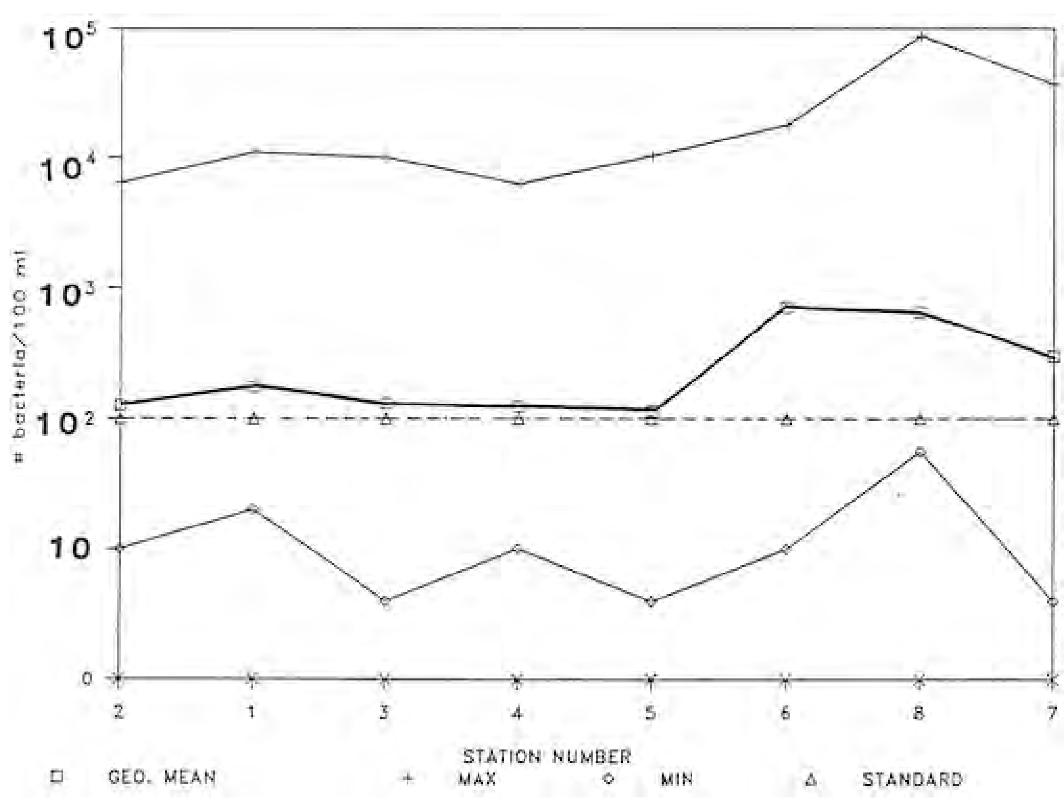


Figure 11. Fecal *Streptococci* Levels

Figure 12 illustrates the low degree of variability between the stations in terms of their geometric means, except for Station 7. The Max curve demonstrates the very high levels which do sporadically occur. The majority of these elevated values occurred on wet dates, specifically Oct. 26 and Nov. 9, 1987 and Jan. 18 and Feb. 1, 1988. The latter two were mid-winter thaws causing elevated pollution levels in all categories. Human wastes are somehow reaching the drains during these periods perhaps from septic system weeping bed overflow which is exacerbated by frozen ground. Station 7 is the only station which recorded consistently excessive *P. aeruginosa* levels.

Elevated *Escherichia coli* levels were recorded only once or twice in the downstream stations (Stations 1 to 5), but their geometric means are well within the acceptable levels (Figure 13). Only Station 7 displays a geometric mean value for *E. coli* above the standard. Overall, only 18% of the samples exceeded the standard. There is quite a bit of variability between individual samples. Standard deviations for Stations 1,2,3,7 and 8 were over 1,000. Figures 10 and 13 illustrate how closely related the curves for *E. coli* and fecal coliform are. This would suggest that *E. coli* bacteria are a large component of the fecal coliform bacterial group.

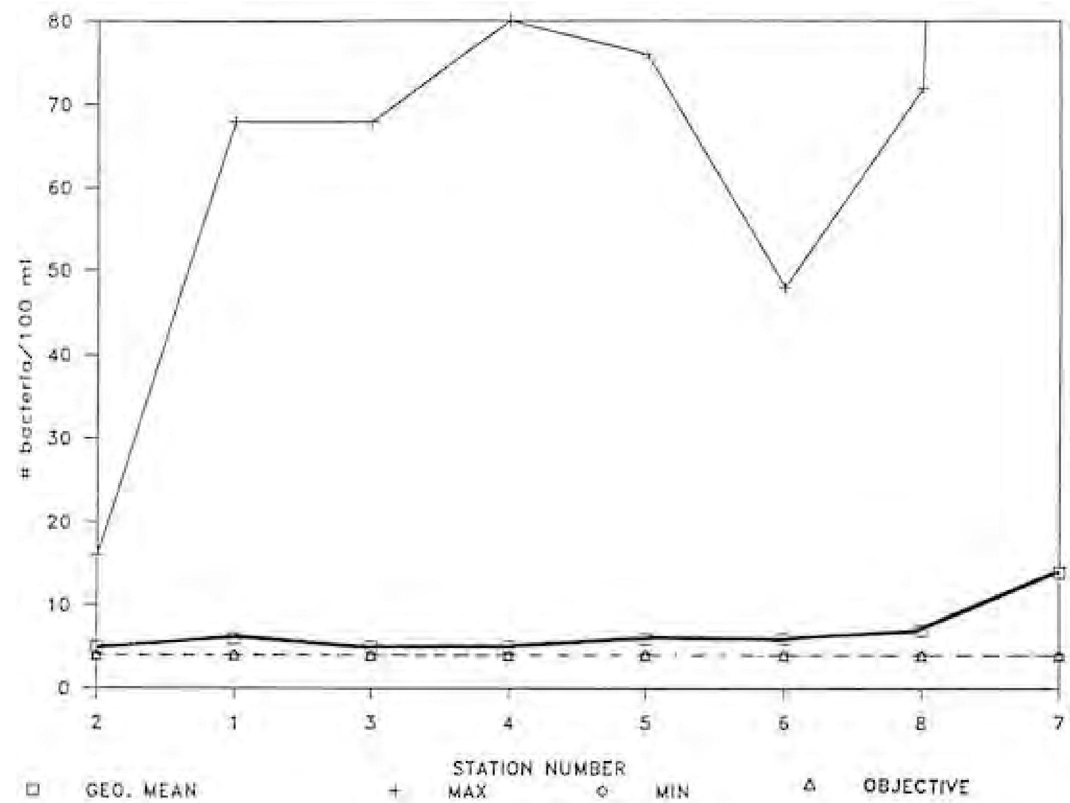


Figure 12. *Pseudomonas Aeruginosa* Levels

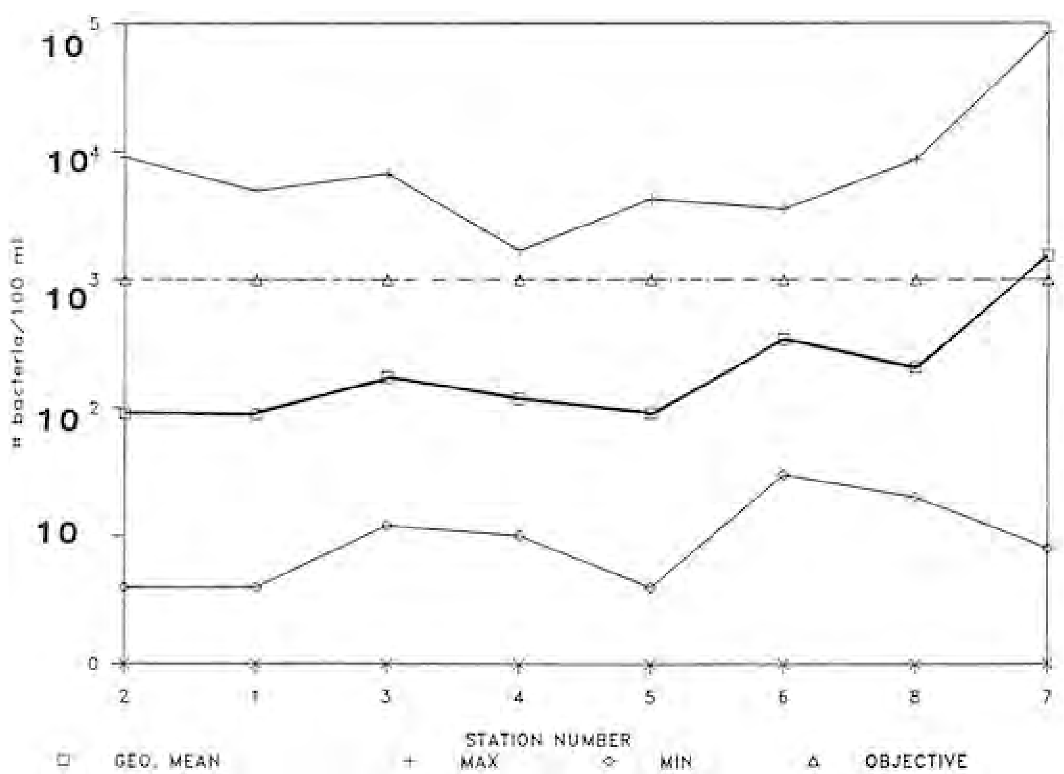


Figure 13. *Escherichia Coli* Levels

5.3 Chemical Analysis and Results

Table 3 summarizes the results of the chemical analysis for all of the eight stations. Table 4 describes the parameters, the MOE Objectives associated with them, their effects on the environment and the findings of this study.

Water temperatures ranged from 0 to 20 degrees Celsius over the study period from September 1987 to March 1988. Water temperatures were 2 to 3 degrees warmer in the midstream stations (Stations 3 and 4) in the early fall compared with the other stations. Paradoxically, the upstream stations were warmer in the late fall and winter months (Figure 14). Heated tiles probably account for the warm temperatures at the upstream stations in the winter as they are very close to their underground sources (buried tile networks). In the summer and fall, the water undoubtedly warms up as it travels from its headwater area, across unshaded fields to the Conservation Area. The watercourse is somewhat more shaded between Stations 3 and 1.

Biological Oxygen Demand levels were excessive only occasionally and no geometric mean was above the desired level of 4 mg/L. Station 7 showed the highest overall levels and its average concentration was slightly above the objective (Figure 15). There was not a great deal of variability between individual samples or between the geometric means aside from the occasional excessive sample.

The amount of Suspended Sediment was only rarely excessive and no geometric mean exceeded the limit. Oddly enough, Stations 1 and 6 recorded the highest overall levels (see Figure 16). Occasional high levels occurred primarily after a winter thaw or early in the fall when the upstream stations were stagnant.

Table 3. Summary Of The Chemical Analysis

i) GEOMETRIC MEANS

	No. Samples	WATER TEMP	BOD	S.S.	T.AMM	U.AMM	TKN
Objectives	--	---	---	----	----	0.020	0.50
Station 1	20	2	0.83	7.8	0.029	0.001	0.71
Station 2	21	3	0.84	5.9	0.031	0.001	0.68
Station 3	21	3	0.65	6.9	0.016	0.000	0.67
Station 4	23	3	0.61	4.5	0.031	0.001	0.68
Station 5	19	4	0.50	4.4	0.021	0.000	0.70
Station 6	17	6	0.51	9.5	0.022	0.000	0.83
Station 7	21	4	1.33	6.8	0.109	0.002	1.17
Station 8	12	5	0.33	8.0	0.034	0.001	0.88

	NITRITE	NITRATE	T.PHO	S.PHO	pH	Cl	COND
Objectives	(10.00)		0.030	---	6.50- 8.50	---	---
Station 1	0.03	5.9	0.057	0.021	7.88	30.05	631
Station 2	0.03	3.6	0.097	0.047	7.87	39.51	670
Station 3	0.03	4.3	0.047	0.019	7.99	27.77	609
Station 4	0.04	4.0	0.096	0.063	7.30	30.12	486
Station 5	0.05	7.5	0.154	0.093	8.03	44.71	715
Station 6	0.02	3.4	0.103	0.028	7.95	16.69	602
Station 7	0.03	4.4	0.187	0.118	7.95	24.18	638
Station 8	0.03	14.5	0.072	0.038	7.87	20.17	613

ii) AVERAGES

	No. Samples	WATER TEMP	BOD	S.S.	T.AMM	U.AMM	TKN
Objectives		---	---	----		0.020	0.50
Station 1	20	5	1.34	13.7	0.104	0.001	0.82
Station 2	21	6	1.27	7.9	0.127	0.001	0.82
Station 3	21	7	1.02	8.2	0.055	0.000	0.73
Station 4	23	7	0.87	6.0	0.075	0.001	0.71
Station 5	19	7	0.79	6.2	0.069	0.001	0.75
Station 6	17	8	1.61	26.1	0.102	0.001	1.05
Station 7	21	7	6.31	10.4	1.544	0.029	3.10
Station 8	12	5	0.99	15.4	0.077	0.001	1.00

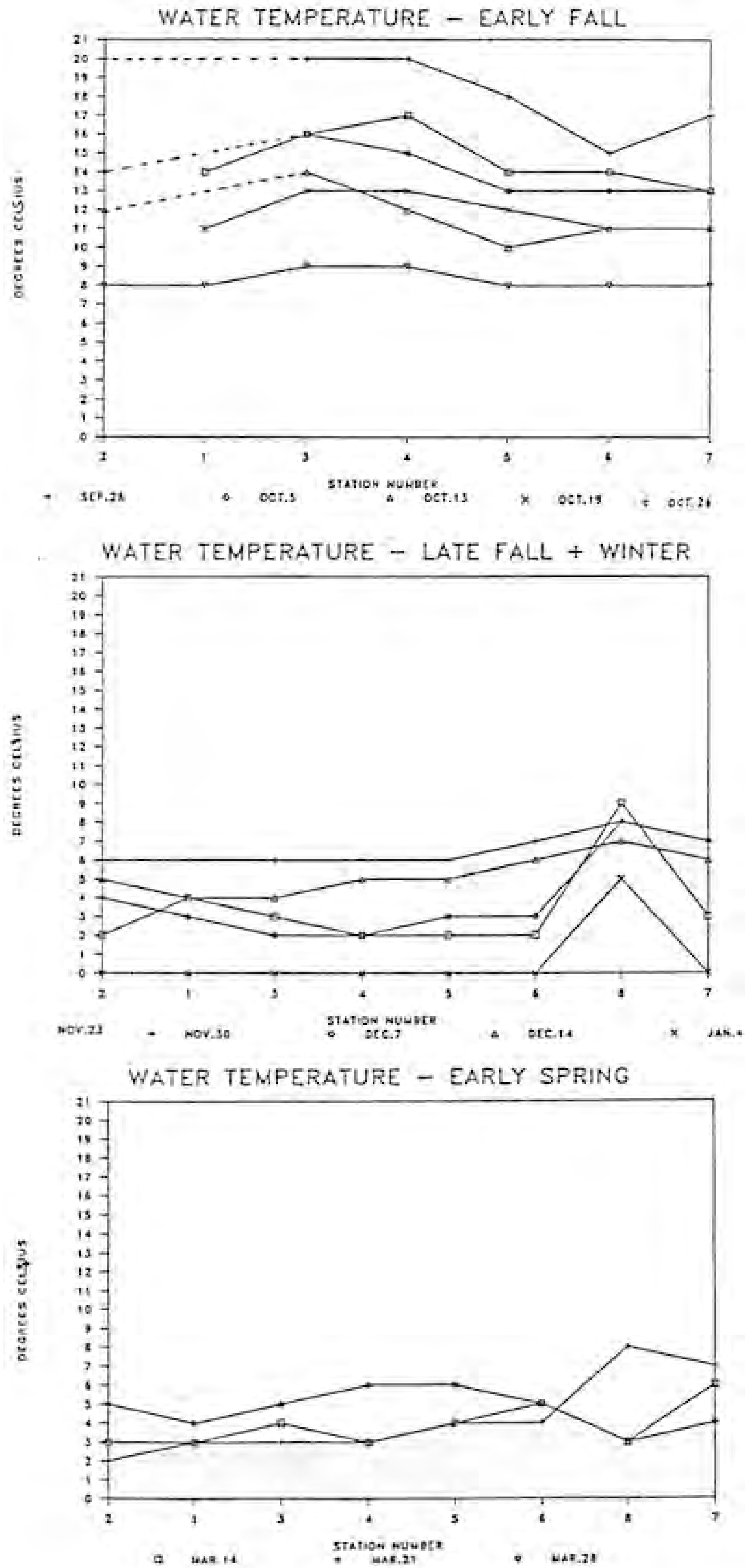
	NITRITE	NITRATE	T.PHO	S.PHO	pH	Cl	COND
Objectives	(10.00)		0.030	---	6.50- 8.50	---	---
Station 1	0.04	7.11	0.099	0.051	7.88	32.48	639
Station 2	0.06	7.53	0.129	0.072	7.87	40.82	680
Station 3	0.04	6.06	0.078	0.042	8.00	28.57	618
Station 4	0.05	7.24	0.106	0.077	7.99	38.46	650
Station 5	0.32	9.18	0.184	0.126	8.04	58.49	735
Station 6	0.04	12.10	0.180	0.051	7.97	20.16	615
Station 7	0.06	9.46	0.966	0.742	7.95	29.08	672
Station 8	0.05	15.25	0.112	0.060	7.87	20.05	620

Water Temp - Water Temperature In Degrees Celsius
BOD - Biological Oxygen Demand
SS - Suspended Solids
T. AMM - Total Ammonia
U. AMM - Unionized Ammonia
TKN - Total Kjeldahl Nitrogen
T.PHO - Total Phosphorus
S.PHO - Soluble Phosphorus
Cl - Chloride
COND - Conductivity

TABLE 4. Description of Chemical Parameters

Parameter	MOE Objective	What It Measures	Affects	Results
Temperature	---	- lack of shade and high turbidity causes water temperature to rise - oxygen is less soluble in warm water but many chemicals are more soluble and therefore dangerous to fish	- high temperatures or quick changes in temperature can be dangerous to fish	- ranged from 0 - 20°C - upstream Stations warmest
Biological Oxygen Demand	<4 mg/L	- amount of O_2 consumed by microbial decomposers to break down organic material in water	- high levels are dangerous to aquatic life	- all Stations in acceptable range
Suspended Sediment	---	- clarity or turbidity - includes silt, clay, organic matter, microscopic organisms in suspension	- aesthetics - destroys fish spawning areas - reduces photosynthesis which affects the food chain	- Stations 1,6 + 8 highest - rarely over 20 mg/L
Unionized Ammonia	0.02 mg/L	- most reduced form of Nitrogen - sources: normal biological activities and fertilizers - soluble in water - a non-persistent, noncumulative toxic substance	- eutrophication - toxic to fish at certain levels	- only Station 7 recorded excessive amounts(in the fall only)
Total Kjeldahl Nitrogen	0.5 mg/L	- Ammonia and organic Nitrogen together	- eutrophication	- all Stations excessive - Stn 7 highest
Nitrate	10 mg/L for Nitrate plus Nitrite	- the primary combined form of Nitrogen - is reduced from Ammonia - highly soluble and stable - major sources: human and animal wastes	- stimulates plant and algal growth	- all Stations in acceptable range except Stn 8 - 40% of individual samples were excessive
Nitrite		- an intermediate form between Ammonia and Nitrate - sources: animal rumens and moist feeds - usual range:0.001 mg/L	- toxic to aquatic life	- ranged from 0.02 to 0.04 mg/L, slightly above background levels - on Dec.7 all Stns recorded levels around 0.26 mg/L
Total Phosphorus	0.03 mg/L	- Phosphorus in water from natural erosion, fertilizers and detergents - quickly used by plants	- encourages algal blooms and eutrophication	- all Stations excessive
Soluble Phosphorus	---	- amount of Phosphorus in solution	- as above	- Stations 4,5 + 7 had highest levels
pH	6.5-8.5	- measures the balance between the acids and bases in solution	- can cause eye irritation to swimmers	- all Stations in acceptable range
Chloride	---	- salt content of water	- disrupts the ionic balance in fish - can be corrosive	- ranged from 20-30 mg/L - Stn 5 sometimes over 100 mg/L
Conductivity	---	- numerical expression of a water's ability to conduct electrical current - increases with concentrations of dissolved solids such as Magnesium, Sodium and Sulfur		- ranged from 600-700 - Stations 5 + 7 sometimes over 1000

Figure 14.
Water Temperature



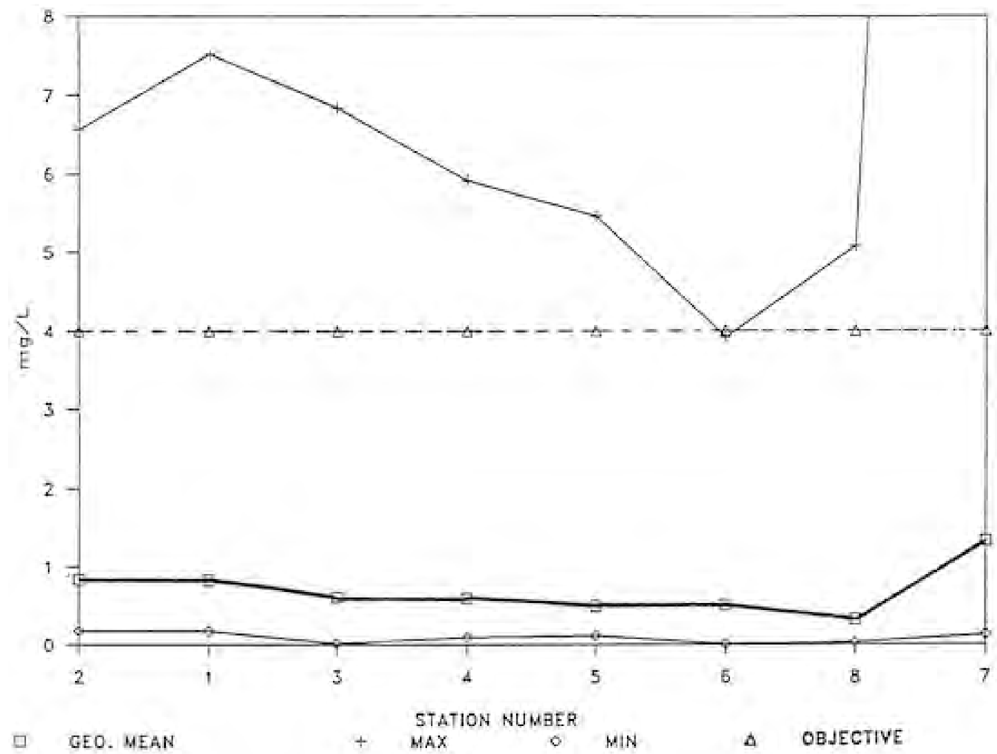


Figure 15. Biological Oxygen Demand

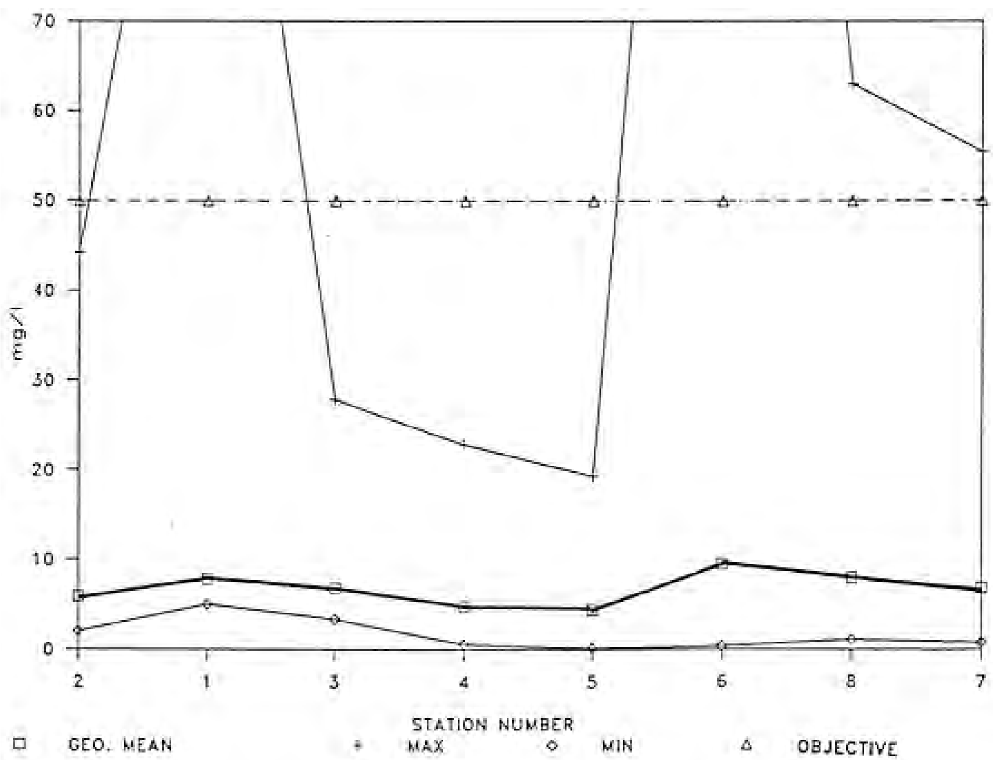


Figure 16. Suspended Solids

The lab analyzed the samples for Total Ammonia for which there is no standard. There is, however, a standard for that portion of Total Ammonia which is unionized. The unionized portion is pH and temperature dependent. This was calculated empirically using the table given in the MOE Water Management Handbook (1984). Unionized Ammonia was found to be quite low in most of the samples except for five fall samples taken at Station 7 (see Figure 17).

Geometric means for TKN exceeded the acceptable limit in all stations (Figure 18). In fact, 80% of the samples were excessive. The values were fairly uniform between stations, although Station 7 again showed the highest levels. All of the samples taken at Station 8 were above the standard.

All of the eight stations recorded levels within acceptable levels for Nitrite. Geometric means were in the 0.02 to 0.04 mg/L range, somewhat higher than the usual background levels (Figure 19). Only Station 5 recorded a sample with Nitrite levels over 2.0 mg/L. All samples collected on December 7, 1987 were particularly high and all hovered around a concentration of 0.26 mg/L.

Only Station 8 recorded a geometric mean above the standard for Nitrate (see Figure 20). All of the downstream stations experienced elevated levels 25 to 30 percent of the time primarily in November and December, but their geometric means were not excessive. Approximately 50% of the individual samples at the upstream stations were above the guidelines.

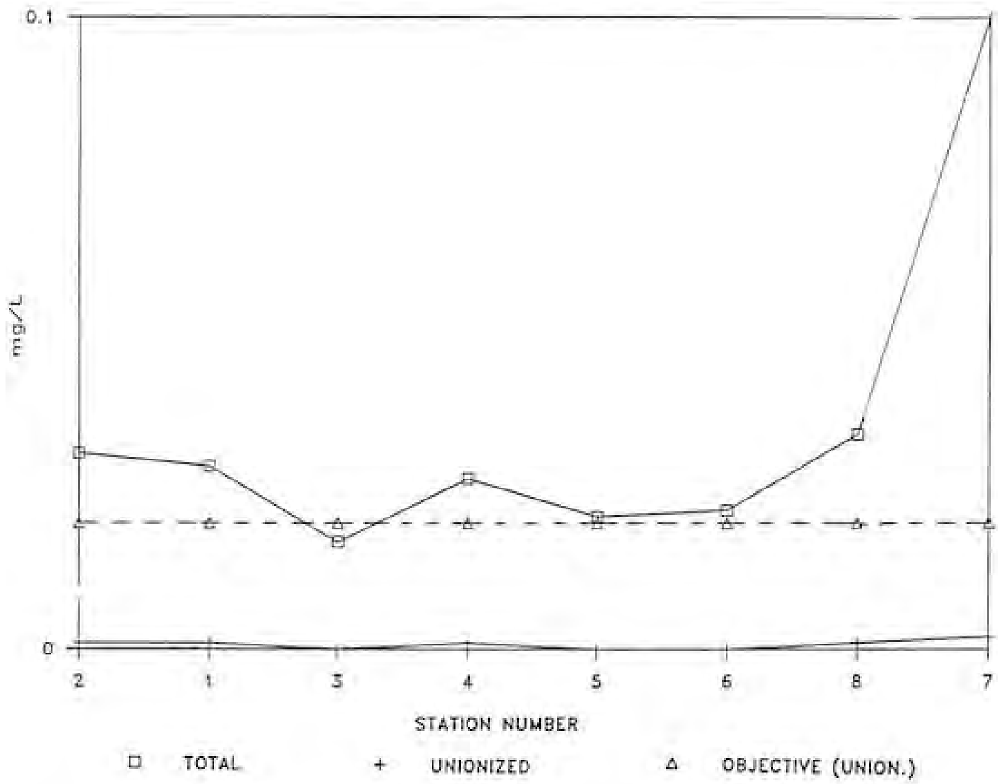


Figure 17. Total Vs. Unionized Ammonia

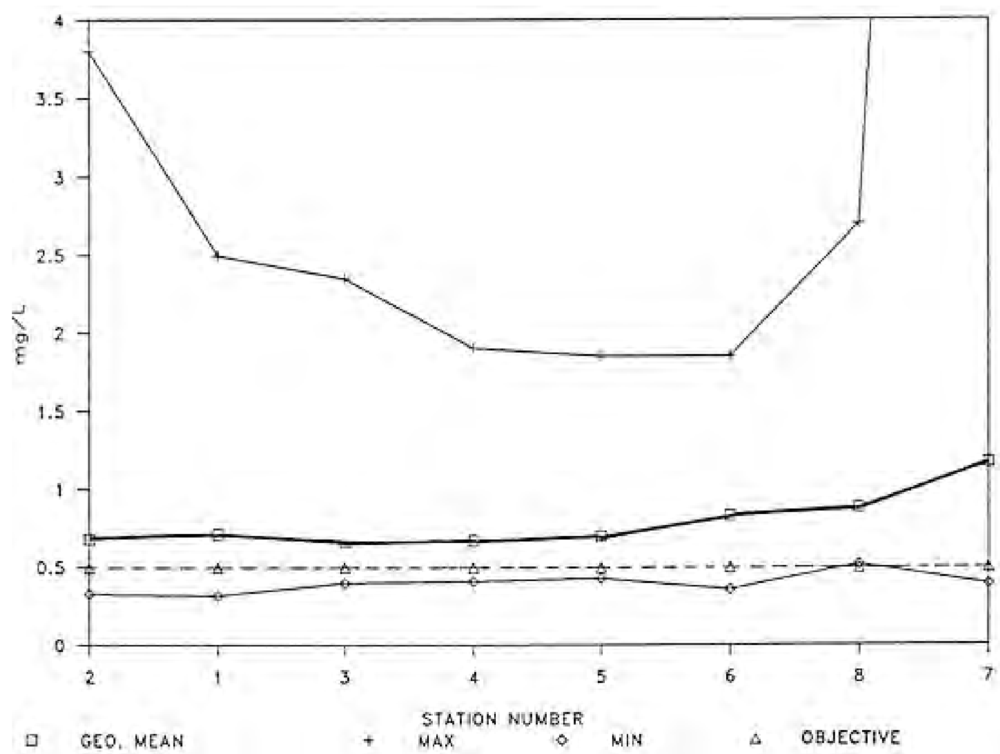


Figure 18. Total Kjeldahl Nitrogen

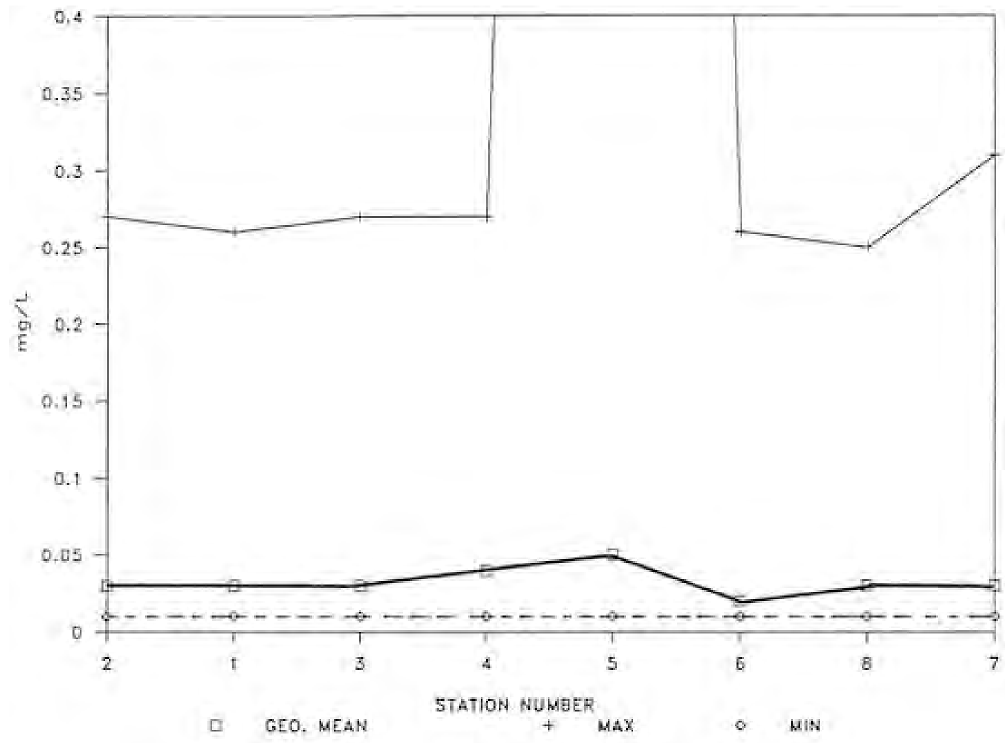


Figure 19. Nitrite Levels

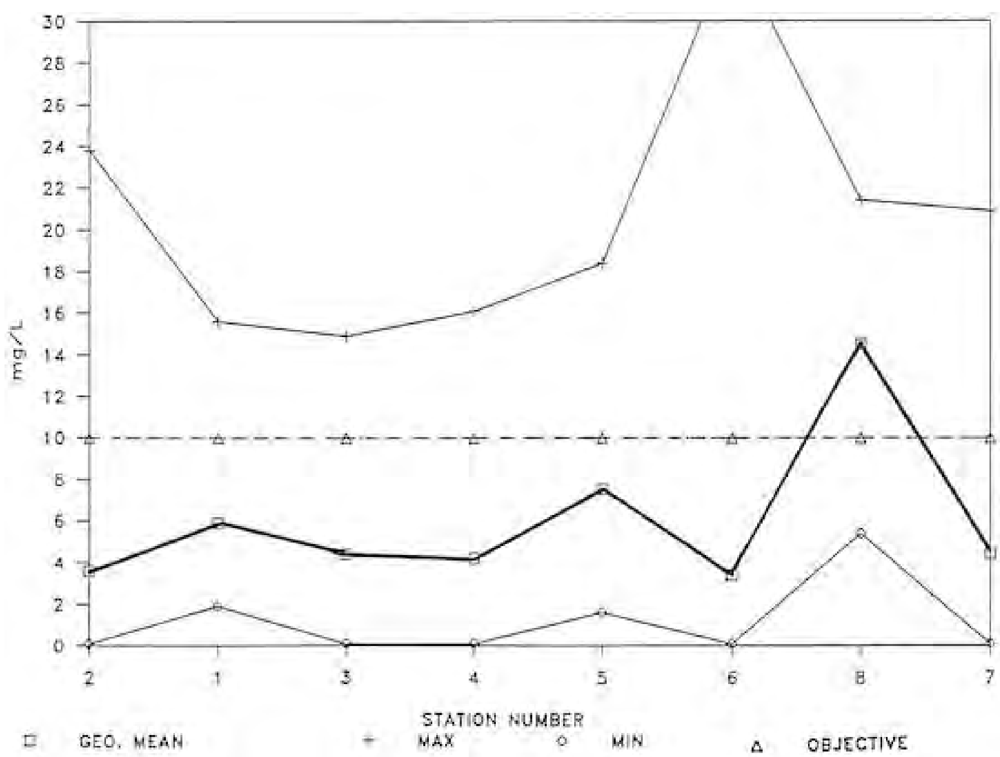


Figure 20. Nitrate Levels

The geometric mean for Phosphorus was above the guidelines for all of the stations. Stations 5 and 7 recorded the highest values with levels in excess of 0.15 mg/L. All of the samples taken at Station 5 were above the standard (see Figure 21) . In total, 87% of all of the samples exceeded MOE's guidelines. There was also a high degree of variability between the phosphorus loadings in individual samples. These levels may decline in the summer months when the vegetation actively takes up and utilizes the phosphorus.

There is no standard set for Soluble Phosphorus; it is simply a measure of the amount of total phosphorus which is in solution and thus readily available for use by plants and algae. The figures varied between the stations, but generally soluble phosphorus accounted for between one-third to two-thirds of the total phosphorus load. Stations 4,5 and 7 showed the highest absolute as well as percentage soluble phosphorus levels (Figure 22).

Overall, the pH was fairly steady around the 7.8 to 7.9 range for all of the stations (Figure 23).Only two individual samples were slightly above 8.5.These were recorded only once at Stations 5 and 6 and the levels were 8.54 and 8.52, respectively.

Chloride levels were generally in the 20 to 30 mg/L range (Figure 24). Station 5 was the only station with occasional samples containing over 100 mg/L.

The levels for Conductivity ranged from 600 to 700 (Figure 25). Stations 5 and 7 were the only stations with occasional levels above 1,000. As expected, there is a good correlation (similar shaped curves) between the levels of Chloride and Conductivity.

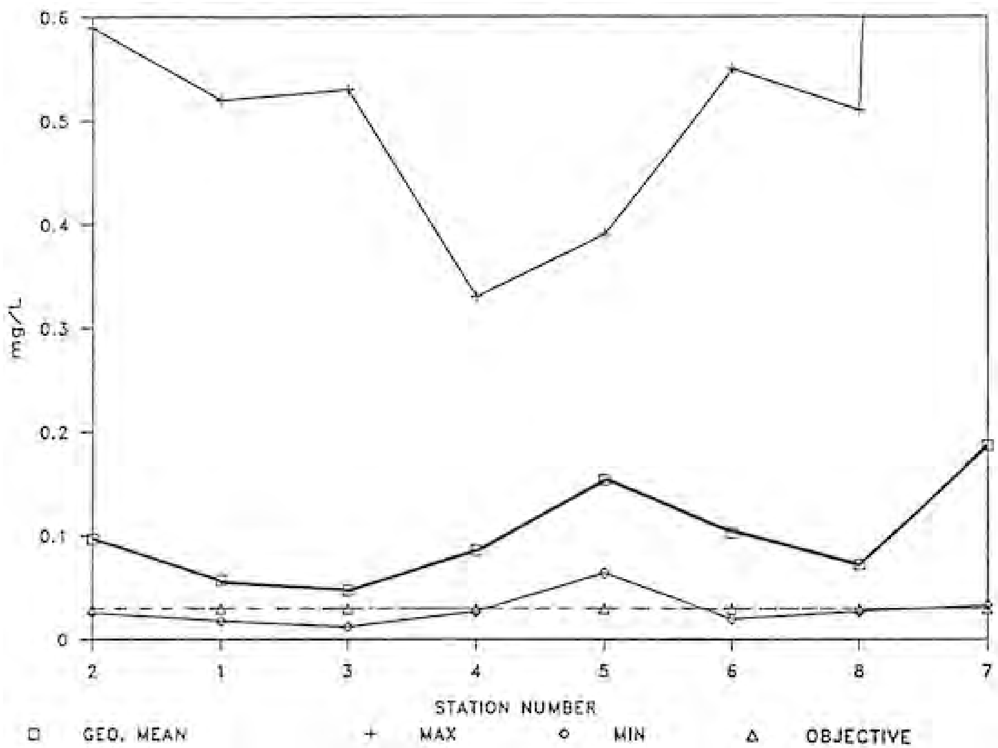


Figure 21. Total Phosphorus Levels

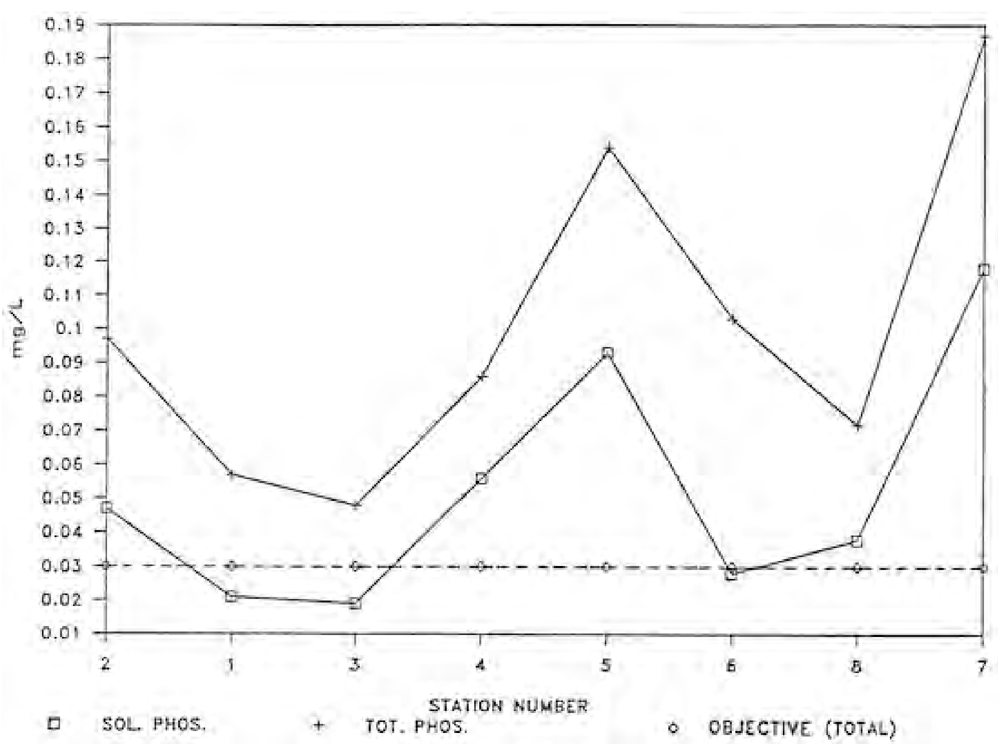


Figure 22. Total vs Soluble Phosphorus

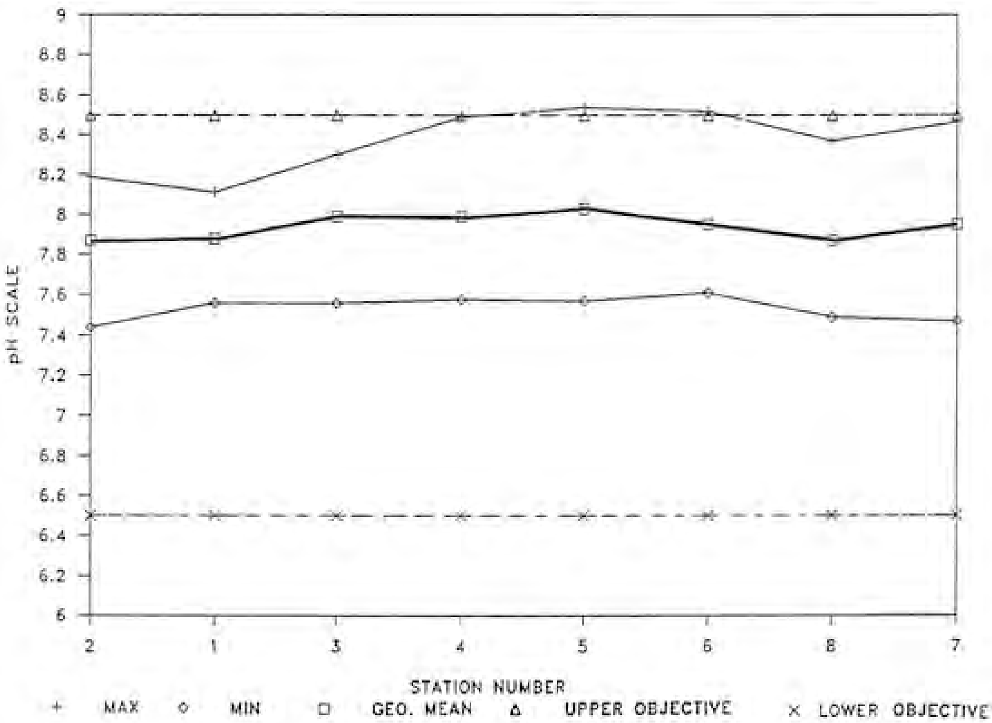


Figure 23. pH Levels

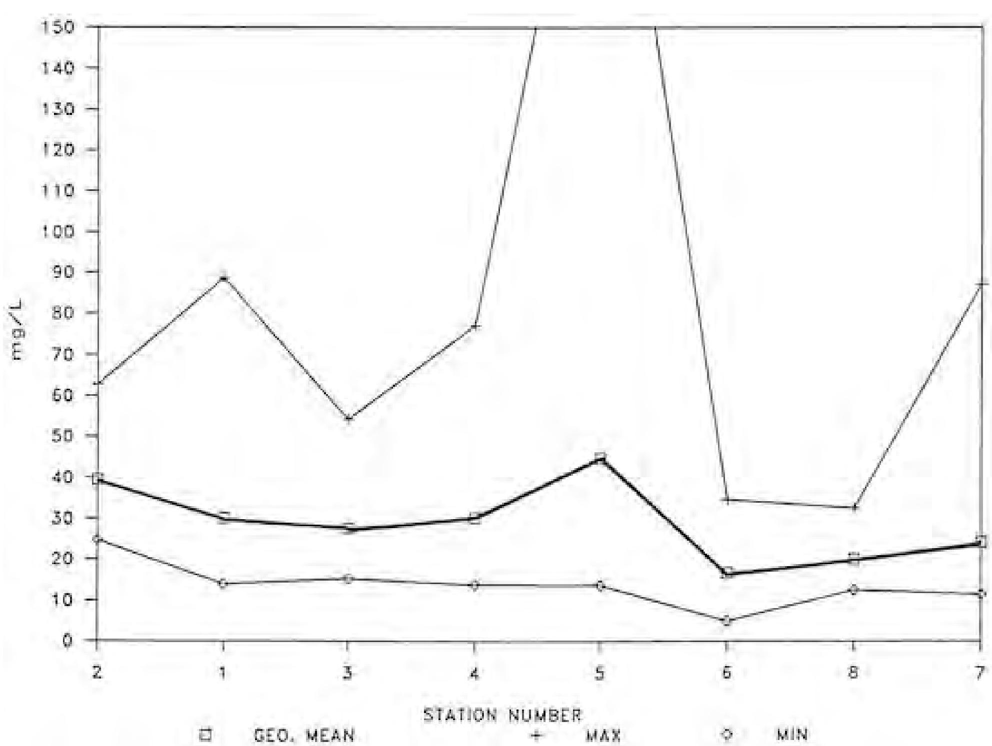


Figure 24. Chloride Levels

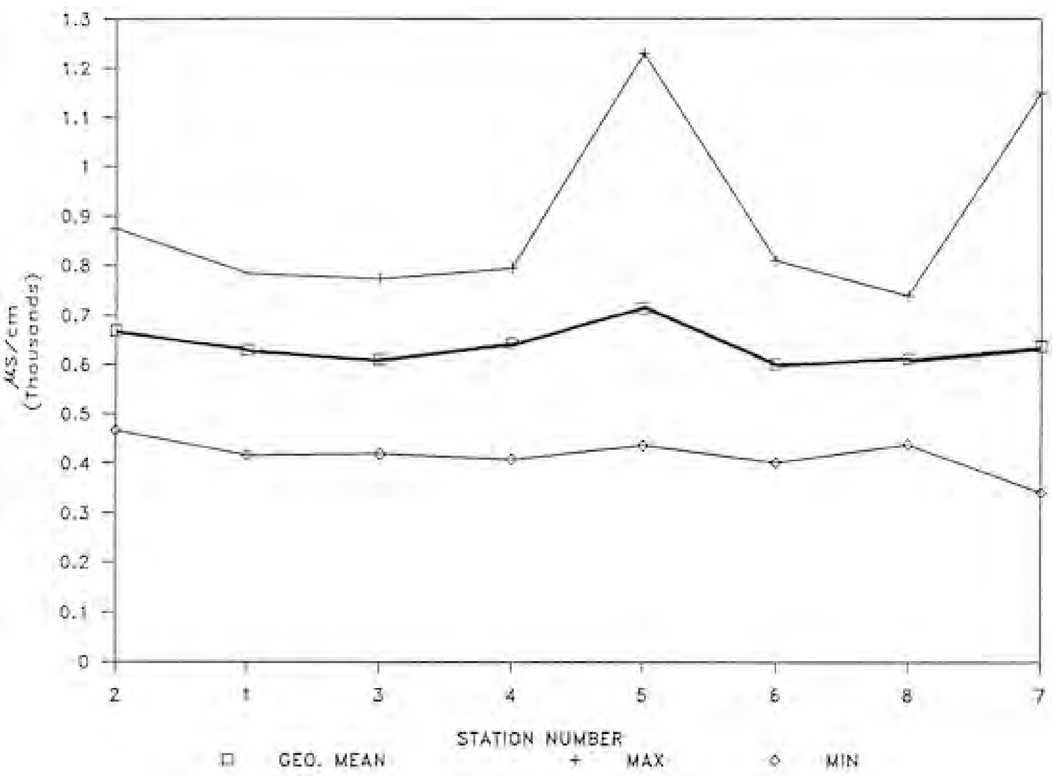


Figure 25. Conductivity Levels

5.4 Additional Samples and Station to Station Comparisons

In an attempt to isolate at least stretches of the watercourse where pollution is entering, the data was examined on a Station-to-Station basis. Water samples were collected from 25 additional locations to further isolate the sources of the pollution to the watercourse. The results of this analysis and a map depicting their location are found in Table 5 and Figure 26, respectively.

At a glance, Figure 26 seems to indicate that London Township is the problem area due to the density of samples taken there. This was simply a matter of time. This area was investigated in the fall while Lobo Township was not investigated until early winter when many of the drains and tile outlets were frozen and samples could not be taken. Also, there are many more open drains in London Township, whereas many are buried and the network is not as dense in Lobo Township.

The water from Station 8 flows through approximately 1.5 kilometers of crop fields before it reaches Station 6. On a sample to sample comparison, bacterial and chemical levels were usually, though not always lower at Station 6. One would expect a gradual die-off of bacteria between the two stations providing there were no additional pollution sources. However, the fact that the levels are sometimes very much higher at Station 6 suggests there is such a source between these two stations. There are no major tile outlets along this branch but there are several small field drainage tiles. The fields here were spread with manure during the fall and winter and so this probably accounts for the elevated levels. No additional samples were collected along this stretch.

Table 5. Additional Data - Summary Of Geometric Means

SITE	# Samp	F.c.	F.s.	P.a.	E.col	BOD	S.S.	T.AMM	U.AMM
Obj.		100	100	4-20	1000	---	---	---	---
A	1.5	4	40	4	4	0.76	15.1	0.470	0.005
B	2.0	28	452	4	20	0.42	12.1	0.110	0.001
C	1.0	100	3300	10	100	2.14	17.9	0.100	0.000
D	3.0	103	47	4	101	0.27	1.1	0.017	0.001
E	3.0	60857	710	18	51542	6.00	10.0	1.692	0.040
F	1.0	4	4	4	4	0.01	5.0	0.100	0.001
G	1.0	112	1500	4	88	1.00	5.0	0.019	0.000
H	1.0	10	10	4	10	0.01	5.0	0.001	0.000
I	2.0	23091	2180	247	21531	9.50	8.9	0.040	0.000
J	1.0	76	630	44	88	0.40	5.0	0.040	0.001
K	1.0	4	12	2	4	0.44	1.7	0.032	0.000
L	1.5	224	208	2	208	0.68	5.0	0.105	0.000
M	1.0	10	180	4	10	0.46	5.0	0.200	0.002
N	1.0	20	240	4	20	0.69	69.2	0.200	0.001
0	1.5	10	10	4	10	2.40	5.8	0.070	0.001
P	1.0	60,	200	4	60	0.15	0.9	0.003	0.000
Q	1.0	270	380	4	200	0.36	5.0	0.010	0.000
R	2.0	1234313	50498	72	1200833	98.12	106.8	7.490	0.029
S	1.0	230	120	4	220	0.60	0.9	0.001	0.001
T	2.0	87	205	4	60	0.39	48.4	0.014	0.001
U	2.0	230	47	7	178	0.16	5.7	0.014	0.001
V	2.0	219	306	6	110	0.45	5.5	0.100	0.000
W	2.0	1817	2055	9	1530	2.41	3.0	0.424	0.003
X	2.0	492	190	4	334	0.58	6.7	0.100	0.001
Y	1.0	10	350	4	10	0.77	5.8	0.020	0.000

SITE	TKN	NITRITE	NITRATE	T. PHO	S. PHO	pH	CL	COND
Obj.	0.50		(10.00)	0.030	----	6.50-8.50	---	---
A	0.86	0.01	0.10	0.070	0.007	7.67	119.79	922
B	0.86	0.12	9.47	0.123	0.010	7.71	22.38	585
C	1.20	0.04	5.90	0.200	0.100	7.57	10.74	380
D	0.58	0.06	39.67	0.053	0.031	7.44	67.40	1046
E	6.53	0.25	20.47	1.131	0.526	7.76	44.62	1005
F	0.20	0.03	2.40	0.004	0.002	7.84	7.89	520
G	0.69	0.01	15.60	0.089	0.059	7.82	25.45	575
H	0.45	0.01	11.00	0.015	0.002	7.87	15.80	540
I	3.02	0.08	12.45	0.520	0.031	7.70	79.21	882
J	0.46	0.01	28.00	0.033	0.007	7.81	69.84	825
K	0.39	0.01	17.10	0.053	0.036	7.89	36.42	765
L	0.53	0.03	8.05	0.230	0.040	7.99	33.92	726
M	0.50	0.02	0.03	0.130	0.056	8.09	215.70	1110
N	1.00	0.02	3.80	0.370	0.240	7.74	222.60	1320
0	1.52	0.01	0.10	0.152	0.006	7.85	3.05	312
P	0.54	0.01	7.60	0.026	0.024	7.82	15.15	530
Q	1.02	0.01	14.80	0.042	0.039	7.82	23.61	670
R	20.02	0.01	0.10	4.775	1.752	7.99	199.76	1125
S	1.04	0.03	14.80	0.088	0.037	7.78	27.04	670
T	1.08	0.02	13.19	0.147	0.027	7.76	8.88	595
U	0.86	0.02	6.61	0.087	0.055	7.89	20.07	542
V	0.82	0.03	4.72	0.082	0.155	7.78	27.19	492
W	1.70	0.11	9.65	0.300	0.171	7.86	41.93	660
X	0.86	0.03	5.90	0.065	0.037	8.00	26.45	620
Y	0.44	0.02	6.20	0.035	0.019	7.59	21.95	605

No. Samp - Number of Samples Taken (0.5 indicates only bacteria OR chemicals analyzed for, not both)

Obj.	- MOE Objective	BOD	- Biological Oxygen Demand	T.Pho	- Total Phosphorus
F.c.	- fecal coliform	S.S.	- Suspended Solids	S.Pho	- Soluble Phosphorus
F.s.	- fecal *streptococc*i	T.Amm	- Total Ammonia	Cl	- Chloride
P.a.	- *Pseudomonas aeruginosa*	U.Amm	- Unionized Ammonia	Cond	- Conductivity
E.coli	- *Escherichia coli*	TKN	- Total Kjeldahl Nitrogen		

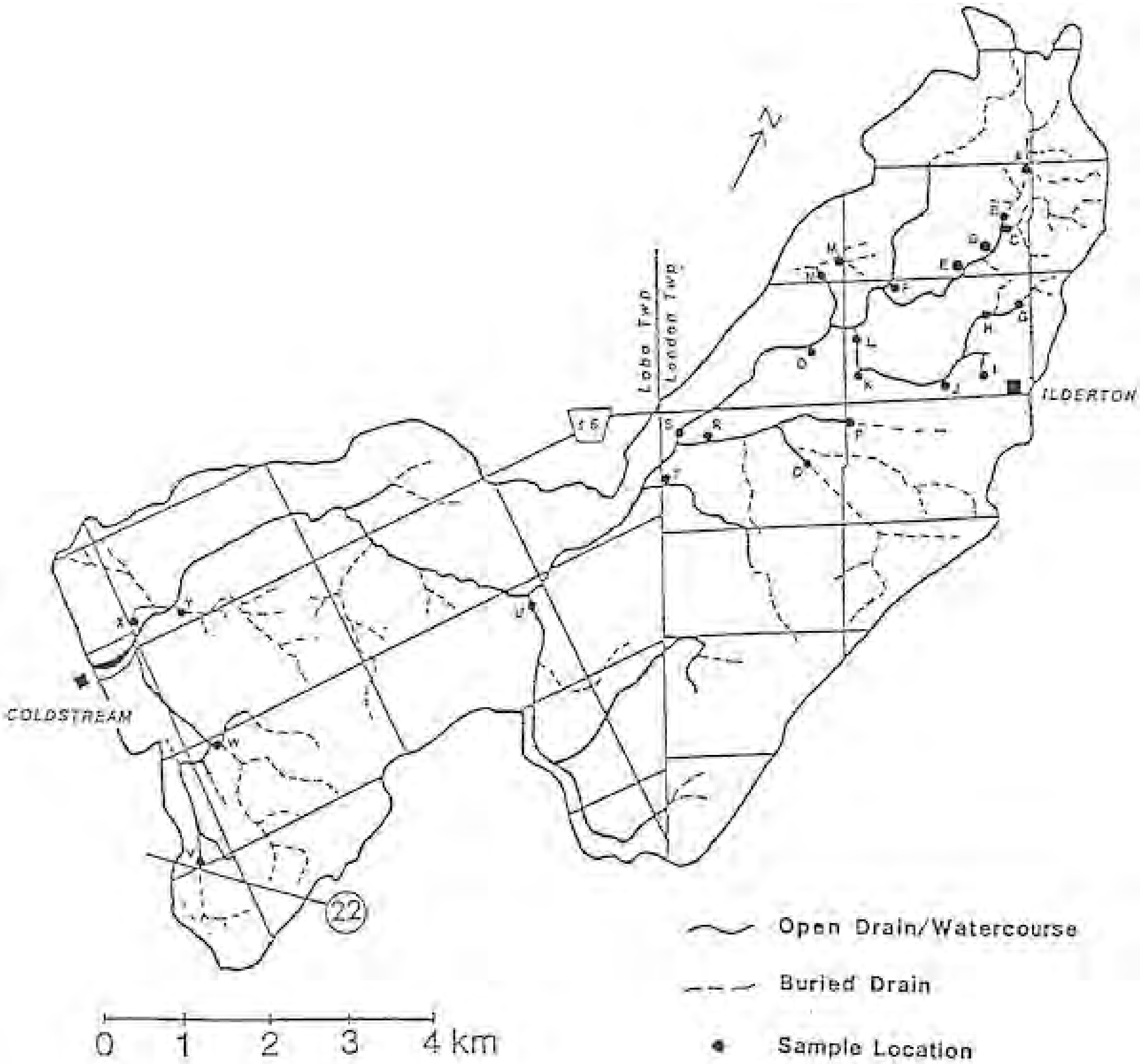


Figure 26. Location of the Additional Sampling Sites along the upper East Sydenham River watercourse

There is no permanent station upstream of Station 7 and so a Station to Station comparison is not possible. However, several additional samples were collected (A-E). A few meters upstream of this station is a 15 centimeter corrugated tile outlet (Sample E on the map) which was discharging odorous water and had fungus growing in and around the outlet. The flow was not strong but it was steady. Samples were collected and the results indicate that this is definitely a problem source as the fecal coliform levels were well over 7,000/100 ml. The fecal *Streptococci, Pseudomonas aeruginosa, E. coli*, Ammonia, TKN, Nitrate and Phosphate levels were also well above their standards. The high fecal coliform and *Pseudomonas aeruginosa* levels indicate a possible human source. The fecal *streptococci* levels suggest an animal source. The source is difficult to determine as there are two homes nearby but also a feed bin and cattle barn.

Samples taken upstream of this tile indicate that it is not the only source of pollution to Station 7. The drain was followed upstream to two 45 centimeter corrugated steel outlets which drain the underground Branches of the Ashworth Bloomfield Drainage Works (Additional Samples B and C). Fecal *Streptococci* were extremely high in 2 of the 3 samples taken suggesting an animal source. Since the water comes from a long underground tile network, it is not surprising that this more resilient bacteria was found instead of fecal coliform or *E. coli.* There were not enough samples taken to determine which of the two outlets is the primary source of the pollution.

Though not a problem at time, a dugout pond (Sample D) located near the railway tracks upstream of station 7 contained fungus and bacteria, suggesting a possible manure source. The water entering the pond from a tile outlet was high in fecal coliform and *Streptococci* bacteria and was extremely high in Nitrate. There is a settling or die-off effect because the water exiting the pond into the drain was not excessive in bacteria, although the nitrogen parameters were still above MOE guidelines.

The highly polluted waters from Stations 6 and 7 merge and then flow as one to Station 5. Two medium sized tributaries drain into Bear Creek Drain between these points as well. These include the McIntyre-Gysber Drainage Works and the Ilderton Drain. Several additional samples were collected along this stretch of the watercourse as well. These include additional samples G through O.

The Ilderton Storm Sewer Outlet (I) which drains into the Ilderton Drain was found to contain very high bacterial levels including the pathogenic bacterium *Pseudomonas aeruginosa.* Standards for BOD were greatly exceeded as well as TKN, Nitrate and Phosphorus. The presence of fecal coliform and *Pseudomonas aeruginosa* indicate the bacterial contamination may be human in origin. Storm water should not contain any waste or sewage water. Several local landowners who were interviewed thought a new subdivision in Ilderton was to blame.

Location G was at the tile outlet which forms the headwaters of the north branch of the Ilderton Drain. Very high fecal *Streptococci* levels were present the one time it was sampled. A sample taken another day at Location H which is downstream of Sample G and a wetland revealed good conditions. Location G is either receiving only sporadic inputs of pollution or the wetland is acting to filter the water somewhat. Additional sampling would be needed to confirm this. Location G drains portions of two fields which are fairly rolling.

A tile outlet labelled "J" located along the Ilderton Drain drains a small area on the south side of County Road 16 just west of Ilderton. It recorded elevated pollution levels. Portions of a field and a couple of homes are present in the area. High *Pseudomonas aeruginosa* and levels suggest human waste contamination, although the high fecal *streptococci* levels would indicate a livestock source.

Samples taken at M and N along the McIntyre-Gysber Drainage Works recorded moderately high fecal *streptococci* levels. Location N had excessive suspended solid levels as well as Ammonia, TKN, Phosphorus, Chloride and Conductivity readings. Locations M and N collect water from two fairly large fields, parts of which may have been spread with manure at the time. These should be sampled again in the summer to determine if this is the source or if the nearby cattle holding barn has any contribution.

Considering the high contamination present at Stations 6 and 7 as well as the additional samples noted above, there is a significant decline in bacterial levels by the time the water reaches Station 5. There were also moderate to slight drops in the levels of Ammonia, Suspended Solids, Biological Oxygen Demand, and Total Kjeldahl Nitrogen. Conversely, there is an increase in Nitrate, Chloride and Conductivity.

Although the bacterial concentrations approached acceptable levels at Station 5, storm events still re-suspended high concentrations past this station at certain times throughout the study period. In addition, most of the study period was during the winter where die-off is expected to be quicker. During the summer when bacteria multiply, conditions may degrade.

Although research into the rate of bacterial die-off is still very preliminary, some results from the Toronto area suggest that there is a greater die-off rate when bacterial concentrations are higher, perhaps due to competition (MTRCA, 1988, unpublished). The study also found die-off rates were higher in urban areas. This may be because the types of pollution found in these environments adversely affects the survival of the bacteria. This may explain the rapid rate of die-off in the Ilderton Drain and the significant drop in levels from Stations 6 and 7 to Station 5 compared with the rate between other stations.

To further complicate the picture, most of the graphs reveal a rise in pollution concentrations downstream of Station 5. Whatever cleaning effect occurred upstream of this point is offset by inputs further along.

As the water travels down Bear Creek Drain from Station 5 to 4, there is a moderate increase in the levels of fecal coliform, *E. coli*, and Ammonia. There are also very small increases in the levels of fecal *Streptococci* and BOD. Conversely, there is a drop in the levels of Nitrate, Total Phosphorus, Chloride, Conductivity and pH. Five additional samples were collected along this stretch of the watercourse (P through T).

One of these, a slow flowing yet highly concentrated source of bacteria was found at sample "R". This was a thick black puddle perched on the bank of Branch 2 of the Bear Creek Drain which was slowly draining down into it. The bacterial ratios indicate a possible human source, most probably a leak or improper connection from the septic bed of the nearby farmstead.

Water collected from a tile outlet located along Branch 3 of the Bear Creek Drain just south of the Olson Drain, labelled Q, also recorded moderately high levels. Fecal coliform and *Streptococci* were moderately high as well as TKN and Nitrate. This should be sampled again to determine its influence especially considering the large area it drains.

The water leaving the tile outlet at additional sample T along Branch 3 of the Bear Creek Drain near the Township Road was very brown on one visit and so was sampled. The analysis revealed very high levels in all of the bacteria categories except *Pseudomonas aeruginosa*. Suspended Sediment levels were particularly high. A subsequent sample taken another week revealed acceptable levels. A new home and barn were being constructed nearby and so this may have reflected a one-time event. However, it should be monitored to ensure this.

As the watercourse flows further downstream from Station 4 to Station 3, there were further increases in some parameters. There was a small to moderate increase in the bacterial levels as well as BOD, SS, and Nitrate. There was a significant drop in Total Ammonia and Total Phosphorus and all others showed only moderate declines. With the addition of the Taylor and Ivan Drains between these two stations and a nearly doubling of volume, one would expect to see more significant drop-off rates. Also, the Sydenham River's course is fairly natural along this stretch with vegetation buffering the banks most of the way. There is, however, a cattle access point directly upstream of Station 3 and along the Taylor Drain.

The water sample collected at "U" was taken in stream at the furthest point downstream of the Taylor Drain just before it merges with the Sydenham River. The first sample taken showed good results, but the second revealed quite high bacterial levels. However, the second sample was taken on January 20, 1988 during a mid-winter thaw when most stations were recording very high pollution levels. Additional samples should be taken to determine this long drain's contribution. There are cattle access points along this drain as well as areas of bank erosion.

The last stretch of the Sydenham for which there is data is between Stations 3 and 1. Only 5 out of 15 parameters show the expected decline in concentrations. Fecal *streptococci* and BOD showed moderate increases and there were also very small increases in the concentrations of SS, Ammonia, TKN, Nitrate, Total Phosphorus, Chloride and Conductivity. Again, this stretch of the Sydenham is fairly natural with buffers and few field tile drainage outlets. There is, however, a quarry operation and two underground tile networks, the Bycraft and Stevenson Drains, entering this stretch just upstream of Station 1.

A sample taken at the end of the Stevenson Drain and its branches (Y) revealed elevated fecal *streptococci* levels the one time it was sampled. The water did not look particularly clear and it does drain a fairly large field area as well as a residential strip very close to the Conservation Area. This should be monitored further as well.

There is no permanent station upstream of Station 2 but two additional samples (V and W) were collected. The water collected at sample location "V" adjacent to Highway 22, had one poor and one acceptable sample. Again, the poor sample was taken January 20th. The water in this drain does not appear that clean and so should be monitored again.

Sample "W" also recorded consistently high bacterial and chemical levels. The sources include Trunks 1, 3 and 4 of the Colvin Drain in Lobo Township. It is probably the prime source of pollution to Station 2.There is also a cattle access point upstream of Station 2 which has not been monitored.

6. DISCUSSION AND CONCLUSIONS

The primary goal of this study was to gather baseline information on the watershed, monitor the water quality and to identify possible sources of pollution.

The elevated fecal coliform and *Streptococci* levels recorded throughout the study period as well as high Phosphorus, Nitrate, and TKN loadings indicate that there is a water quality problem in the Upper East Sydenham River Watershed. Livestock wastes from either point or non-point sources appear to be the primary source of the contamination. In addition, human wastes appear to be occasionally entering the water course based on the presence of *Pseudomonas aeruginosa*. A few of the sources can be isolated to specific tile outlets, but many more are non-point or diffuse. The fact that many of the drains are buried makes isolating sources more difficult as well.

This water quality problem has reduced the attractiveness of the beach area at the Coldstream Conservation Area and hence visitor attendance has dropped off over the years. The local residents surveyed would like to see the water improved so that the area can be utilized for swimming and fishing.

6.1 Suspected Sources or Causes

In general the highest bacterial readings are coming from the upstream stations, that is, Stations 6 to 8. This was somewhat expected due to the lower volume of water in these drains compared to the main branch of the Sydenham. Although there are livestock barns in the area, the pollution appears to be entering both upstream and downstream of these farms. Contamination from manure spread fields is suspected.

In fact, complaints about winter manure spreading from the local landowners came largely from this area of the watershed. The lack of windbreaks, buffer strips along the open drains and conservation tillage practices in this area probably allows the liquid manure easy access to the tiles and open drains during wet periods or thaw events.

The landowner who operates much of this area indicated that the liquid manure was being spread in the winter to avoid compaction problems on the heavy clay soil. A move towards irrigation application was being considered if it proves feasible. This landowner also owns land near Location W where high levels were recorded as well.

Although only 35% of the farmers interviewed indicated that they spread their manure in the winter, this does not mean that only 35% of the land is being covered since some of these owners own very large properties. Also, when this occurs near open drains, the problem is magnified. Since bacteria can live for weeks or months in the water or soil, it only takes one inoculation of polluted water into a reservoir to contaminate the water for an entire season or each time the sediments are stirred (MOE, 1984a).

Aside from this more-or-less non-point source problem, Section 5.4 outlined a number of individual tiles or sites where pollution was entering the watercourse. The tile just upstream of Station 7 is definitely contributing high bacterial levels. The landowner has been notified but the situation had not changed when inspected at the end of April, 1988. If future inspections reveal unchanged conditions, MOE Abatement should become involved directly.

The problem with pollution in the Ilderton storm sewer is somewhat more difficult to isolate. This is an apparently common situation in small southern Ontario towns which do not have sewage treatment plants. If the local consensus is correct and there is an illegal connection between overflowing septic systems and the storm sewer network, this should be sought out and blocked. The situation should be corrected or improved. Water conservation practices in the homes would also reduce the load on the system and should be promoted.

Another single point source which could be cleared up with the owner's cooperation is the puddle at location R which contained extremely high bacterial levels. The owner has also been notified of the situation. Similar action should be taken in terms of monitoring and enforcement.

Cattle access to streams is still a common practice in this watershed. There are approximately four locations where this occurs, some quite close to the Reservoir. The problems associated with cattle access is still largely unrecognized based on the landowner interviews. There is also one stretch of Taylor Drain (Lot 16 Concession 7) which is experiencing bank erosion problems at least in part as a result of cattle access.

There is also a potential threat to the cattle drinking from the watercourse. Although cattle can adjust to relatively high bacterial levels in the water, they may not be guarded against extreme fluctuations in bacterial loadings. For example, there is a cattle access point upstream of Station 2 and the data from this Station indicates there is a great deal of variability in the bacterial concentrations from one week to the next. Levels varied from under 50/100 ml to over 1,000/100 ml. The cattle watering near Stations 3 and 4 may also be affected in a similar manner.

The landowner questionnaire program revealed other potential problems. Firstly, there are few vegetative buffers along the drains of this watershed and the fields are plowed very close to the banks. Fertilizers, soil and manure thus have quick access to the drains. Only

31% of the landowners were aware of the grants available to seed down drain banks.

Also, very few farmers are using conservation tillage techniques, although many reported they were experimenting with it or watching the results of their neighbors. Windbreaks are still sparse in this watershed as well.

Most of the farmers still deal with solid manure. The majority, however, store it in a pile on the earth with no structures to catch the run off. Although almost two-thirds of the farmers interviewed have their soil tested regularly, none test their manure for nutrient content. Also, many were not sure of the amount of manure applied per acre. Over application of fertilizers and manure may be occurring considering the large size of some of the livestock operations.

Also, since manure is not spread evenly over the entire farm acreage, the average 100 acre farm may not be large enough to handle the volume of manure produced. The information from the landowner questionnaires summarized in Appendix A reveals an average dry manure loading of 25,000 pounds per acre per year. This is a conservative estimate using the entire acreage of the farm. The loading is probably closer to 2 to 3 times that amount on the fields where manure is actually spread. The average loading reported for liquid manure was 4,000 gallons per acre.

The final piece of information which the interviews highlighted was the trend towards utilizing systematic drainage. This will likely reduce the erosion problem along drainage ditches associated with numerous tile outlets.

7. RECOMMENDATIONS

This study has concluded that there is a water quality problem in the upper East Sydenham River watershed and the problems contributing to it should be corrected. A few point and nonpoint sources of pollution have been identified. Further isolation of the sources and correction of the known and existing problems can only be achieved through continued study and involvement in the watershed. The following recommendations should be undertaken:

1. Weekly water samples from the eight stations should continue through the summer to obtain an all-season data base. This will be useful considering the assumption that much of the problem in the upstream stations is related to winter manure spreading.

   This will also indicate if the relatively rapid die-off rate of bacteria in the drains from Stations 6 and 7 to Station 5 during the winter, is similar in the summer. The cold temperatures may have killed off the bacteria before they were able to reach the downstream stations closer to Coldstream Conservation Area. The additional data may also demonstrate the positive effect of plants in using up phosphorus in the streams, thus decreasing their concentration at the Coldstream Conservation Area.

2. The two point sources of pollution identified should be monitored to ensure the landowners correct them. These include additional samples E located at Lot 26, Concession 12 in London Township and R at Lot 31, Concession 10 in London Township. The MOE Abatement Section should approach the landowners if these sources are not eliminated voluntarily.

3. The tile outlets which were thought to be major contributors of pollution should be sampled further to determine their magnitude and followed upstream to further isolate the sources and eliminate any illegal hookups. These outlets include additional sample W located at Lot 9 Concession 7 in Lobo Township along the Colvin Drain and B and C upstream of Station 7 at Lot 26, Concession 12 in London Township.

4. There are a number of additional sample sites which were determined to deliver at least sporadic inputs of pollution to the watercourse. These should be occasionally sampled over the course of the summer to determine the magnitude of their influence. If they prove to be significant problems, the procedure identified in item 3 should be applied. They include the following:

D - a dug out pond at Lot 26, Concession 12, London Twp.

H - a tile outlet from an underground tile network at the headwaters of the Ilderton Drain at Lot 26, Concession 11, London Township

J - a tile outlet along the Ilderton Drain which may have a septic origin at Lot 27, Concession 11, London Township

N - the McIntyre-Gysber Drainage Works at Lot 29, Concession 12, London Township

Q - the outlet from the Olson Drain (underground) at Lot 29, Concession 10, London Township

T - a tile outlet along Branch 3 of the Bear Creek Drain next to the Township Road at Lot 32, Concession 10, London Township

U - mouth of the Taylor Drain at Lot 16, Concession 7, Lobo Township

V - tile outlet from an underground tile network located south of Highway 22. The tile is located at Lot 8 Concession 7, Lobo Township.

Y - a tile outlet of the Stevenson Drain (underground) at Lot 9, Concession 9, Lobo Township

5. Three additional drainage networks should also be sampled occasionally to determine their influence as they have not been sampled to date. They include:

   a) Bycraft Drain - Lot 9 Concession 9 Lobo Township
   b) Ivan Drainage Works - Lot 14 Concession 8 Lobo Township
   c) Branch 3 of Bear Creek Drain - Lot 32 Concession 10 London Township.

6a. The location of all illegal hook-ups, malfunctioning septic systems and other problems in the Ilderton Storm Sewer system should be sought out and corrected.

b. Water conservation practices should be promoted through mail outs or flyers.

7. A summary of the results of this study should be sent to interested parties in the area.

8. Information packages about water quality and the grants and measures available to correct the problems should be sent to farms in the study either in person or through the mail. This can include information on manure storages, manure spreading practices, conservation tillage techniques, septic system, cattle access, et cetera.

9. The two hog operations located at Lot 15, Concession 5, Lobo Township and Lot 24 Concession 12 London Township which are presently closed should be monitored if they re-open. The landowner survey indicated that there were problems with them in the past concerning overflowing manure tanks.

10. The St. Clair Region Conservation Authority should closely monitor the cost-effectiveness of the Remedial Measures Programs being carried out by other Conservation Authorities in Southern Ontario to determine if this is the direction to go. The experiments being carried out into such areas as bacteria die-off rates should also be examined.

11. A study should be set up to determine what percentages of manure related pollution originating from a farm is coming from: a) illegal hookups, b) barnyard runoff, c) "properly" or "improperly" spread manure, and the magnitude of each. This would require sampling all tile drainage outlets over a certain time period. This would indicate where money is best spent on remedial measures.

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APPENDIX A

LANDOWNER QUESTIONNAIRE RESULTS

RESULTS OF THE LANDOWNER QUESTIONNAIRE

Total Number of Respondents : 32 Tenant 5 Owner 27
Non-Farming Resident 2 Cash Crops Only 7
Crops + Livestock 21 Livestock Only 2
8/23 keep only a few head of livestock or hobby farm
Average Farm Size 157 acres (64 hectares)

SECTION 1. CASH CROP PRODUCERS

No. of Respondents	Percent	Crop	Acres (per farm)
24	89	corn	110
19	66	winter wheat	52
14	48	soy beans	76
13	45	hay/pasture	33
11	40	oats, barley	32
3	10	white beans	70
1	4	apples	15
1	4	Christmas trees	60

52% Spread manure on their fields.
100% Use chemical fertilizers.
44% Leave some, plant residue or cover crops on their soil over the winter, primarily the soy and hay fields
44% Have some windbreaks to protect their fields but most were not consistent rows.
65% Have their soil tested regularly, about every 2-3 years.
21% Have had their manure tested, but only once (liquid only).
85% Do know about the grants available to aid farmers in using conservation tillage techniques.

SECTION 2. DRAINAGE

Tiling system:
Systematic Only 22% Average Age under 20 years
Random Only 49% Average Age present - 100 yrs
Systematic + Random 29%
21% Use surface drains or grassed waterways in their crop fields to carry away surface water in low lying areas.
22% Said there are areas where they might be able to use them.

66% Have an open drain or stream on their property.

30% Said the ditch had been filling in with sediment and weeds and had been recently cleaned out

5% Said some flooding had occurred onto their fields

1% Commented on the poor smell and appearance

63% Maintain a buffer along open ditches or streams (most people exaggerated based on field check)

31% Know about the grants available to use grassed waterways and to leave buffers along drains.

SECTION 3. TYPE OF LIVESTOCK ENTERPRISE

No. of Respondents	Percent	Livestock Type	Aver. # Head
7	29	Beef	150
7	29	Horses	2
5	21	Dairy	60
4	17	Hogs	100
4	17	Poultry	30,000
2	8	Goats	20
1	4	Sheep	20

SECTION 4. TYPE OF MANURE AND MANURE STORAGE SYSTEM

SOLID 83% LIQUID 4% SOLID + LIQUID 13%

0% Have a Runoff Containment Tank or Pond for their solid manure.

Storage: 43% pile on earth 22% in barn
17% pile on concrete 11% in horse arena
7% animals in pasture only

3% Had problems with water entering the barn.

4 landowners have LIQUID manure systems
- 3 are in-ground circular concrete pits with 6 - 9 month capacity
- 1 is an in-ground earthen pit

5 landowners have Dairy Operations
- 2 store milkhouse washwater in pits
- 1 in a septic bed
- 2 forgot to ask the question

Reasons for not changing manure system:

50% Operation too small
14% Presently Adequate
14% Near Retirement

92% Know about the OSCEPAP II grants to correct manure systems.

SECTION 7. LIVESTOCK WATERING

Only one farmer answered this question.

100% (35 head) of his livestock water directly IN the stream or ditch.
Spring, Summer and Fall is the time of year they water in stream.
Access is not restricted.
Water is always available from the stream.

SECTION 8. HOUSEHOLD SEPTIC SYSTEM

ALL respondents had a septic system.

34% Had their septic system been changed or expanded in the 15 years.
13% Had extra facilities added to their homes such as extra tubs, toilets, washing or dishwashing machines.
0% Had water from their eaves troughs entering their septic system.
28% Have had problems with their system, primarily ponding on ground or tree roots breaking tiles.
34% Rarely if ever get their tanks pumped.
66% Have it cleaned on an average of every 4 years.

SECTION 9. GENERAL QUESTIONS

36% Thought there was enough information on water pollution from farming activities and the government does not need to supply more.
50% of these said so because they feel polluters know what they are doing and so more information will not help. They felt more enforcement is needed.
64% Said the government should supply more information and 25% of these said more enforcement is also needed.
19% Felt there was no need for more information or enforcement.

The 2 best sources of information to farmers concerning farm management:

77%	Farm Newspaper/Magazines	27%	Factsheets
17%	Government Staff	0%	Demonstrations
23%	Neighbours	7%	Equipment Dealers
7%	Experience	3%	Radio + Television

53% Felt their present farm management practices were adequate for controlling water pollution.

37% Felt there was room for improvement.

10% Said it probably was not adequate.

27% Were familiar with the general guidelines of the Ontario Agricultural Code of Practice.

53% Had heard of the Certificate of Compliance.

SECTION 10. GENERAL COMMENTS FROM LANDOWNERS

Five landowners were concerned about the over-use, handling and disposal of pesticides as a potential pollution problem. They would like to *see* more courses offered, better instructions on bottles, facilities for disposal, and a move towards more biodegradable chemicals.

Four landowners mentioned the new subdivision in Ilderton as a probable source of the water pollution exiting from Ilderton. Small lots, big families, heavy clay soil are believed to be the causes of the septic tank problem there. One landowner had heard that the contractor simply put a tile under the basements of the new homes to get rid of the excess water. This was connected to the storm sewer system.

Several landowners said they no longer swam at Coldstream because the water is too dirty and polluted. One respondent said her son had contracted an ear infection from swimming there years ago. Most think the condition is a shame and would like to see the area improve.

Three or four people expressed concern about the quality of their well water because of the location of the well near a barn or in areas of heavy winter spreading.

Several people feel that it is the big operators with the high intensity livestock operations who are the biggest threat to water quality. There are 2 hog operations in the watershed which are now closed but were mentioned by the local residents because they had sloppy operations. Liquid manure tanks were seen to be overflowing or entering drains.

Several people mentioned their anger that the perpetrator of last summer's (1987) manure spill had not been charged. All knew or thought they knew the identity of the source and could not understand why the MOE did not charge them. A few thought the Township was to blame for allowing such a large operation on such small acreage.

Several landowners mentioned their strong desire to see a law prohibiting heavy winter spreading of manure due to the problems it causes everyone else in the area in terms of odour, messy roads, and water pollution.

One farmer felt subsidies are a waste of money as it always costs the same down the line. Contractors get busy and so people pay extra to get the work done right away.

One farmer also mentioned that he would like to see the results of the water quality study before being asked questions so that he is not involved if the pollution is not in his area.

Another farmer would like to see MOE follow up on all complaints from landowners. He had reported a problem once and never heard back or saw any results.

ST. CLAIR REGION CONSERVATION AUTHORITY
205 Mill Pond Crescent, Strathroy, Ontario, N7G 3P9   519 - 245 - 3710

March 8, 1988

MEMORANDUM TO: All landowners in the Upper East Sydenham River Watershed

As you may be aware, the St. Clair Region Conservation Authority and the Ministry of the Environment have been conducting a Water Quality Study of the Upper East Sydenham River Watershed upstream of Coldstream. The purpose of this study is to identify the possible sources of pollution which have led to beach closures, fish kills and other complaints from landowners in this area.

The preliminary results of this study indicate that our drains and rivers are becoming carriers of soil, nutrients and bacteria in concentrations that impair water quality and present a potential risk to livestock and people. To the farmer, this reflects a loss of productivity of the land.

Since the problems and solutions to water pollution affect everyone in the community, we will be attempting to contact all landowners over the next few weeks. We hope you will be willing to meet with our Water Quality Technician, Cathy Quinlan, at a convenient time to you, to answer a brief questionnaire. This should only take about 5 to 20 minutes of your time. We think it is very important to obtain YOUR views and concerns and to discuss the types of activities which may or may not be contributing to water pollution and the grants available to correct them. This information will, of course, be treated as confidential.

If you have any questions or comments, please feel free to contact this office. We appreciate you cooperation and look forward to hearing your views.

Yours truly,

Donald Craig
Conservation Services Supervisor

APPENDIX B

WATER QUALITY INFORMATION DAY INFORMATION FLYERS

ST. CLAIR REGION CONSERVATION AUTHORITY
205 Mill Pond Crescent, Strathroy, Ontario, N7G 3P9   519 - 245 - 3710

NEWS RELEASE

The St. Clair Region Conservation Authority will be hosting a Water Quality Information Day at the Coldstream Community Hall in the Village of Coldstream. The event will be held March 23, 1988 from 12:30 p.m. to 4:30 p.m. The session will be open to anyone with an interest in water quality and admission is free.

Experts on a variety of water quality 'topics have been invited to speak. They include representatives from the Ministries of Agriculture and Food, Natural Resources and the Environment, the Middlesex Health Unit, a veterinarian and a representative from the farming community.

The event is sponsored as part of a co-operative water quality study between the St. Clair Region Conservation Authority and the Ontario Ministry of the Environment. The study is being carried out in the watershed upstream of Coldstream to determine the causes of degraded water quality in that area.

Although the study applies to a certain area, the nature of the problem and the possible solutions are not unique to the area. The Authority is therefore expecting a number of people from outside the study area to be present.

Cathy Quinlan
Water Quality Technician
St. Clair Region Conservation Authority
205 Mill Pond Crescent
Strathroy, Ontario
N7G 3P9
(519) 245-3710

WATER QUALITY INFORMATION DAY

Wednesday : March 23, 12:30 - 4:00 p.m.
Coldstream Community Hall
Middlesex County Rd. 16, Coldstream

Free Admission, Free Coffee & Doughnuts

EVERYONE IS WELCOME

TOPICS: THE CAUSES AND SOLUTIONS TO WATER POLLUTION IN THE RURAL COMMUNITY

Sponsored by the St. Clair Region Conservation Authority and the Ministry of the Environment

WATER QUALITY INFORMATION DAY

Date:	Wednesday, March 23, 1988
Time:	12:30 p.m.
Place:	Coldstream Community Hall

Tentative Agenda

12:30	Registration
12:55	Opening Remarks - Ken Brooks Vice Chairman
1:00	Introduction to Water Pollution Murray Blackie, Ministry of the Environment
1:25	Water Quality & Livestock Health (tentative)
1:50	Manure Storage Structures Mel Sojak, Agricultural Engineer, Ministry of Agriculture and Food
2:15	Break - Coffee & Doughnuts
2:35	Fisheries and Water Quality Harold Schroeder, Ministry of Natural Resources
3:00	Water Quality and Public Health Dan MacMillan, Middlesex County Health Unit
3:25	Farmer's Experience in Manure Handling and Tillage Charles Bolton, Strathroy Area Farmer
4:00	Wrap up

APPENDIX C

COMPUTER PRINTOUTS

COMPUTER PRINTOUT LEGEND

F.c.- fecal coliform
F.s. - fecal *Streptococci*
P.a. - *Pseudomonas aeruginosa*
E.coli - *Escherichia coli*

BOD - Biological Oxygen Demand
SS - Suspended Solids
T. Amm - Total Ammonia
Un. Amm - Unionized Ammonia

T. Pho - Total Phosphorus
S. Pho - Soluble Phosphorus
Cl - Chloride
Cond - Conductivity

PPT - Precipitation accumulated over previous week in mm.
Air Temp - Mean daily air temperature averaged over previous 7 days.

* Data not available
--- No MOE objective set

STATION 1 LOT 9 CONC. IX LOBO TOWNSHIP

Main Branch of the Sydenham River just upstream of Coldstream Reservoir

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	-----	---	0.020	0.50	(10.00)		0.030	---	8.50	---	---	--	---
24/09/87	14	110	260	4	110	0.61	5.2	0.005	0.000	0.38	0.03	1.9	0.023	0.001	8.01	14.00	615	12	15
28/09/87*																		1	14
05/10/87*																		20	11
13/10/87*																		9	7
19/10/87	11	60	52	4	60	1.21	6.2	0.005	0.000	0.51	0.01	2.2	0.022	0.005	7.75	31.20	605	5	10
26/10/87	8	600	508	4	600	0.69	5.0	0.005	0.000	0.72	0.01	3.1	0.029	0.007	7.88	38.28	645	34	5
02/11/87	10	20	30	4	10	0.83	5.0	0.005	0.000	0.55	0.05	9.6	0.029	0.015	8.10	35.48	765	28	6
09/11/87	8	16	64	4	16	0.77	5.0	0.005	0.000	0.48	0.01	3.3	0.025	0.003	7.99	31.70	670	22	7
17/11/87	10	16	64	4	16	0.79	5.0	0.005	0.000	0.51	0.01	5.5	0.018	0.006	7.88	32.39	645	4	6
23/11/87	4	8	344	4	4	1.22	1.4	0.026	0.000	0.32	0.01	3.5	0.033	0.002	7.86	88.75	785	24	1
30/11/87	6	256	600	20	236	0.55	9.8	0.067	0.001	0.96	0.02	14.3	0.086	0.061	7.56	28.47	610	69	4
07/12/87	3	156	48	4	104	0.36	5.0	0.141	0.002	0.67	0.26	12.2	0.045	0.040	7.92	34.60	695	5	-2
14/12/87	4	100	100	8	90	0.18	5.0	0.003	0.000	0.63	0.01	12.3	0.041	0.014	7.89	25.74	645	18	3
05/01/98	0	52	140	4	44	0.73	8.6	0.035	0.000	0.63	0.07	15.6	0.177	0.145	7.94	23.76	710	0	-6
11/01/88	1	130	72	4	90	4.00	124.3	0.073	0.001	1.28	0.06	11.7	0.360	0.151	7.87	39.79	785	1	-8
18/01/88		5000	4100	68	5000	7.52	21.9	0.424	0.002	2.50	0.06	3.0	0.520	0.215	7.69	37.65	416	12	-10
25/01/88	0	10	30	4	10	0.22	5.0	0.014	0.000	0.59	0.02	5.0	0.041	0.024	8.11	23.48	615	5	-13
01/02/88	2	1000	11000	52	600													17	-3
08/02/88	0	40	20	4	20	0.36	5.0	0.028	0.000	0.54	0.02	8.0	0.035	0.022	7.96	25.15	670	13	-12
15/02/88	2	32	36	4	24	0.38	5.0	0.057	0.000	0.49	0.03	6.3	0.034	0.022	7.92	23.53	645	25	-7
22/02/88	1	600	488	4	600	1.43	8.3	0.088	0.001	0.81	0.03	6.3	0.075	0.042	7.75	34.60	605	18	-4
29/02/88		600	140	4	600	1.17	5.0	0.750	0.009	1.49	0.04	6.6	0.121	0.085	7.89	23.05	590	4	-6
07/03/88		590	1700	4	590	2.46	18.3	0.244	0.003	1.44	0.05	4.7	0.172	0.100	7.80	15.57	426	0	-3
11/11/11																			
No. samples	17	20	20	20	20	19	19	19	19	19	19	19	19	19	19	19	19	23	23
GEO MEAN	2	109	177	6	89	0.83	7.8	0.029	0.001	0.71	0.03	5.9	0.057	0.021	7.88	30.05	631	8	-7
AVERAGE	5	470	990	11	441	1.34	13.7	0.104	0.001	0.82	0.04	7.1	0.099	0.051	7.98	32.48	639	16	1
MAXIMUM	14	5000	11000	68	5000	7.52	124.3	0.750	0.009	2.50	0.26	15.6	0.520	0.215	8.11	88.75	785	69	15
MINIMUM	0	8	20	4	4	0.18	5.0	0.003	0.000	0.32	0.01	1.9	0.018	0.001	7.56	14.00	416	0	14
STD DEV	4	1076	2472	17	1072	1.70	26.5	0.183	0.002	0.52	0.05	4.2	0.129	0.060	0.13	15.03	95	16	7

STATION 2 LOT 8 CONC. VIII LOBO TOWNSHIP

Dykstra Drain flowing north into Coldstream Reservoir

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH	Cl	Cond	PPT	Air Temp
Objectives	--	100	140	4	1000	----	---	---	0.020	0.50		(10.00)	0.030	---	6.50 8.50	---	---	--	---
24/09/87*																		12	15
28/09/87	20	660	330	4	660	3.32	44.2	0.005	0.000	0.65	0.01	0.1	0.095	0.014	7.96	43.05	650	1	14
05/10/87	14	170	110	4	170	0.83	9.8	0.005	0.000	0.50	0.02	0.2	0.052	0.004	8.19	31.56	625	20	11
13/10/87	12	10	50	4	10	1.04	5.0	0.005	0.000	0.33	0.01	0.1	0.049	0.024	7.44	53.73	745	9	7
19/10/87*																		5	10
26/10/87	8	600	600	12	600	0.85	5.0	0.005	0.000	0.85	0.10	9,1	0.187	0.120	7.83	62.88	800	34	5
02/11/87	10	50	10	4	50	0.90	6.6	0.018	0.000	0.63	0.09	5.8	0.086	0.060	8.00	53.34	875	28	6
09/11/87	7	52	44	4	52	0.63	5.0	0.005	0.000	0.52	0.01	2.1	0.126	0.057	7.96	41.35	750	22	7
17/11/87	11	24	12	4	24	0.72	3.6	0.005	0.000	0.60	0.04	2.2	0.067	0.039	7.91	48.37	755	4	6
23/11/87	2	24	40	4	8	0.67	3.0	0.023	0.000	0.45	0.01	2.1	0.157	0.120	7.89	45.72	720	24	1
30/11/87	6	600	600	4	600	0.31	2.1	0.016	0.000	0.57	0.04	20.5	0.072	0.051	7.54	44.44	765	69	4
07/12/87	4	100	96	4	100	0.27	5.0	0.126	0.002	0.50	0.27	19.5	0.055	0.051	7.94	48.16	785	5	-2
14/12/87	5	110	60	4	80	0.18	5.0	0.001	0.000	0.51	0.01	23.8	0.045	0.019	7.89	40.53	730	18	3
04/01/88	0	32	24	4	20	0.37	5.0	0.320	0.004	0.53	0.03	7.5	0.039	0.027	7.98	24.90	670	0	-6
11/01/88	1	12	20	4	4	0.61	6.6	0.022	0.000	0.45	0.01	6.6	0.026	0.018	7.88	30.36	705	1	-8
18/01/88		9000	6400	16	9000	6.56	11.0	0.770	0.003	3.80	0.10	3.4	0.590	0.315	7.65	37.07	467	12	-10
25/01/88	1	20	10	4	10	1.22	14.4	0.125	0.002	0.69	0.04	5.8	0.137	0.102	8.07	36.46	665	5	-13
01/02/88	2	750	6200	12	620													17	-3
08/02/88*																		13	-12
15/02/88	2	360	220	4	316	1.20	5.0	0.335	0.004	0.91	0.06	6.9	0.186	0.169	7.79	27.26	471	25	-7
22/02/88	0	1500	600	4	1500	2.36	5.0	0.240	0.001	1.19	0.10	11.6	0.159	0.065	7.66	47.23	670	18	-4
29/02/88		12	104	4	4	0.45	5.0	0.130	0.002	0.76	0.05	10.7	0.110	0.084	7.99	34.34	595	4	-6
07/03/88		112	600	4	88	1.63	3.7	0.260	0.003	1.13	0.05	5.0	0.220	0.032	7.92	24.81	474	0	-3
11l11/11																			
NO. SAMPLES	19	21	21	21	21	19	19	19	19	19	19	19	19	19	19	19	19	23	23
GEO MEAN	3	117	127	5	90	0.84	5.9	0.031	0.001	0.68	0.03	3.6	0.097	0.047	7.87	39.51	670	8	-7
AVERAGE	6	710	801	5	696	1.27	7.9	0.127	0.001	0.82	0.06	7.5	0.129	0.072	7.87	40.82	680	16	1
MAXIMUM	20	9000	6400	16	9000	6.56	44.2	0.770	0.004	3.80	0.27	23.8	0.590	0.315	8.19	62.88	875	69	15
MINIMUM	0	10	10	4	4	0.18	2.1	0.001	0.000	0.33	0.01	0.1	0.026	0.004	7.44	24.81	467	0	14
STD DEV	5	2092	1989	5	2094	1.536	2.991	0.200	0.001	0.81	0.06	6.6	0.132	0.074	0.14	10.46	121	16	7

STATION 3 LOT13 CONC. IX LOBO TOWNSHIP

Sydenham River adjacent to County Road17

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)		0.030	---	6.50 8.50	---	---	--	---
24/09/87	16	1000	110	4	740	0.67	5.0	0.005	0.000	0.45	0.04	2.6	0.014	0.001	8.27	17.49	665	12	15
28/09/87	20	2600	180	4	1500	1.32	7.4	0.005	0.000	0.63	0.03	3.1	0.029	0.001	8.18	23.89	540	1	14
05/10/87	16	430	90	4	320	0.76	6.9	0.005	0.000	0.51	0.03	2.0	0.015	0.033	8.30	30.78	550	20	11
13/10/87	14	70	40	4	60	0.84	5.0	0.005	0.000	0.46	0.03	3.3	0.012	0.006	7.97	32.96	645	9	7
19/10/87	13	60	70	4	60	0.85	3.4	0.005	0.000	0.43	0.01	3.2	0.014	0.003	8.15	28.06	575	5	10
26/10/87	9	600	464	4	600	0.99	6.9	0.005	0.000	0.76	0.02	5.0	0.112	0.085	8.08	54.44	650	34	5
02111/87	11	70	10	4	70	0.83	5.0	0.005	0.000	0.60	0.06	10.6	0.037	0.022	8.23	33.50	775	26	6
09/11/87	8	60	56	4	60	0.63	5.0	0.005	0.000	0.50	0.01	3.3	0.082	0.017	8.17	35.18	680	22	7
17/11/87	11	100	80	4	100	0.56	5.0	0.005	0.000	0.52	0.01	0.1	0.019	0.004	7.95	30.79	645	4	6
23/11J87	3	72	108	4	48	0.58	5.0	0.026	0.000	0.40	0.01	4.1	0.034	0.005	8.04	30.61	655	24	1
30/11/87	6	288	460	4	248	0.39	9.2	0.012	0.000	1.00	0.02	14.9	0.078	0.061	7.66	28.53	645	69	4
07/12/87	2	116	56	4	112	0.34	5.0	0.140	0.002	0.70	0.27	12.9	0.053	0.050	7.99	33.73	715	5	-2
14/12/87	4	80	20	4	40	0.26	7.0	0.001	0.000	0.62	0.01	13.6	0.048	0.022	7.92	25.46	650	18	3
04/01/88	0	.24	12	4	24	0.22	5.1	0.035	0.000	0.59	0.03	7.6	0.075	0.033	8.03	23.16	660	0	-6
11/01/88*																		1	-8
18/01/88		6800	5500	68	6800	6.84	27.8	0.237	0.001	2.35	0.06	3.0	0.530	0.260	7.56	30.11	419	12	-10
25/01/88	2	20	50	4	20	0.02	3.7	0.027	0.000	0.60	0.02	4.9	0.047	0.033	8.12	22.46	630	5	-13
01/02/88	2	1500	10000	32	900													17	-3
08/02/88	0	24	4	4	12	0.36	5.0	0.047	0.001	0.62	0.03	8.2	0.042	0.026	7.82	23.80	665	13	-12
15/02/88*																		25	-7
22/02/88	0	600	600	4	600	1.22	24.2	0.075	0.000	0.84	0.02	6.7	0.097	0.047	7.73	31.45	590	18	-4
29/02/88	0	244	92	4	220	0.82	7.0	0.300	0.004	1.04	0.04	7.0	0.093	0.060	7.95	19.69	575	4	-6
07/03/88		300	650	4	180	1.84	16.3	0.154	0.002	1.02	0.06	5.0	0.133	0.077	7.82	15.26	429	0	-3
11/11/11																			
NO. SAMPLES	19	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	20	23	23
GEO MEAN	3	216	131	5	173	0.61	6.8	0.017	0.000	0.66	0.03	4.4	0.048	0.019	7.99	27.52	612	8	-7
AVERAGE	7	717	886	8	605	1.02	8.2	0.055	0.000	0.73	0.04	6.1	0.078	0.042	8.00	28.57	618	15	1
MAXIMUM	20	6800	10000	68	6800	6.84	27.8	0.300	0.004	2.35	0.27	14.9	0.530	0.260	8.30	54.44	775	69	15
MINIMUM	0.1	20	4	4	12	0.02	3.4	0.001	0.000	0.40	0.01	0.1	0.012	0.001	7.56	15.26	419	0	14
STD DEV	6.32	1490	2340	15	1434	1.40	6.5	0.084	0.001	0.42	0.06	4.0	0.109	0.056	0.20	8.09	84	15	7

STATION 4 LOT 17 CONC. VIII LOBO TOWNSHIP

Bear Creek Drain just upstream of where it is renamed the Sydenham River

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)		0.030	---	8.50	---	---	--	---
24/09/87	17	130	230	4	60	0.50	5.0	0.005	0.000	0.44	0.02	0.1	0.043	0.011	7.98	13.83	715	12	15
28/09/87	20	250	200	4	120	0.77	0.6	0.005	0.001	0.44	0.01	0.1	0.039	0.008	8.49	66.25	595	1	14
05/10/87	15	110	70	4	60	1.01	5.0	0.005	0.000	0.62	0.07	0.8	0.060	0.183	8.39	77.20	650	20	11
13/10/87	12	40	10	4	10	0.70	5.0	0.005	0.000	0.45	0.07	2.7	0.147	0.128	8.33	67.20	715	9	7
19/10/87	13	100	52	4	60	0.55	1.1	0.005	0.000	0.41	0.03	0.7	0.027	0.007	8.12	54.12	635	5	10
26/10/87	9	600	600	16	600	0.77	5.0	0.005	0.000	0.76	0.10	16.0	0.315	0.192	8.12	50.69	730	34	5
02/11/87	10	160	60	4	160	0.44	2.9	0.013	0.001	0.61	0.07	11.3	0.112	0.090	8.25	46.03	795	28	6
09i11/87	8	650	880	8	500	0.76	5.1	0.005	0.000	0.88	0.01	11.2	0.256	0.165	8.26	46.85	715	22	7
17/11/87	11	160	90	4	80	0.74	5.0	0.005	0.000	0.59	0.06	5.3	0.064	0.031	7.91	45.14	690	4	6
23/11/87	2	60	36	4	60	0.98	5.0	0.034	0.000	0.48	0.01	4.2	0.096	0.072	8.09	45.29	680	24	1
30111/87	6	460	590	4	260	0.25	4.5	0.006	0.000	0.90	0.02	16.1	0.070	0.060	7.65	30.54	670	69	4
07/12/87	2	248	92	4	164	0.36	5.0	0.178	0.002	0.63	0.27	14.2	0.096	0.074	7.97	33.85	670	5	-2
14/12/87	5	130	90	4	70	0.17	5.0	0.008	0.000	0.63	0.01	13.3	0.070	0.035	7.92	27.54	655	18	3
04/01/88	0	60	28	4	56	0.34	7.3	0.058	0.001	0.64	0.04	9.0	0.072	0.048	8.00	27.20	685	0	-6
11/01/88	1	92	20	4	80	1.01	9.0	0.151	0.001	0.66	0.03	7.5	0.068	0.054	7.74	33.83	755	1	-8
18/01/88		2300	6300	80	1700	5.92	22.8	0.171	0.001	1.90	0.06	3.6	0.330	0.194	7.50	24.56	408	12	-10
25/01/88	1	50	80	4	10	0.10	7.8	0.186	0.002	0.75	0.03	5.5	0.083	0.066	8.08	27.65	645	5	-13
01/02/88	2	1700	4300	20	600													17	-3
08/02/88	0	348	72	4	228	0.52	5.0	0.114	0.001	0.64	0.04	9.7	0.058	0.045	7.09	27.02	660	13	-12
15/02/88	0	204	164	8	184	0.90	5.0	0.329	0.004	0.88	0.04	6.7	0.093	0.080	7.81	24.65	575	25	-7
22/02/88	0	600	432	4	600	0.48	4.7	0.092	0.000	0.71	0.03	7.5	0.073	0.054	7.62	34.10	610	18	-4
29/02/98		610	112	4	560	0.54	5.0	0.210	0.003	0.87	0.04	8.1	0.079	0.058	7.84	24.14	580	4	-6
07/03/88		50	340	4	20	1.23	10.1	0.069	0.001	0.80	0.08	5.6	0.085	0.047	7.80	18.41	477	0	-3
11/11/11																			
NO.SAMPLES	20	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22	23	23
GEO MEANS	3	183	124	5	118	0.60	4.8	0.027	0.001	0.67	0.04	4.2	0.086	0.056	7.99	35.16	644	8	-7
AVERAGE	7	396	646	9	271	0.87	6.0	0.075	0.001	0.71	0.05	7.2	0.106	0.077	7.99	38.46	650	15	1
MAXIMUM	20	2300	6300	80	1700	5.92	22.8	0.329	0.004	1.90	0.27	16.1	0.330	0.194	8.49	77.20	795	69	15
MINIMUM	0	40	10	4	10	0.10	0.6	0.005	0.000	0.41	0.01	0.1	0.027	0.007	7.58	13.83	408	1	14
STD DEV	6	540	1483	16	367	1.14	4.2	0.090	0.001	0.30	0.05	4.9	0.082	0.057	0.24	16.42	85	15	7

STATION 5 LOT 31 CONC. XI LONDON TOWNSHIP

Bear Creek Drain at County Road16 west of Ilderton

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	----	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---	--	---
24/09/87	14	250	150	4	170	0.18	5.0	0.005	0.000	0.50	0.03	2.3	0.183	0.015	8.01	13.71	805	12	15
28/09/87	18	160	40	4	112	0.45	0.8	0.005	0.001	0.43	0.02	1.6	0.064	0.038	8.54	66.39	740	1	14
05/10/87	13	90	30	4	40	0.34	5.0	0.005	0.000	0.65	0.11	6.7	0.390	0.055	8.24	82.44	780	20	11
13/10/87	10	10	20	4	10	0.38	5.0	0.005	0.000	0.49	0.01	5.8	0.260	0.244	8.22	72.45	810	9	7
19/10/87	12	8	20	4	4	0.69	0.1	0.005	0.000	0.60	2.60	2.9	0.310	0.400	9.38	56.75	665	5	10
26/10/87	8	290	576	20	280	0.42	5.0	0.007	0.000	0.66	0.02	16.4	0.345	0.334	8.12	50.02	755	34	5
02/11/87	10	70	130	4	40	0.34	5.0	0.005	0.000	0.72	0.02	12.5	0.158	0.156	8.24	44.16	840	28	6
09/11/87	8	1500	1500	56	970	0.49	5.0	0.005	0.000	0.69	0.01	14.0	0.270	0.165	8.23	39.51	730	22	7
17/11/87	11	10	40	4	10	0.44	5.0	0.005	0.000	0.55	0.03	7.4	0.133	0.104	7.91	44.96	705	4	6
23/11/87	2	120	160	4	104	1.05	5.0	0.024	0.000	0.45	0.01	5.6	0.260	0.197	8.12	173.60	1050	24	1
30/11/87	6	310	730	4	310	0.30	4.0	0.030	0.000	0.90	0.03	16.4	0.098	0.078	7.67	32.12	655	69	4
07/12/97	3	250	210	4	120	0.33	5.0	0.170	0.002	0.60	0.27	15.9	0.096	0.076	7.97	36.66	690	5	-2
14/12/87	5	160	130	4	110	0.12	5.0	0.012	0.000	0.55	0.01	17.0	0.067	0.055	7.94	30.08	655	18	3
04/01/88	0	00	44	4	80	0.70	8.9	0.154	0.002	0.80	0.04	10.9	0.082	0.065	8.00	29.01	690	0	-6
11/01/98	0	48	4	4	44	1.07	5.0	0.322	0.004	0.76	0.03	8.5	0.081	0.072	7.75	35.72	745	1	-8
18/01/88		4300	4600	76	4300	5.46	19.3	0.019	0.000	1.85	0.05	3.8	0.365	0.160	7.57	31.20	436	12	-10
25/01/88	1	80	50	4	60	0.20	4.5	0.307	0.004	0.86	0.03	6.1	0.112	0.093	8.14	232.10	1230	5	-13
01/02/88	2	210	10400	8	90	0.62	12.5	0.100	0.001	1.35	0.04	12.0	0.110	0.030	7.88	19.36	525	17	-3
08/02/88*																		13	-12
15/02/88*																		25	-7
22/02/98*																		18	-4
29/02/88*																		4	-6
07/03/88		50	140	4	40	1.35	12.9	0.120	0.001	0.89	2.75	6.7	0.107	0.064	7.80	21.06	465	0	-3
11/11/11																			
NO.SAMPLES	17	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	23	23
GEO MEAN	4	121	114	6	91	0.50	4.4	0.021	0.000	0.70	0.05	7.5	0.154	0.093	8.03	44.71	715	8	-7
AVERAGE	7	420	999	12	363	0.79	6.21	0.069	0.001	0.75	0.32	9.2	0.194	0.126	8.04	58.49	735	15	9
MAXIMUM	18	4300	10400	76	4300	5.46	19.3	0.322	0.004	1.85	2.75	18.4	0.390	0.400	8.54	232.10	1230	69	15
MINIMUM	0.1	8	4	4	4	0.12	0.1	0.005	0.000	0.43	0.01	1.6	0.064	0.015	7.57	13.71	436	0	14
STD DEV	5	969	2446	19	952	1.15	4.3	0.099	0.001	0.33	0.81	5.2	0.108	0.102	0.24	53.36	177	15	7

STATION 6 LOT 28 CONC. XII LONDON TOWNSHIP

Upper West Branch of Bear Creek Drain

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	--	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---	--	
24/09/87	14	1600	700	4	800	1.72	14.3	0.060	0.002	0.36	0.05	0.1	0.102	0.025	7.77	11.83	565	12	15
28/09/87	15	320	350	4	150	1.70	41.5	0.100	0.003	0.70	0.02	0.1	0.125	0.019	7.77	5.08	545	1	14
05/10/87	13	360	2200	4	360	2.14	39.7	0.025	0.001	1.60	0.02	0.2	0.550	0.037	7.90	5.92	500	20	11
13/10/87	11	400	18000	4	400	3.66	194.3	0.075	0.000	1.40	0.02	0.1	0.320	0.035	7.71	5.66	555	9	7
19/10/87	11	420	2000	4	300	2.20	93.8	0.005	0.000	0.75	0.04	0.1	0.200	0.001	7.69	7.44	550	5	10
26/10/87	8	1340	1500	16	1340	0.26	3.9	0.005	0.000	0.72	0.04	21.1	0.090	0.072	8.04	20.88	680	34	5
02111/87	11	90	190	4	70	0.35	5.0	0.005	0.000	0.56	0.01	20.3	0.036	0.032	8.18	23.33	775	28	6
09/11/87	8		1500	12	600	0.98	4.0	0.016	0.000	0.72	0.01	17.4	0.210	0.142	8.18	34.83	810	27	7
17/11/87	11	2300	100	4	1900	0.06	5.0	0.005	0.000	0.61	0.02	10.2	0.020	0.009	7.91	22.52	590	4	6
23/11/87	2	1500	1500	8	1100	1.02	4.3	0.034	0.000	0.58	0.01	8.8	0.125	0.060	8.14	23.89	505	24	1
30/11/87	7	120	430	4	110	0.34	0.4	0.001	0.000	0.57	0.01	20.5	0.041	0.033	7.67	32.50	720	69	4
07/12/87	3	40	100	4	40	0.02	5.0	0.120	0.001	0.52	0.26	33.6	0.023	0.019	8.24	34.58	695	5	-2
14/12/87	6	40	30	4	40	0.06	5.0	0.001	0.000	0.53	0.01	22.8	0.025	0.013	8.11	29.46	705	18	3
04/01/88*						0.12	7.1	0.014	0.000	0.76	0.08	23.3	0.050	0.016	8.15	27.63	690	0	-6
11/01/88*																		1	-8
18/01/88		1500	2800	48	1500	3.92	9.4	0.251	0.003	1.85	0.05	5.0	0.475	0.277	7.83	15.39	402	12	-10
25/01/88	1	90	10	4	30	0.01	5.0	0.006	0.000	0.64	0.02	10.4	0.036	0.022	8.52	18.24	610		-13
01/02/88	3	520	8000	24	520	0.27	5.0	0.100	0.001	1.04	0.03	19.1	0.076	0.010	7.87	19.96	585	17	-3
08/02/88*																		13	-12
15/02/88*																			
22/02/88*																		18	-4
29/02/88*																		4	-6
07/03/88		4700	9000	4	3600	10.20	26.4	1.020	0.004	5.00	0.03	4.7	0.740	0.099	7.61	23.74	585	0	-7
11/1I/11																			
NO.SAMPLES	16	17	18	18	18	18	18	18	18	18	18	18	18	18	I8	18	18	23	23
GEO MEAN	6	292	714	6	341	0.47	9.4	0.022	0.000	0.83	0.03	3.8	0.099	0.028	7.96	17.16	606	8	-7
AVERAGE	8	959	2595	538	550	1.61	26.1	0.102	0.001	1.05	0.04	12.1	0.180	0.051	7.97	20.16	615	15	1
MAXIMUM	15	4700	18000	48	3600	3.92	194.7	0.251	0.003	1.85	0.26	33.6	0.550	0.277	8.52	34.83	810	69	15
MINIMUM	1	40	10	4	30	0.01	0.4	0.001	0.000	0.36	0.01	0.1	0.020	0.001	7.61	5.08	402	1	14
STD DEV	4	1170	4491	11	890	2.40	46.5	0.231	0.001	1.03	0.06	10.1	0.203	0.065	0.24	9.60	102	15	7

STATION 7 LOT 26 CONC. XII LONDON TOWNSHIP

Upper East Branch of Bear Creek Drain adjacent to the CN tracks

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---	---	---
24/09/87	13	72000	37000	112	60000	16.30	16.2	7.200	0.194	12.00	0.04	0.1	4.600	3.450	7.76	12.14	1040	12	15
28/09/87	17	3000	200	10	3000	23.50	55.4	9.700	0.262	16.50	0.29	0.4	3.700	2.750	8.14	54.59	1150	1	14
05/10/87	13	129000	10000	232	66000	23.30	11.3	4.500	0.122		0.31	0.4	2.600	1.900	7.97	67.81	1050	20	11
13/10/87	11	43000	1200	570	26000	22.70	24.2	4.900	0.029	10.50	0.02	0.1	4.150	3.250	7.49	87.16	995	9	7
19/10/87	11	84000	100	400	22000	36.30	30.9	6.600	0.039	14.00	0.02	0.1	4.350	3.850	7.47	72.75	1020	5	10
26/10/87	8	200	390	4	200	0.63	5.0	0.011	0.000	0.68	0.01	20.9	0.093	0.060	7.90	28.92	685	34	5
02/11/87	11	1310	40	4	1220	0.54	3.0	0.055	0.001	0.58	0.01	16.7	0.065	0.049	8.10	24.42	760	28	6
09/11/87	9	230	516	4	230	0.24	5.0	0.005	0.000	0.60	0.01	17.0	0.045	0.023	8.13	20.42	665	22	7
17/11/87	12	388	190	4	240	0.77	4.4	0.032	0.001	0.39	0.05	12.8	0.052	0.031	7.89	24.90	630	4	6
23/11/87	3	2300	1500	52	2300	1.59	6.4	0.109	0.001	0.68	0.01	14.3	0.163	0.109	7.91	27.52	635	24	1
30/11/87	7	2000	630	4	2000	0.41	0.8	0.003	0.000	0.60	0.01	16.3	0.063	0.058	7.68	24.18	600	69	4
07/12/87	7	1200	100	4	1200	0.18	5.0	0.136	0.002	0.48	0.26	14.6	0.036	0.040	8.03	24.93	565	5	-2
14/12/87	6	1500	40	12	1500	0.25	5.0	0.011	0.000	0.50	0.01	15.9	0.047	0.045	7.97	22.52	610	18	3
04/01/88	0	320	4	4	60	0.40	5.0	0.028	0.001	0.58	0.03	11.2	0.034	0.014	8.38	17.39	575	0	-6
11/01/88*																		1	-8
18/01/88		85000	3500	28	85000	2.46	8.2	0.040	0.000	1.35	0.04	5.3	0.240	0.170	7.73	12.68	342	12	-10
25/01/88	2	120	80	4	120	0.43	3.8	0.020	0.001	0.74	0.02	7.9	0.054	0.028	8.46	20.62	565	5	-13
01/02/88	3	2300	7300	20	1600	0.57	5.0	0.100	0.001	0.94	0.03	11.1	0.114	0.040	7.77	13.20	469	17	-3
08/02/88	0	600	28	4	600	0.22	5.0	0.036	0.000	0.46	0.02	11.0	0.077	0.042	8.17	17.75	545	13	-12
15/02/88	4					5.64	5.0	0.327	0.001	1.40	0.04	8.4	0.570	0.357	7.70	19.38	495	25	-7
22/02/88	2	1400	92	8	1400	0.65	5.0	0.054	0.001	0.60	0.01	8.4	0.061	0.035	8.01	17.95	505	18	-4
29/02/88		68	8	4	8	0.13	5.0	0.010	0.004	0.49	0.03	9.0	0.033	0.012	8.42	14.90	481	4	-6
07/03/88		1500	1390	8	1500	1.55	13.8	0.094	0.001	1.04	0.03	6.3	0.112	0.064	7.84	11.57	411	0	-3
11/11/11																			
NO.SAMPLES	19	21	21	21	21	22	22	22	22	21	22	22	22	22	22	22	22	23	23
GEO MEAN	4	2178	302	14	1529	1.33	6.8	0.109	0.002	1.17	0.03	4.41	0.187	0.118	7.95	24.18	638	8	-7
MAXIMUM	17	129000	37000	570	85000	36.30	55.4	9.700	0.262	16.50	0.31	20.90	4.600	3.850	8.46	87.16	1150	69	1
MINIMUM	0	68	4	4	8	0.13	0.8	0.003	0.000	0.39	0.01	0.10	0.033	0.012	7.47	11.57	342	1	15
STD DEV	5	37241	8000	146	24630	10.37	12.1	2.872	0.067	5.03	0.09	6.24	1.619	1.288	0.26	20.74	225	15	14

STATION 8 LOT 27 CONC. XIII LONDON TOWNSHIP

Upper West Branch of Bear Creek Drain adjacentto the CN tracks

Date	Water Temp	Bacteria F.c.	F.s.	F.a.	E.coli	BOD	S.S.	Nitrogen T. Amm	Un. Amm	TKN	Nitrite	Nitrate	t. Pho	s. Pho	pH 6.50	Cl	Cond	PPT	Air Temp
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---	--	---
23/11/87	9	12500	25200	52	8700	2.31	58.6	0.057	0.001	1.28	0.16	17.8	0.182	0.070	7.85	32.71	655	24	1
30/11/87	8	90	730	4	80	0.41	1.1	0.002	0.000	0.86	0.01	20.4	0.184	0.029	7.63	28.63	700	69	4
07/12/87	8	300	100	4	1200	0.20	5.0	0.135	0.002	0.74	0.25	19.0	0.042	0.033	7.79	30.81	740	5	-2
14/12/87	7	90	130	4	90	0.25	5.0	0.001	0.000	0.52	0.01	21.4	0.028	0.022	7.86	27.14	705	18	3
04/01/88	3	730	84	4	730	0.03	5.0	0.020	0.000	0.70	0.03	14.6	0.044	0.028	8.21	19.90	665	1	-6
11/01/88*																		1	-8
18/01/88		6500	88000	72	5000	5.08	6.7	0.318	0.003	2.70	0.06	5.4	0.510	0.341	7.68	19.51	438	12	-10
25/01/88	4	340	170	4	310	0.03	5.0	0.027	0.001	0.74	0.02	11.2	0.044	0.038	8.37	19.00	680	5	-13
01/02/88	3	180	14200	20	130	0.44	9.8	0.100	0.000	0.94	0.02	16.5	0.070	0.010	7.65	16.99	570	17	-3
08/02/88	3	44	56	4	28	0.13	5.0	0.022	0.000	0.52	0.02	16.1	0.027	0.023	8.14	19.18	650	13	-12
15/02/88	2	32	600	4	24	0.36	5.0	0.028	0.000	0.80	0.02	15.3	0.060	0.048	7.76	14.07	555	25	-7
22/02/88	3	20	360	4	20	1.96	25.4	0.057	0.001		0.03	15.6	0.063	0.046	7.90	16.94	630	18	-4
29/02/88			80	4		0.04	5.0	0.060	0.001	0.54	0.04	15.1	0.029	0.014	7.78	16.25	615	4	-6
07/03/88		60	1030	4	40	1.68	63.0	0.175	0.001	1.60	0.01	9.7	0.175	0.079	7.49	12.57	457	1	-3
11/11/11																			
NO. SAMPLES	10	12	13	13	12	13	13	13	13	12	13	13	13	13	13	13	13	15	15
GEO. MEAN	5	223	657	7	206	0.33	8.0	0.034	0.001	0.88	0.03	14.5	0.072	0.04	7.87	20.17	613	8	ERR
AVERAGE	5	1741	10057	14	1363	0.99	15.4	0.077	0.001	1.00	0.05	15.2	0.112	0.060	7.87	21.05	620	14	-4
MAXIMUM	9	12500	88000	72	8700	5.0B	63.0	0.318	0.003	2.70	0.25	21.4	0.510	0.341	8.37	32.71	740	69	4
MINIMUM	2	20	56	4	20	0.03	1.1	0.001	0.000	0.52	0.01	5.4	0.027	0.010	7.49	12.57	438	0	-13
STD DEV	2	3685	23645	21	2590	1.40	20.2	0.086	0.001	0.59	0.07	4.2	0.128	0.08	0.24	6.29	89	17	5

SUMMARY OF GEOMETRIC MEANS

	Water	Bacteria				BOD	S.S.	Nitrogen					t. Pho	s. Pho	pH	Cl	Cond
	Temp	F.c.	F.s.	F.a.	E.coli			T. Amm	Un. Amm	TKN	Nitrite	Nitrate			6.50		
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---
Station 1	2	109	177	6	89	0.83	7.8	0.029	0.001	0.71	0.03	5.9	0.057	0.021	7.88	30.05	631
Station 2	3	117	127	5	90	0.84	5.9	0.031	0.001	0.68	0.03	3.6	0.097	0.047	7.87	39.51	670
Station 3	3	216	131	5	173	0.61	6.8	0.017	0.000	0.66	0.03	4.4	0.048	0.019	7.99	27.52	612
Station 4	3	183	124	5	118	0.60	4.8	0.027	0.001	0.67	0.04	4.2	0.086	0.056	7.99	35.16	644
Station 5	4	121	114	6	91	0.50	4.4	0.021	0.000	0.70	0.05	7.5	0.154	0.093	8.03	44.71	715
Station 6	6	292	714	6	341	0.51	9.5	0.022	0.000	0.83	0.02	3.4	0.103	0.028	7.95	16.69	602
Station 7	4	2178	302	14	1529	1.33	6.8	0.109	0.002	1.17	0.03	4.4	0.187	0.11B	7.95	24.18	638
Station 8	5	223	657	7	206	0.33	8.0	0.034	0.001	0.88	0.03	14.5	0.072	0.038	7.87	20.17	613

SUMMARY OF AVERAGES

	Water	Bacteria				BOD	S.S.	Nitrogen					t. Pho	s. Pho	pH	Cl	Cond
	Temp	F.c.	F.s.	F.a.	E.coli			T. Amm	Un. Amm	TKN	Nitrite	Nitrate			6.50		
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50	(10.00)**		0.030	---	8.50	---	---
Station 1	5	470	990	11	441	1.34	13.7	0.104	0.001	0.82	0.04	7.1	0.099	0.051	7.88	32.48	639
Station 2	6	710	807	5	696	1.27	7.9	0.127	0.001	0.82	0.06	7.5	0.129	0.072	7.87	40.82	680
Station 3	7	717	888	8	605	1.02	8.2	0.055	0.000	0.73	0.04	6.1	0.078	0.042	8.00	28.51	618
Station 4	7	396	646	9	271	0.87	6.0	0.075	0.001	0.71	0.05	7.2	0.106	0.077	7.99	38.46	650
Station 5	7	420	999	12	363	0.79	6.2	0.069	0.001	0.75	0.32	9.2	0.184	0.126	8.04	58.49	735
Station 6	8	959	2595	538	550	1.11	26.0	0.048	0.001	0.82	0.04	12.5	0.147	0.048	7.99	19.95	617
Station 7	7	20545	3062	71	13151	6.31	10.4	1.544	0.029	3.10	0.06	9.5	0.966	0.742	7.95	29.08	672
Station 8	5	1741	10057	14	1363	0.99	15.4	0.077	0.001	1.00	0.05	15.2	0.112	0.060	7.87	21.05	620

SUMMARY OF MAXIMUMS

	Water Temp	Bacteria				BOD	S.S.	Nitrogen					t. Pho	s. Pho	pH	Cl	Cond
		F.c.	F.s.	F.a.	E.coli			T. Amm	Un. Amm	TKN	Nitrite	Nitrate			6.50		
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50		(10.00)**	0.030	---	8.50	---	---
Station 1	14	5000	11000	68	5000	7.52	124.3	0.750	0.009	2.50	0.26	15.6	0.520	0.215	8.11	88.75	785
Station 2	20	9000	6400	16	9000	6.56	44.2	0.770	0.004	3.80	0.27	23.8	0.590	0.315	8.19	62.86	875
Station 3	20	6800	10000	68	6800	6.84	27.8	0.300	0.004	2.35	0.27	14.9	0.530	0.260	8.30	54.44	775
Station 4	20	2300	6300	80	1700	5.92	22.8	0.329	0.004	1.90	0.27	16.1	0.330	0.194	8.49	77.20	795
Station 5	18	4300	10400	76	4300	5.46	19.3	0.322	0.004	1.85	2.75	18.4	0.390	0.400	8.54	232.10	1230
Station 6	15	4700	18000	48	3600	3.92	194.3	0.251	0.003	1.85	0.26	33.6	0.550	0.277	8.52	34.83	810
Station 7	17	129000	37000	570	85000	36.30	55.4	9.700	0.262	16.50	0.31	20.9	4.600	3.850	8.46	87.16	1150
Station 8	9	12500	88000	72	8700	2.31	58.6	0.135	0.003	1.28	0.25	21.4	0.184	0.070	8.21	32.71	740

SUMMARY OF MINIMUMS

	Water Temp	Bacteria				BOD	S.S.	Nitrogen					t. Pho	s. Pho	pH	Cl	Cond
		F.c.	F.s.	F.a.	E.coli			T. Amm	Un. Amm	TKN	Nitrite	Nitrate			6.50		
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50		(10.00)**	0.030	---	8.50	---	---
Station 1	0	8	20	4	4	0.18	5.0	0.003	0.000	0.32	0.01	1.90	0.01B	0.001	7.56	14.00	416
Station 2	0	10	10	4	4	0.18	2.1	0.001	0.000	0.33	0.01	0.10	0.026	0.004	7.44	24.81	467
Station 3	0	20	4	4	12	0.02	3.4	0.001	0.000	0.40	0.01	0.10	0.012	0.001	7.56	15.26	419
Station 4	0	40	10	4	10	0.10	0.6	0.005	0.000	0.41	0.01	0.10	0.027	0.007	7.58	13.83	408
Station 5	0	8	4	4	4	0.12	0.1	0.005	0.000	0.43	0.01	1.60	0.064	0.015	7.57	13.71	436
Station 6	0	40	10	4	30	0.01	0.4	0.001	0.000	0.36	0.01	0.10	0.020	0.001	7.61	5.08	402
Station 7	0	68	4	4	8	0.13	0.8	0.003	0.000	0.39	0.01	0.10	0.033	0.012	7.47	11.57	342
Station 8	2	20	56	4	20	0.03	1.1	0.001	0.000	0.52	0.01	5.40	0.027	0.010	7.49	12.57	438

SUMMARY OF STANDARD DEVIATIONS

	Water Temp	Bacteria				BOD	S.S.	Nitrogen					t. Pho	s. Pho	pH	Cl	Cond
		F.c.	F.s.	F.a.	E.coli			T. Amm	Un. Amm	TKN	Nitrite	Nitrate			6.50		
Objectives	--	100	100	4	1000	----	---	---	0.020	0.50		(10.00)**	0.030	---	8.50	---	---
Station 1	4	1076	2472	17	1072	1.70	26.5	0.183	0.002	0.52	0.05	4.17	0.129	0.060	0.13	15.03	95
Station 2	5	2092	1989	5	2094	1.54	3.0	0.200	0.001	0.81	0.06	6.56	0.132	0.074	0.14	10.46	121
Station 3	6	1490	2340	15	1434	1.40	6.5	0.084	0.001	0.42	0.06	4.02	0.109	0.056	0.20	8.09	84
Station 4	6	540	1483	16	367	1.14	4.2	0.090	0.001	0.30	0.05	4.87	0.082	0.057	0.24	16.42	85
Station 5	5	969	2446	19	952	1.15	4.3	0.099	0.001	0.33	0.81	5.19	0.108	0.102	0.24	53.36	177
Station 6	4	1170	4491	11	890	2.40	46.5	0.231	0.001	1.03	0.06	10.11	0.203	0.065	0.24	9.60	102
Station 7	5	37241	8000	146	24630	10.37	12.1	2.872	0.067	5.03	0.09	6.24	1.619	1.288	0.26	20.74	225
Station 8	2	3685	23645	21	2590	1.40	20.2	0.086	0.001	0.59	0.07	4.22	0.128	0.083	0.24	6.29	89

EXTRA DATA (see below for corresponding locations and attached map

		- - - - - - - Bacteria - - - - - - -						- - - - - - - - - - - - - Nitrogen - - - - - - - - -							pH		
Date	Site	F. c.	F.s.	P.a.	E. Coli	BOD	S.S.	T.Amm	Un.Amm	TKN	Nitrite	Nitrate	t.Pho	s.Pho	6.50	Cl	Cond
		100	100	4	1000	----	---	---	0.020	0.50	(10.00)**		0.030	---	8.50		---
10/11/87	A					0.70	14.9	0.200	0.004	0.45	0.02	0.10	0.042	0.015	7.88	87.78	730
17/11/87	A	4	40	4	4	0.83	15.3	1.120	0.007	1.92	0.01	0.10	0.122	0.003	7.46	163.50	1165
20/01/88	B	200	1600	4	100	2.96	29.1	0.100	0.000	1.15	0.06	5.50	0.150	0.050	7.67	10.35	319
07/12/87	B	4	128	4	4	0.06	5.0	0.120	0.002	0.64	0.24	16.30	0.101	0.002	7.75	22.38	585
29/11/87	B+C					1.12	2.4	0.005	0.000	0.65	0.01	22.70	0.156	0.015	7.69	18.72	680
20/01/88	C	100	3300	10	100	2.14	17.9	0.100	0.000	1.20	0.04	5.90	0.200	0.100	7.57	10.74	380
01/12/87	D-up	470	220	4	470	0.2B	0.8	0.006	0.000	0.58	0.01	16.30	0.058	0.005	7.81	23.84	590
01/12/87	D-ENT	230	140	4	220	0.23	0.1	0.001	0.000	0.38	0.01	62.00	0.061	0.045	7.53	71.05	1110
01/12/87	D-EXT	90	60	4	90	0.23	2.8	0.033	0.000	0.52	0.07	53.00	0.059	0.054	7.82	62.98	1030
07/12/87	D	52	12	4	52	0.38	5.0	0.130	0.002	1.00	0.30	19.00	0.042	0.012	7.88	68.43	1000
22/12/87	E-UP	310	380	4	300	0.56	5.0	0.100	0.000	0.65	0.01	11.00	0.070	0.050	7.66	15.65	492
22/12/87	E-DOW	300	410	4	300	0.66	5.0	0.100	0.000	0.65	0.02	10.40	0.080	0.070	7.67	16.15	483
22/12/87	E	7200	2800	48	5800	19.80	5.0	0.100	0.000	2.15	0.39	19.40	0.430	0.100	7.44	48.94	1045
06/01/88	E	55900	640	4	45400	7.72	5.0	5.100	0.062	7.20	0.25	28.00	1.160	0.990	8.11	42.92	985
18/01/88	E	560000	200	28	520000	1.35	40.3	9.500	0.037	18.00	0.16	15.80	2.900	1.470	7.74	42.29	985
16/11/87	F	4	4	4	4	0.01	5.0	0.100	0.001	0.10	0.03	2.40	0.004	0.002	7.84	7.89	520
24/11/87	G	112	1500	4	08	1.00	5.0	0.019	0.000	0.69	0.01	15.60	0.089	0.059	7.82	25.45	575
14/12/87	H	10	10	4	10	0.01	5.0	0.001	0.000	0.45	0.01	11.00	0.015	0.002	7.87	15.80	540
24/11/87	I	62000	6600	600	61000	12.00	22.8	0.040	0.000	3.00	0.01	13.60	0.610	0.198	7.72	83.95	905
14/12/87	1	8600	720	102	7600	7.52	3.5			3.04	0.64	11.40	0.450	0.158	7.69	74.73	860
24/11/87	J	76	630	44	88	0.40	5.0	0.040	0.001	0.46	0.01	28.00	0.033	0.007	7.81	69.84	825
19/11/87	K	4	12	2	4	0.44	1.7	0.032	0.000	0.39	0.01	17.10	0.053	0.036	7.89	36.42	765
19/11/87	L	224	208	2	208	0.87	5.0	0.007	0.000	0.49	0.01	5.40	0.480	0.396	8.11	31.32	775
14/12/87	L					0.53	5.0	0.034	0.000	0.59	0.09	12.00	0.110	0.100	7.88	36.73	680
10/11/87	N	10	180	4	10	0.46	5.0	0.200	0.002	0.50	0.02	0.30	0.130	0.056	8.09	215.70	1110
10/11/87	N	20	240	4	20	0.69	69.2	0.200	0.001	1.00	0.02	3.80	0.370	0.240	7.74	222.60	1320
27/11/87	O					2.40	7.5	0.037	0.000	1.70	0.01	0.10	0.230	0.001	7.70	3.18	302
14/12/87	O	10	10	4	10	2.40	4.5	0.134	0.002	1.35	0.01	0.10	0.100	0.024	8.00	2.93	323
01/12/87	P	60	200	4	60	0.15	0.9	0.003	0.000	0.54	0.01	7.60	0.026	0.024	7.82	15.15	530
02/12/87	O	270	380	4	200	0.36	5.0	0.010	0.000	1.02	0.01	14.80	0.042	0.039	7.82	23.61	670
01/12/87	R	1090000	17000	164	1030000	33.20	20.5	5.200	0.020	10.20	0.01	0.10	1.900	1.010	7.56	163.00	1125
06/01/88	R	1400000	150000	32	1400000	290.00	556.7	10.800	0.042	40.00	0.02	0.20	12.000	3.040	7.54	244.80	
01/12/87	S	230	120	4	220	0.60	0.9	0.001	0.001	1.04	0.03	14.80	0.088	0.037	7.78	27.04	670
02/12/87	T	1900	2100	4	1800	0.48	389.8	0.002	0.000	2.60	0.04	14.50	0.720	0.037	7.47	9.41	575
06/01/88	T	4	20	4	4	0.31	6.0	0.100	0.001	0.45	0.01	12.00	0.030	0.020	8.07	8.38	615
14/12/87	U	50	80	4	40	0.01	5.0	0.002	0.000	0.61	0.01	12.50	0.047	0.043	7.93	22.65	615
20/01/88	U	1060	2200	12	790	2.54	6.6	0.100	0.001	1.20	0.04	3.50	0.160	0.070	7.85	17.79	478
06/01/88	V	96	72	4	24	0.06	4.0	0.100	0.000	0.50	0.02	7.70	0.040	0.300	7.93	23.33	585
20/01/88	V	500	1300	10	500	3.30	7.5	0.100	0.000	1.35	0.04	2.90	0.170	0.080	7.64	31.68	414
06/01/88	W	600	264	4	600	0.66	5.0	0.300	0.004	0.95	0.08	13.30	0.200	0.140	8.10	35.88	715
20/01/88	W	5500	16000	20	3900	8.80	1.8	0.600	0.002	3.05	0.14	7.00	0.450	0.210	7.62	49.00	610
06/01/88	X	200	24	4	92	0.13	6.4	0.100	0.001	0.65	0.03	7.50	0.030	0.020	8.00	29.77	705
20/01/88	X	1210	1500	4	L210	2.59	7.0	0.100	0.001	1.15	0.03	4.60	0.140	0.070	7.82	23.50	545
20/01/88	Y	10	350	4	10	0.77	5.8	0.020	0.000	0.44	0.02	6.20	0.035	0.019	7.59	21.95	605

EXTRA DATA - LOCATIONS AND DESCRIPTION

LETTER	LOT	CONC	TOWNSHIP	DESCRIPTION
A	25	XII	LONDON	catch basin at road intersection upstream of Stn 7
B	25	XII	LONDON	Ashworth Bloomfield Drainage Works (Br. 1-6) outflow into NE branch of Bear Creek Drain upstream of Stn7
C	25	XII	LONDON	Ashworth Bloomfield Drainage Works (Br.7-11) outflow into NE branch of Bear Creek Drain upstream of Stn7
D	25	XII	LONDON	pond draining into Bear Creek Drain, upstream of Station 7
E	25	XII	LONDON	tile outlet just upstream of Station 7,bad quality, probable source house and/or barn
F	26	XI	LONDON	tile outlet along NW branch of Bear Creek Drain, downstream of Station 6
G	25	XI	LONDON	Ilderton Drain, NE branch, tile outlet source
H	26	XI	LONDON	Ilderton Drain, NE branch, adjacent to CN Railway Tracks, downstream of #i7
I	26	XI	LONDON	Ilderton Storm Sewer Outlet
J	27	XI	LONDON	Ilderton Drain, tile outlet
K	28	XI	LONDON	Ilderton Drain, tile outlet
L	28	XI	LONDON	Ilderton Drain just before it meets Bear Creek Drain
M	29	XII	LONDON	Gysber Works Drain, outlet along Denfield Road
N	29	XII	LONDON	McIntyre Drain, headwaters, catches inflow from #N13 as well
O	29	XI	LONDON	natural pond in wooded area, drains into Bear Creek Drain upstream of Station5
P	28	X	LONDON	Bear Creek Drain, NE branch of Br 2, water exiting from the Heronry Swamp
O	30	X	LONDON	Bear Creek Drain, SE branch of Br 2downstream of the outlets of Olson Drain and Br.3A + 3B of Bear Cr. Dr.
R	31	X	LONDON	black puddle draining into Br.2 of Bear Creek Drain, probable source house and barn
S	32	X	LONDON	Bear Creek Drain just down stream of Station 5
T	32	X	LONDON	tile outlet next to big new house and barn along the London-Lobo Townline Road
U	16	VII	LOBO	Taylor Drain just before it meets Sydenham River
V	8	VII	LOBO	Colvin Drain SW branch, outflow from tiles
W	9	VII	LOBO	Colvin Drain NE branch, just downstream of outlets from Tr. 1, 3, 4 and Govers Drain
X	9	IX	LOBO	Bycraft Drain just before it meets Sydenham River at Station1
Y	9	IX	LOBO	Stevenson Drain just before it reaches Sydenham River at Station 1