

**STREAM ASSESSMENT  
STECKLY DRAIN  
J. ROE FARM  
E. WILSON FARM  
R. WILSON FARM**



LOT 5-8, CONCESSION 5  
MORNINGTON TWP., PERTH CTY.  
UPPER NITH RIVER  
Grand River Conservation Authority

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## 1. INTRODUCTION

Non-point source pollution, specifically agriculture, is one of the main causes of surface water quality problems in southern Ontario (Terrell and Perfetti, 1988). A surplus of sediment, nutrients, organic matter, and micro-organisms can be types of agricultural pollution (So and Singer, 1982a; Terrell and Perfetti, 1988).

Sediment is among the most easily recognized of non-point pollution sources, with cropland erosion accounting for approximately 40 to 50 percent of river sedimentation and stream bank erosion accounting for another 26 percent of sediment to surface waters (Terrell and Perfetti, 1988).

The increased loads of sediment and dissolved substances to streams, rivers and lakes, via erosion and runoff is detrimental to aquatic life and increases the costs of maintaining reservoirs, channels and drinking water. Sediments can also carry loads of phosphorus, heavy metals, pesticides and other organic compounds that have the potential to cause further problems in water bodies.

Water quality degradation resulting from erosion is considered to be of two types: that of local significance and that having an impact on distant water downstream. During the erosion process, the finer soil particles are more likely to become suspended and carried further than coarser particles. Fine, suspended particles tend to remain suspended as long as water is moving and turbulent. The transport of pollutants, such as phosphorus, with fine sediment can have serious detrimental effects on the health of downstream reservoirs (Robinson and Miller, 1978). In addition, sedimentation in surface waters alters stream flow and influences the aquatic organisms living in the water body.

Pollutants associated with coarse particles most often result in localized problems (Robinson and Miller, 1978). Nutrients associated with larger soil particles may become dissolved in water. Dissolved nutrients are readily available for the growth of photosynthetic organisms or for absorption into the food chain by aquatic invertebrates.

It has been well documented that cattle with unrestricted access to streams also have several impacts on watercourses which leads to agricultural pollution (Ryan, 1982; Doran et al, 1981; Shelton and Lessman, 1978; and Semple, 1970). Grazing near stream banks reduces vegetative cover. Providing sediment, associated nutrients and bacteria with a

direct route to the stream. Grazing often occurs directly on the stream banks, reducing vegetative cover, which results in stream bank erosion and related sedimentation. So and Singer (1982b) report that restricting cattle access from a watercourse will reduce sedimentation of a stream by 10 percent. Cattle that have direct access to the stream channel disturb the channel bottom sediment, increasing downstream sedimentation and turbidity, smothering stream bottom life and increasing the frequency of drain clean-out. In addition, cattle activity in the stream includes defecation and urination. Cattle waste-products introduce nutrients and bacteria into the stream promoting excessive aquatic plant growth, which reduces dissolved oxygen (DO) levels and impairs fish habitat. In addition, the bacterial contamination of the watercourse can present livestock and human health risks downstream of the point of impact.

Biological determinants are being increasingly used by scientists as a measure of water quality rather than chemical determinants (Sandilands, 1971). Aquatic invertebrates are very sensitive to both physical and chemical changes in their habitat. Biological assessment methods are often capable of detecting minute gradual changes that chemical assessments would not demonstrate (Barton *et al*, 1994; Sandilands, 1971).

Benthic macrofauna provides a good indication of pollution sources because they exhibit a response to pollution, have a sufficiently long life cycle to prevent a response to intermittent relief from pollution, and have either a mean of locomotion that prohibits extended rapid migrations or a sessile-attached mode of life that reduces the influence of neighboring water conditions on the organisms (Terrell and Perfetti, 1988). There is a reduction in abundance of sensitive benthic macrofauna when pollution occurs. Species (beginning with the most sensitive organisms) elimination occurs as pollution concentration increases, until no macrofauna exists.

Microorganisms utilize extensive amounts of oxygen in order to assimilate the organic matter associated with coarse soil and the increased biomass created by nutrient enrichment. A study by Barton *et al* (1994) has indicated that small agricultural streams in southern Ontario have a high biodiversity of benthic invertebrates. The benthic communities are responsive to soil, pesticide, fertilizer, and other organic material inputs. Invertebrates are especially affected by stream nutrient loading. High levels of nutrients, specifically nitrogen and phosphorous, result in the excessive growth of photosynthetic organisms (i.e., phytoplankton blooms).

Increased plant biomass promotes the increase of particular types of invertebrate

organisms, specifically those that feed largely on photosynthetic organisms. When the increased plant biomass dies, microorganisms assimilate the material. This process requires the utilization of oxygen dissolved in the stream. There is a reduction in dissolved oxygen (DO) reservoirs if this process occurs on a large scale. Oxygen can limit the presence and distribution of organisms (e.g., caddisfly larvae require high levels of oxygen compared to midge larvae). Therefore, reduced DO levels will allow tolerant organisms to flourish and result in an absence of intolerant organisms, which require high DO conditions (Terrell and Perfetti, 1988). Organisms that exhibit a rapid response to aquatic environmental changes and are killed, driven out of the area, or as a group are substantially reduced in number when their environment is degraded are considered intolerant organisms. Tolerant organisms are capable of withstanding adverse conditions within the aquatic environment (Terrell and Perfetti, 1988).

Most intolerant or sensitive invertebrates that reside in high quality water prefer cobble stone bottoms and medium flows. Sedimentation that occurs due to erosion will alter the stream bed. With the addition of sediment, the stream bed becomes silted, and stream flow changed. In clean streams, the quality and quantity of organisms is different from degraded watercourses. Intolerant organisms, such as caddisfly larvae (Trichoptera), have a better chance of survival in high quality water. There is also a high diversity in the types of organisms (richness) with a low number of individuals belonging to each taxa present (abundance). The opposite is true for degraded streams. Therefore, this study will use aquatic invertebrates as a gauge of stream quality, and provide a database in order to monitor the improving health of the Steckly Drain as best management practices take effect.

## **2. STUDY AREA**

The drain traverses three farms; Reid Wilson's, Earl Wilson's, and John Roe's. The farms (Lot 6 -8) are located approximately 1 kilometer north of the village Milverton at the junction of King's Highway No. 19 and concession 5, in Mornington Township, Perth County (Appendix 1). The watercourse traversing the property is the Steckly Municipal Drain. The drain meets with the Smith Creek less than 1 kilometer downstream of John Roe's farm. Therefore, the drain could potentially have a negative impact on the water quality of the Nith River. Smith Creek has also been identified as having suitable spawning and rearing habitat for Walleye. Therefore, improving water quality will enhance the fisheries potential of the creek.

### **3. BACKGROUND**

#### **3.1 Reid Wilson Property (Lot 6, Concession 5, Mornington Twp.)**

The GRCA, Perth County Soil and Crop Improvement Association, Mornington Township and the landowner established a demonstration site to promote the National Soil Conservation Program. The site is conventionally tilled, with approximately 88 acres of corn on the north bank, and a combination of mixed grains (approximately 20 acres) and corn (approximately 87 acres) on the south bank of the drain. The purpose of the demonstration site is to illustrate the effectiveness of an enhanced buffer in controlling soil erosion along a municipal drain.

A vegetated buffer was established to reduce the amount of erosion occurring from the field. Buffers are also known to act as sediment traps, catching soil in the runoff. If the amount of soil reaching the watercourse is reduced, there will be fewer expenditures on drain clean-out and improvements to downstream water quality (the Nith River).

Nutrients are also removed with the sediment because they are attached to soil particles. Therefore, through the removal of sediments and nutrient uptake by vegetation, a buffer strip can reduce the amount of nitrogen and phosphorous entering a watercourse. A vegetative buffer also provides a physical barrier keeping equipment and field activities away from the watercourse (GRCA and Wellington County Soil and Crop Improvement Association, 1991).

In the Spring of 1991, the GRCA planted an enhanced buffer of trees and grasses. The buffer strip is about 40 feet wide with the drain in the center. Trees (White Cedar and White Spruce) and shrubs (multi-flora rose and Russian olive) have been planted on the south side of the drain into a 20 foot grass buffer. The north bank was seeded down to a 10 foot grass buffer. The buffer extends the entire length of the field (2335 feet), retiring 1.6 acres of production. The drain was cleaned out in October 1993, removing all of the stream bed and associated organisms.

#### **3.2 Earl Wilson Property (Lot 7, Concession 5, Mornington Twp.)**

In cooperation with the Clean-Up Rural Beaches (CURB) Program, Earl Wilson installed manure runoff storage and tank in the summer of 1994. Currently, CURB representatives are encouraging Mr. Wilson to restrict livestock access to the watercourse.

The site (approximately 200 acres) has a combination of pastured land and field crops. The downstream end of the property undergoes rotational grazing of 70 beef cows for 45 acres on the south bank and 53 acres on the north bank. Approximately 25 acres of the pasture has been harvested for hay. Upstream of the pasture there is 27 acres of corn on the north bank and 25 acres of hay on the south bank (adjacent to Lot 8). West of the 25 acres of hay there is 15 acres of hay on the south bank.

Improperly handled manure can pollute water. Potential pollutants from manure include: bacteria, nitrogen and phosphorous, and the related increased algae growth; manure odors; and dangerously high concentrations of methane and hydrogen sulfide (Arnold *et al*, nd.). These pollutants can be introduced to a watercourse in a variety of ways: runoff from solid manure storage areas, feedlots, and barnyards; manure spreading practices; cattle access to streams; and milkhouse waste water disposal (Fuller and Fleming, 1990).

Proper manure storage can aid in the reduction of water contamination by containing or eliminating run-off (Arnold *et al*, nd.). Runoff to streams is usually caused by direct precipitation on to the storage or feedlot. The runoff is transported to the stream by overland flow, through a channel, or through an improperly located drainage tile (Fuller and Fleming, 1990).

### **3.3 John Roe Property (Lot 8, Concession 5, Mornington Twp.)**

In cooperation with the CURB Program, John Roe installed approximately 2,800 feet of three strand, high tensile fence in order to restrict livestock access to Steckly Drain. The fence was installed in 1993, with a setback from the stream of about 1.8 to 3 m. During the summer of 1993, the CURB committee approved funding for Mr. Roe to install proper solid manure storage. To date, the manure storage has not been installed.

The site (approximately 100 acres) has a combination of pastured land and crop fields. The south side of the property undergoes rotational grazing of 68 beef cows for 15 acres on the south bank and 15 acres on the north bank. The northeastern section of the farm is a 20 acre lightly pastured field. The northwestern portion of the property is a 20 acre hay field.

It is important to restrict cattle access to the stream because recent studies have identified this practice as a significant source of water pollution. Cattle access can cause: bacterial contamination; increased phosphorous and nitrogen concentrations that can cause nuisance algae growth; increased erosion (through cattle trampling stream banks); stream

bank instability; increased sedimentation; and loss of aquatic habitat. A single cow can input up to 500,000 fecal bacteria to a stream each day (unhealthy conditions occur at 100 fecal bacteria per 100 ml). Through the removal of livestock from a watercourse, all related problems are removed. Water quality is subsequently improved and the possibility of diseases (Leptospirosis, Salmonellosis, and Bovine Virus Diarrhea) being spread through contaminated water are reduced (Briggs and Merkley, 1990).

#### **4. PURPOSE**

A stream assessment was performed on the Steckly Drain, Lots 6 - 8, Concession 5, Mornington Township (Appendix 1), through the CURB program. The purpose of the assessment was to collect, identify, and create an inventory of stream invertebrates. Once data was collected, it was analyzed to determine the relative health of the stream. Physical stream conditions were documented along with bank vegetation to compliment the stream invertebrate analysis. Data will be used in the future for: reference, comparison, and to determine the benefits of soil and water conservation practices and measures (such as the buffer strip) on the quality of water in the Upper Nith watershed.

#### **5. PROCEDURE**

Thirty-five stations were selected on the basis of total stream representation and potential impacts to stream health (e.g., tiles, erosion areas, wetlands, treed buffers). The thirty-five stations were visited from, June 9, 1994, to June 28, 1994. Weather varied from warm, to hot and sunny, to overcast. Sites selected are shown in Appendix 1.

For point sources, samples were taken upstream and downstream of the point of discharge or change. Differences in richness (Appendix 2), diversity (using a biotic index -- Appendix 3), physical parameters (Appendix 4), and total abundance (Appendix 5) were calculated for each station. The sampling methodology was designed to reflect average stream conditions as well as event-related discharges.

Samples were obtained with a square, 3 cm width, 1 mm mesh dip net. The bottom and sides of approximately 1m by 1m of the stream bed were swept with the net. The net was placed upright in the sampling station. The stream bottom upstream of the net was disturbed to dislodge any organisms located there. Dislodged macrofauna were carried by

the stream current into the net. Several rocks along the sampling location were overturned in order to collect clinging organisms. Sediment, water and aquatic organisms collected in each sweep were placed in an observation dish and macrofauna was identified, and classed according to Beck's Biotic Index (Terrell and Perfetti, 1988) and counted after being separated from sediment and debris. This procedure was repeated until each station area had been completely sampled.

In addition to recording the data obtained on aquatic invertebrates, water sampling was performed (Appendix 6), and physical stream conditions and stream bank vegetation recorded using Save Our Streams, Stream Quality Surveys<sup>1</sup> (Appendix 4).

Water quality analysis was conducted upstream and downstream of the cattle access on Earl Wilson's property and downstream of John Roe's property for June to August. Water samples were tested for: conductivity, pH, chloride, turbidity, total phosphorous, phosphates, total kjeldahl nitrogen, ammonium, nitrates, nitrites, dissolved organic carbon, *fecal streptococcus*, *Pseudomonas aeruginosa*, *Escherichia Coll*, and *fecal coliforms*.

Physical stream conditions involved recording water velocity, stream depth, stream width, temperature, and visual and olfactory observations regarding stream bed, stream bank, and water surface conditions. The Save Our Streams, Stream Quality Survey (see Appendix 4) was used to record physical data.

The floating body technique was used to measure water velocity (Terrell and Perfetti, 1988). At each station, a distance of 1m was measured. A marker (an orange) was tossed into the stream above the initial point and then timed to for a distance of 1 m. The process was repeated several times to ensure accuracy. Velocity was calculated as distance divided by time. A metre stick was used to measure the stream depth at each sample point. Metric tape was used to measure stream width at each sample station. Stream temperature was recorded at each station with an alcohol thermometer ( $\pm 1$  degree accuracy), which was placed at the bottom of the stream bed for sixty (60) seconds.

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<sup>1</sup> The stream quality surveys were provided by Defenders of Soil, Air, Woods, Waters, and Wildlife, Izaak Walton League of America, SOS Program.

Inventories of stream bank vegetation were performed at each station as well as between each station. R.T. Peterson's Wildflower Guide and the OMAF Handbook of Weeds were used to aid in plant identification (Appendix 7). Transects (approximately 1m width) were taken of each station. Each transect was about 10m in length (from the edge of the water) and perpendicular to the watercourse.

## **5.1 Stream Richness and Abundance**

Stream richness and abundance can be used to make generalizations about water quality in a stream. Stream richness is a measure of the diversity in types (taxa) of organisms living in the stream and stream abundance is a measure of the number of individuals in each taxa. The abundance and species composition of bottom organisms change with eutrophic conditions. In a pristine aquatic environment, there is a high diversity of bottom-dwelling organisms, but the abundance of each taxa is low (Terrell and Perfetti, 1988; Barton, et al, 1994; Sandilands, 1971). Populations of sensitive or intolerant species, such as mayflies, stoneflies, caddisflies, water-penny, and riffle beetles diminish with increased eutrophication. These species are replaced by more tolerant species. The trend is that as nutrients increase over time, the number of species (species diversity or richness) decreases, while the population growth of a few species increases. Therefore, it can be generalized that a large number of taxa, high richness, and proportionately low abundance of individuals in each taxa, indicates high quality water (Terrell and Perfetti, 1988). In addition, richness and abundance are amenable to simple statistical analysis, such as t-tests, which provide an easy method of future comparisons.

## **5.2 Beck's Biotic Index**

The Beck's Biotic index can be used to indicate both the magnitude and probable cause of an environmental stress. Stream macroinvertebrates are categorized as Class 1 (sensitive or intolerant)<sup>2</sup>, Class 2 (Facultative)<sup>3</sup> or Class 3 (Tolerant)<sup>4</sup>. An undisturbed community will consist mainly of representatives from Class 1, with some members from Class 2 and 3 (this does not account for naturally occurring limitations). Stations with the majority of

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<sup>2</sup> Organisms that exhibit a rapid response to aquatic environmental changes and are killed, driven out of the area, or as a group are substantially reduced in number when their environment is degraded.

<sup>3</sup> Organisms that have the capability to live under varying conditions of water quality.

<sup>4</sup> Organisms capable of withstanding adverse conditions within the aquatic environment.

representatives being Class 2 are considered impacted by either natural or human activities. If Class 3 organisms dominate the station, waters are likely adversely affected by organic pollution.

Mathematical calculation for Beck's Biotic Index (B.I.)

$$\text{B.I.} = 2n_1 + n_2$$

where:  $n_1$  = the number of Class 1 species identified from the samples  
 $n_2$  = the number of Class 2 species identified from the samples

B.I. Values are: 0 - 1 = grossly polluted  
2 - 6 = moderately polluted  
7 - 10 = stream clean but monotonous habitat and velocity  
+ 10 = stream clean

## 6. RESULTS

In the Steckly Drain, sixteen taxa were identified. Most of the organisms identified were Haptotaxida (1321 individuals), Ephemeroptera (471 individuals), Coleoptera (325 individuals), Hemiptera (296 individuals), Amphipoda (216 individuals), *Chironomidae* (187 individuals), and Pharyngobdellida (166 individuals). All of the actual taxa found for each station or richness is located in Appendix 2.

The dominant Beck's Biotic Index class rating was Class 3 organisms, followed by Class 2 organisms. The highest Beck's Biotic Index value attained, was fourteen at station nineteen. Two stations were ranked grossly polluted. Ten stations were ranked moderately polluted. Nineteen stations were ranked clean but monotonous habitat and velocity. Four stations were considered to have clean water. The index demonstrated an upward trend from the upstream to downstream portion. Graphs demonstrating Beck's Biotic Index, for each station on the Steckly Drain, are found in Appendix 3.

Data regarding physical parameters and the Save Our Streams, Stream Quality Surveys are in Appendix 4. The average stream width was 2.4 m and the average stream depth was 0.16 m. The average water temperature was 22 degrees Celsius, with a minimum of 16 degrees Celsius and a maximum of 28 degrees Celsius. The Save Our Streams, Stream Quality Survey ranked the Steckly Drain as having overall fair water quality. Scattered

individuals of fish were found at twelve stations and scattered schools at 1 station. There were no barriers to fish movement. The most consistent water surface appearance was brownish or clear, with a couple of sites being milky or muddy. The stream bed bottom deposit was brown, with a large portion of silt and sand. The stream bed experienced instability<sup>5</sup> in a few spots at nineteen sites, and stability at sixteen sites. The stream bed in the Steckly Drain is dominated by gravel, ensued by sand, silt, and cobble consecutively. Algae were seen at every site, with hairy or filamentous algae<sup>6</sup> being the most commonly observed. Almost every site had good bank cover (>70 percent cover) by plants, rocks, and logs. The dominant stream bank vegetation composition was grasses. There are twenty tiles or drains inputting into the section of the Steckly drain flowing through Lot 6-8, Concession 5, Mornington Township.

The number of organisms sampled at each station varied from about 5 to 177. The largest numbers of organisms were identified in the mid-stream portion of the drain. The most abundant Class 1 and Class 2 organisms were found in the downstream portion of the drain. Data concerning abundance of organisms is located in Appendix 5.

Water sampling results for three dates in June are in Appendix 6. For water testing, the majority of samples were above suggested levels. The pH was slightly alkaline. Total phosphorous was consistently above the Ontario Ministry of Environment and Energy's (MOEE) recommended 0.03 mg/L. Total Kjeldahl nitrogen was above Environment Canada, Inland Waters Directorate's recommend levels (0.5 mg/L). Upstream water samples for June 27 and July 25 were equivalent to or above the Canadian Water Quality Guidelines suggested 5 mg/L for nitrate, and downstream samples were below or equal. Levels of nitrite were acceptable for livestock watering (MOEE recommended <10 mg/L). However, nitrite levels were above MOEE recommended standards for toxicity (0.06 mg/L). On the basis of the MOEE 1993 swimming guidelines for *E. Coli* (100 per 100 m/L of water), the Steckly Drain was unsuitable for swimming at all sample times. The pathogen *P. aeruginosa* is a pathogen associated with sewage, and is associated with milkhouse wastes. There are no set guidelines for this pathogen, but elevated levels indicated a problem with milkhouse wastes or human sewage. *P. aeruginosa* was present in elevated levels (above the background level of 2/100 ml) in the Steckly Drain for all but two samples.

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<sup>5</sup> The Save Our Streams, Stream Quality Survey defines the stability of the stream bed as whether or not the bed sinks beneath your feet in no spots, a few spots, or many spots.

<sup>6</sup> The Save Our Streams, Stream Quality Survey defines the color of algae as light green, dark green, brown coated, matted on stream be, or hairy.

There were forty-two different types of vegetation noted along the Steckly Drain. The most common types of vegetation identified were: Sweet flag (*Acorus calamus*), Horsetail (*Equisetum arvense* L.), Common burdock (*Arctium minus*), Jewelweed (*Impatiens pallida*), Goldenrod (*Solidago spp.*), St. John's wort (*Hypericum perforatum* L.), speedwell (*Veronica spp.*), and *Anemone spp.*. This indicates that the buffer strip is not well established because they are early successional species. Inventories of stream bank vegetation are in Appendix 7.

## **7. DISCUSSION**

Many parameters examined for the stream assessments were consistent throughout the Steckly Drain. Therefore comments regarding fish, surface water appearance, odor, and algae will be discussed in reference to the entire site. However, Beck's Biotic Index, abundance, richness, and several other parameters demonstrated distinct trends. Due to trends in stream quality all other parameters will be discussed in sections. The sections are the upstream portion from stations 29 to 35, the mid-stream sector from stations 16 to 28, and the downstream section from stations 1 to 15.

### **7.1 General Stream Conditions**

Removal of vegetation typically leads to higher summer and lower winter temperatures (Barton et al, 1994). The stream bank vegetation composition is dominated by grasses, which compose 96 percent of the floral community. The presence of both trees (2 percent) and shrubs (2 percent) are negligible (see Appendix 4 and 7).

Due to minimal vegetative shading, the stream temperature remains warm throughout the year (see Appendix 4). The minimum temperatures found in the stream occurred where there is a buffer, and the stream was shaded. The minimum stream temperature (16 degrees Celsius) occurred at a station heavily shaded by stream bank vegetation. The maximum stream temperatures (28 degrees Celsius) occurred in open areas, where vegetation was low and there were very few adjacent trees.

Due to the presence of both scattered individuals of fish (12 stations), and scattered schools of fish (1 station), further investigation, in order to determine feasibility as fisheries habitat, may be warranted, Fish were present throughout this section of the tributary. Since there were no barriers to fish movement, minimal in-stream work would be required in order to create a fisheries.

Eutrophication is not always perceptible if sediment "masks" the effects of nutrient enrichment. A symptom of heavy nutrient enrichment is a change in the color of the water due to excessive microscopic plant or algae growth. Nutrient enrichment may also lead to food web simplification and a reduction in species diversity through the elimination of sensitive species. The surface water appearance of the Steckly Drain was mainly brownish and clear, with several stations being milky and/or muddy. There was clear surface water at 83 percent of the stations. All of the milky or muddy surface water occurred in the cattle access portion of the drain. This is probably due to cattle damaging stream banks and removing bank vegetation, thereby increasing erosion and sedimentation. The inputs of animal wastes result in several types of water pollution: pathogenic and nonpathogenic micro-organisms, biodegradable organic matter, nutrients, and salts. Organic matter is the only form that can be seen by the naked eye. These particles color the water, increase its turbidity, and increase the BOD.

On the basis of water sampling, turbidity at the downstream sampling location ranged from 2.45S6 - 4.90S6 and from 2.63S46 - 7.68S6 formazin units and the upstream sampling location. Turbid water is caused by suspended matter, such as dissolved organic and inorganic matter, plankton, and other microscopic organisms. Turbidity is a mathematical expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the water (Greenberg *et al*, 1980). Water experiencing sediment pollution undergoes increased turbidity in the form of suspended solid matter. Increased turbidity may be attributed to overland flow paths or channels that drain from fields and pastures. However, if runoff from overland flow is clear, and there appears to be no bank erosion, then turbidity may be caused by stirred-up stream bottom mud deposits. In those cases, the water quality may still be "excellent". Higher levels of turbidity may have been found due to upstream agricultural activities (such as cattle access, cropping to the edge of the stream bank, vegetation removal, in-stream construction, stream bed disturbances, and erosion) and excessive growth of aquatic life (such as zooplankton and phytoplankton).

There are several other indicators of animal wastes for receiving waters. Visual and olfactory evidence includes the odor and smell of ammonia, and dried, usually odorless, sludge in the water (high turbidity) and on the water's edge. The Steckly Drain had no distinctive odors.

Micro-organisms in animal wastes can lead to about 150 diseases (Terrell and Perfetti, 1988). Disease producing organisms are influenced by climate, soil types and infiltration rates, topography, animal species, animal health, and the presence of "carrier" organisms. The presence of *Escherichia coli* indicates the potential pollution by sewage or animal

manure and the potential for human health risks. *E. coli*. had a range of 40 to 450 at the upstream sampling station, and 350 to 10000 downstream.

Plant growth is dependent on a variety of factors, such as flow rate, bottom type, sunlight amount, nutrient, levels, and water depth. Slow, relatively clear waters or pools support the greatest amount of plant growth. Algae covered 100 percent of the stream bottom at five stations. Eutrophic streams can be described as having large macrophyte infestations, filamentous infestations, or phytoplankton infestations. Macrophyte infestations are the result of a proliferation of floating plants and decreasing light penetration. Decreased light reduces photosynthetic oxygen production. Filamentous alga, which grows along the bottom and sides or attached to rocks and large plants, rises to the surface and dies, creating decaying odors and nuisances. Decaying materials result in increased biological oxygen demand (BOD). Increased levels of BOD lower the DO reserve. Under critical DO conditions, organisms requiring high to moderate levels of oxygen, begin to die slowly. Therefore, phytoplankton infestation leads to excessive levels of photosynthesis that can cause low DO levels. Algae were located on sections of the stream bed at 86 percent of the stations. For the stations at which algae did not completely cover the stream bed, there was an average of 68 percent bed cover and a range of 30 - 95 percent bed cover. Almost every station had a presence of matted and/or filamentous algae.

## **7.2 Upstream Section (Stations 29 to 35)**

Beck's Biotic Index (Appendix 3), which was performed for each station, indicates the poorest water quality in the Steckly Drain is found in the upstream portion. In this region, the water quality was ranked between moderately and grossly polluted (0 - 6). These findings are supported by the stream richness (Appendix 2) and abundance (Appendix 5) calculations. The richness at each station in this section was below the average stream richness (H) of 9. In addition, abundance calculations show an abnormally low number of individuals at each station. Increased nutrient levels decrease species richness, change species compositions, and increase species abundance. The low abundance indicates that the stream may be degraded to a point where very few organisms could survive.

The water in the upstream section appears severely degraded for several reasons. The buffer strip established in 1991 continues to be maintained, however, the trees planted during this period have not had sufficient time to become established and provide the needed shade and bank stabilization required in this region of the drain.

The drain was cleaned out in the fall of 1993. Dredging would have eliminated most, if not all, of the organism that have over-wintering aquatic life stages. The organisms that

survived would be highly tolerant with short life cycles or high mobility, such as scuds, water boatman, water striders, etc.

The stream flow remains monotonously slow and straight, with very few riffles. The flow rate was normal for all of the sites. The average flow rate was 0.092 m/second. The upstream portion of the drain had flows below the average for all except one station. Additionally, this region receives flow input from four different drainage tiles. This additional input could be providing this region with a large degree of excessive nutrients and organic matter. The drain is straight due to channelization. The average width of the stream is 2.38 m, with a variance of 2.1 m to 4.0 m in the upstream sector. Despite the stream's width, the drain is very shallow with an average depth of 15.9 cm, and a range of 12 cm -- 25 cm in the upstream section of the drain.

The Save Our Streams, Stream Quality Survey determined stream bed stability based upon the bed sinking beneath the sampler's feet in either no spots, a few spots, or many spots. At all the upstream stations the bed sank beneath pressure in a few spots. Stream bed instability was largely because of the heavy silt and sand content. Silt was the largest component of the stream bed deposit for all except one of the upstream stations. The general upstream bed deposit consisted of silt, sand, and gravel in turn. There was a negligible presence of gravel and cobbles. Siltation is caused by the removal of stream bank vegetation and the accompanying erosion from upstream and adjacent sources. There is still evidence of vegetative loss because the buffer strip has only been in place for three years, and is still unestablished. Almost all of the sites experienced slight evidence of stream bank erosion (<20 percent), and one station underwent moderate erosion (20 - 49 percent).

Silt or mud bottoms support invertebrate species, such as tube-building worms, burrowing mayflies, midges, mussels, and clams. Sandy beds support very few invertebrate species because they provide minimal stable surfaces for the organism to attach itself. Therefore, a silty stream bed is suitable for tube-building and burrowing invertebrates such as midges (Diptera), aquatic worms (Haplotaxida) and snails (Meglogastropoda, Basommatophora). For stations 29 to 35, Haplotaxida and *Chironomidae* (order Diptera) were the dominate organisms. Two major groups of aquatic insects should be present in unpolluted watercourses, mayflies and caddisflies. If both mayflies and caddisflies are absent from the stream, then the watercourse is severely polluted. If only mayflies or caddisflies are present, then the stream is probably moderately polluted. In the upstream section of the stream very few mayflies and no caddisfly were present.

### **7.3 Mid-stream Section (Stations 16 to 28)**

The region of the Steckly Drain between stations 16 and 28 experiences a variety of physical conditions (refer to maps in Appendix 1 and physical data in Appendix 4). Consequently, the diverse physical conditions are reflected in the Beck's Biotic Index (Appendix 3), which indicates fluctuations in water quality from clean (10 to grossly polluted (0 - 1). The presence of mayflies and few caddisflies, further indicates that the water quality between stations 16 to 28 is moderately polluted to clean but monotonous habitat and velocity.

Stations 25 to 28 are considered to be of clean quality with monotonous habitat. Richness is average ( $H = 9$ ) or above average. The bottom of the stream at these stations had silt-sand-gravel bottoms. The habitat in this portion of the drain will support facultative organisms such as scuds (Amphipoda) and water boatmen (Hemiptera) as indicated in Appendix 2. This area of the Drain is an improvement over the upstream section, probably because it was not dredged. However, this section would have received sediment from the dredging process. Stream health improves toward the downstream portion of the Drain. The water quality improvements are restricted due to a general lack of trees, relatively limited habitat, and the input of three tiles.

The water quality drops dramatically at station 24, where cattle access begins. Cattle access extends from stations 20 to 24. Throughout this area, Beck's Biotic Index fluctuates from grossly polluted to clean with monotonous habitat and velocity.

The highest quality water in the Drain occurred at station 19. This is likely due to the excellent conditions for aquatic life. The station had a cobble bottom and was shaded by trees, making it suitable for Class 1 organisms. There was a small pool and riffing and aquatic vegetation, making the station suitable for clinging Class 2 organisms. The station also had a good food supply making it suitable for all organisms. Water quality gradually decreased to slightly above polluted from stations 16 to 19.

The similar stream bank and stream flow condition at stations 10, 13, and 14, along with the silted bottoms and tile inputs at these stations, support the growth of tolerant organisms such as midges (Diptera). Hence, those sites are rated polluted to grossly polluted by Beck's Biotic Index.

The stream flow remains monotonously slow and straight. The flow rate was normal for all of the sites. The mid-stream portion of the drain had flows below the average (0.092 m/second) for 62 percent of the stations. Additionally, this region receives flow input from

seven different drainage tiles. This additional input could be providing this region with a large degree of excessive nutrients and organic matter. The drain is straight due to channelization. The mid-stream section of the drain varies in width from 1 m to 5.7 m (a pool). Despite the stream's width, the drain is very shallow with a range of 5 cm -- 45 cm (a pool) in the mid-stream section of the drain.

At 69 percent of the mid-stream stations the bed sank beneath pressure in a few spots. The stream bed was stable at all other sites. Stream bed instability is not a major problem due to a fairly even distribution of silt, sand, and gravel on the stream bed. The largest component of the stream bed deposit was gravel for all except two of the mid-stream stations. The general mid-stream bed deposit consisted of gravel, sand, and silt in turn. Silt occurred in larger proportions upstream of this section of the drain. There was a negligible presence of cobbles. Siltation is caused by the removal of stream bank vegetation and the accompanying erosion from upstream and adjacent sources. Approximately 62 percent of the sites experienced slight evidence of stream bank erosion (<20 percent), 23 percent of the stations had high erosion (50 - 80 percent), and 15 percent underwent moderate erosion (20 - 49 percent). Areas of high erosion occurred where vegetative cover was the least.

#### **7.4 Downstream Section (Station 1 to 15)**

Beck's Biotic Index (Appendix 3) ranked the most consistently high quality of water in the Steckly Drain, between stations 1 to 15 (Appendix 1). All stations ranked above 6 (except for station 10) and 50 percent of stations were ranked as clean. Results from Beck's Biotic Index are supported by richness and abundance calculations (see Appendix 2 and Appendix 5 successively). In this portion of the drain, the diversity in taxa (richness) has its highest values (12), and 73 percent of stations were above the average richness (9). The abundance of individuals in each taxa varied, with individuals being distributed fairly equally among tolerant, facultative, and intolerant organisms. Class 1 organisms were dominant or had the second highest presence at some stations. The presence of mayflies, caddisflies, and stoneflies additionally indicates that the stream is probably in good-to-excellent condition.

An exception to the high water quality results occurs at stations 9 and 10. One of which is located downstream of the main field tile. Both stations are in runs, with abundant algae (>90 percent) and sandy bottoms. At these locations the water quality rating falls below clean to a moderately polluted water quality rating.

The region is well buffered with good cover (>70 percent bank covered by plants, rocks, and logs) of tall grasses. Vegetative cover aids in the elimination of upstream (cattle access and dredging) and adjacent negative impacts to the watercourse.

The stream flow remains monotonously slow and straight. The flow rate was normal for all of the sites. The downstream portion of the drain had flows below the average (0.092 m/second) for 62 percent of the stations. Additionally, this region receives flow input from nine different drainage tiles. This additional input could be providing dilution for upstream inputs. The drain is straight due to channelization. The downstream section of the drain varies in width from 1.6 m to 2.9 m. Despite the stream's width, the drain is very shallow with a range of 5 cm - 30 cm in the downstream section of the drain.

At 1 percent of the downstream stations the bed sank beneath pressure in a few spots. The stream bed was stable at all other sites. Stream bed instability is not a major problem due to a fairly even distribution of silt, sand, gravel and cobble on the stream bed. The largest component of the stream bed deposit was gravel for all except three of the downstream stations (these three stations were dominated by cobble or sand). The general downstream bed deposit consisted of gravel, sand, cobble, and silt in turn. Siltation is caused by the removal of stream bank vegetation and the accompanying erosion from upstream and adjacent sources. Approximately 87 percent of the sites experienced slight evidence of stream bank erosion (<20 percent), high (50 - 80 percent), and moderate erosion (20 - 49 percent) were each recorded at one station.

## **8. LIMITATIONS**

A key limitation to the stream assessment is a lack of detailed background regarding tillage/cropping practices in the upstream watershed, and on the adjacent properties. Cropping/tillage practices can largely influence the benthic invertebrate communities present in the stream (Barton *et al*, 1994).

We were also limited by the time-frame which we found may impede our ability to analyze the various genera of aquatic invertebrates, and our time to process our samples.

## 9. RECOMMENDATIONS

For future stream assessment, it would be more comprehensive to reflect seasonal changes in the stream. Benthic communities, as well as physical parameters will change throughout the different seasons. In order to truly reflect stream health, all seasonalities should be observed.

It would be beneficial to compare assessment streams with other southern Ontario streams that have both similar and different morphology and cropping/tillage practices.

On the basis of findings of the benthic stream assessment, apparently the tiles are negatively impacting the stream. It is also evident that deep, stagnant sections in the drain have a low Beck's Biotic Index rating. Therefore, efforts should be made to further analyze the source and content of sediment rich pools or straight and monotonous runs. Efforts should be made to minimize (not eliminate) pooling, and reduce the effects of channelization.

The general trend in Steckly Drain was an increase in water quality in the downstream portion and in areas with extensive stream bank vegetative cover. More intensive efforts should be made to remove negative upstream inputs (cattle access etc.) and retire land adjacent to the stream.

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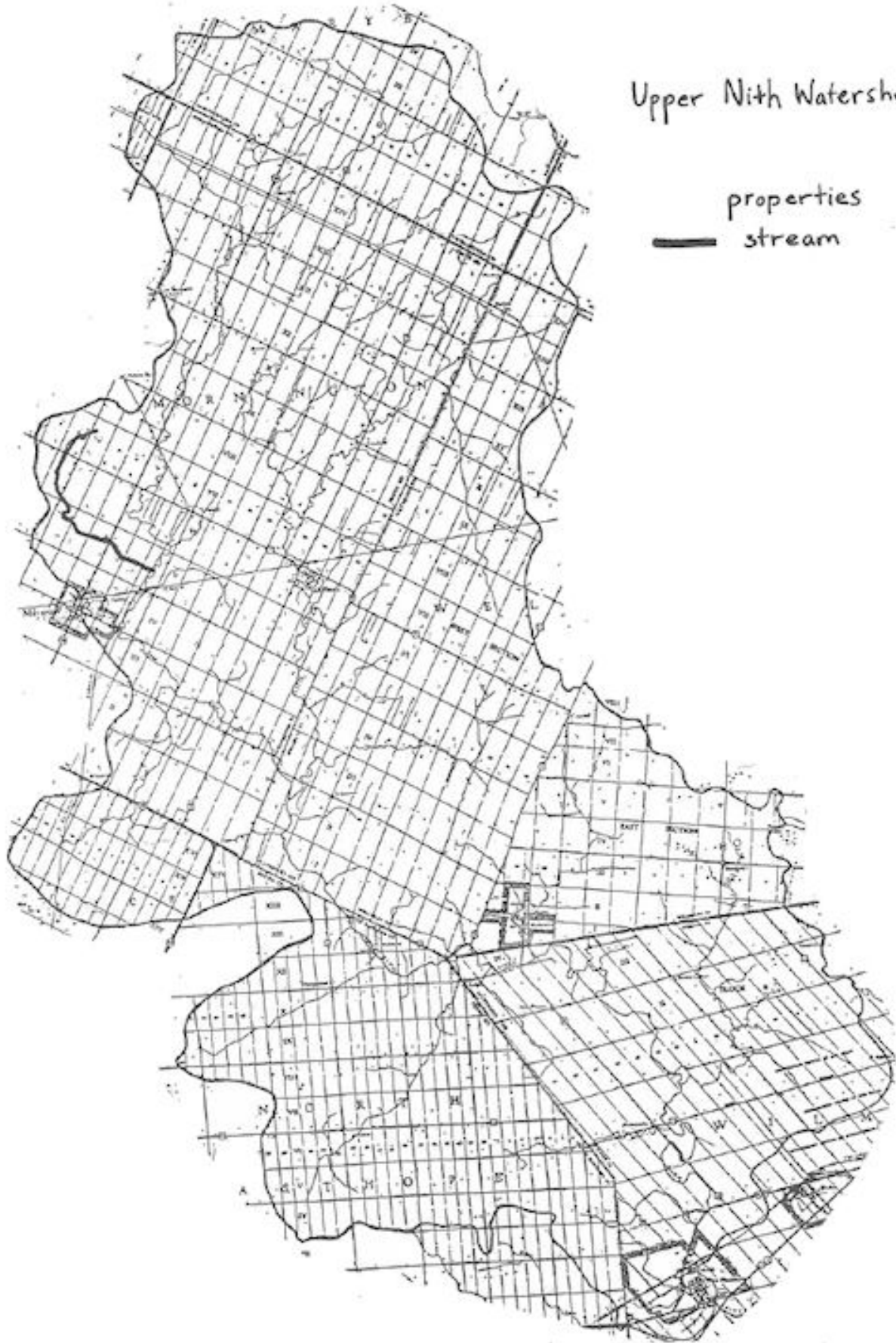
## **APPENDIX 1**

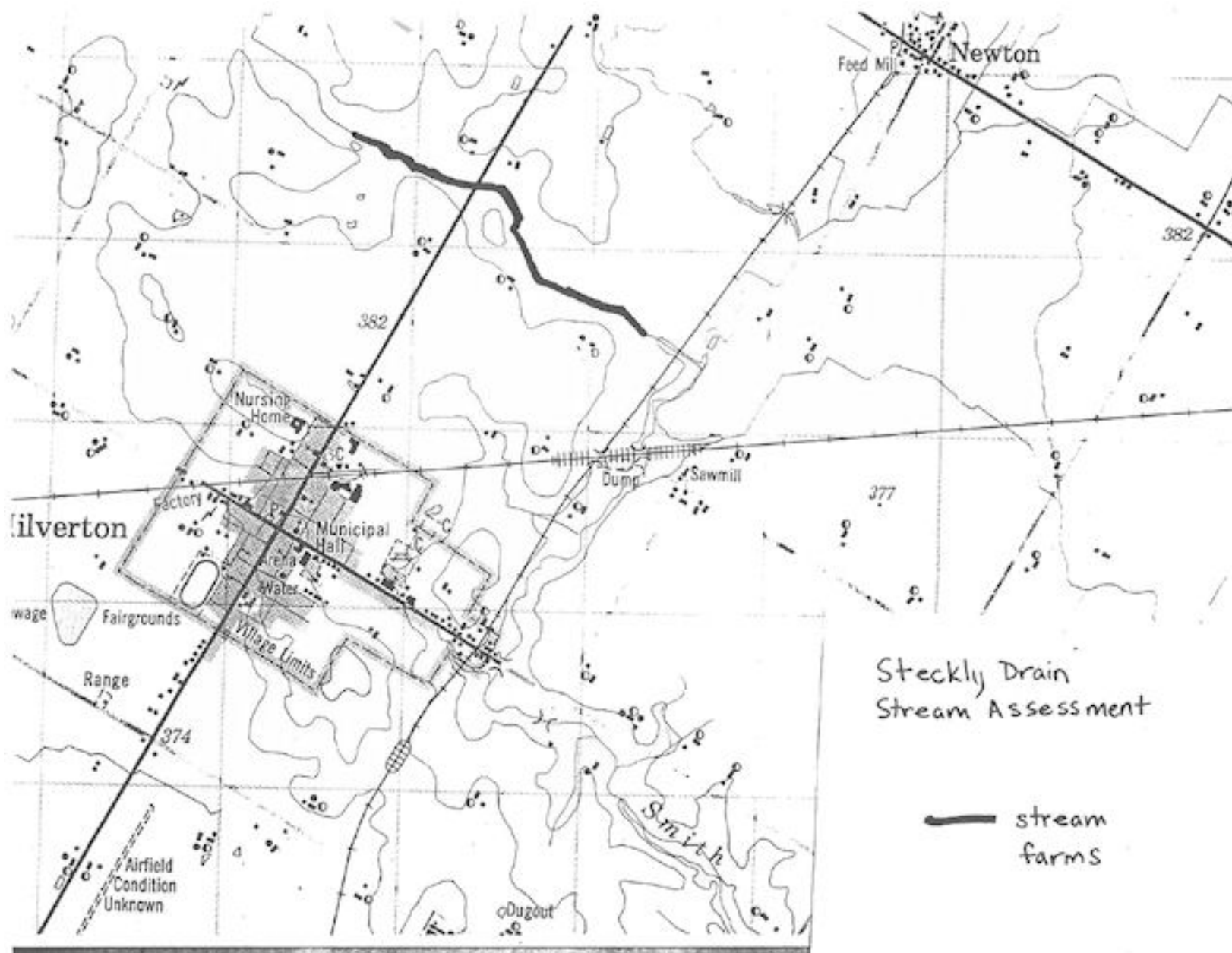
### **MAPS**

- Upper Nith River County Map
- Ontario Base Map with Project Locations
- Map of all Sampling Stations
- Map of Sampling Stations 1-16 (J. Roe)
- Map of Sampling Stations 16-29 (E. Wilson)
- Map of Sampling Stations 30-35 (R. Wilson)

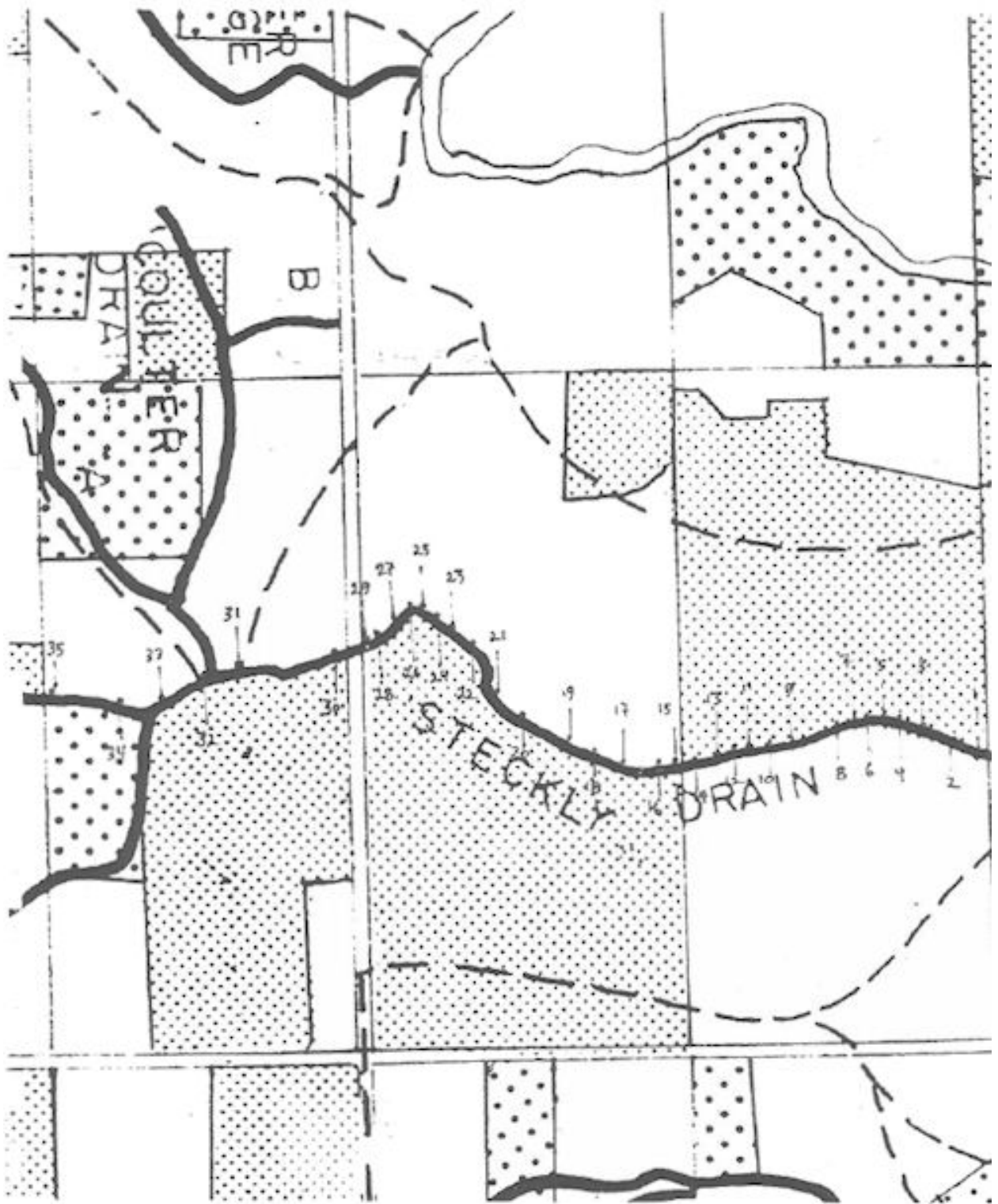


# Upper Nith Watershed





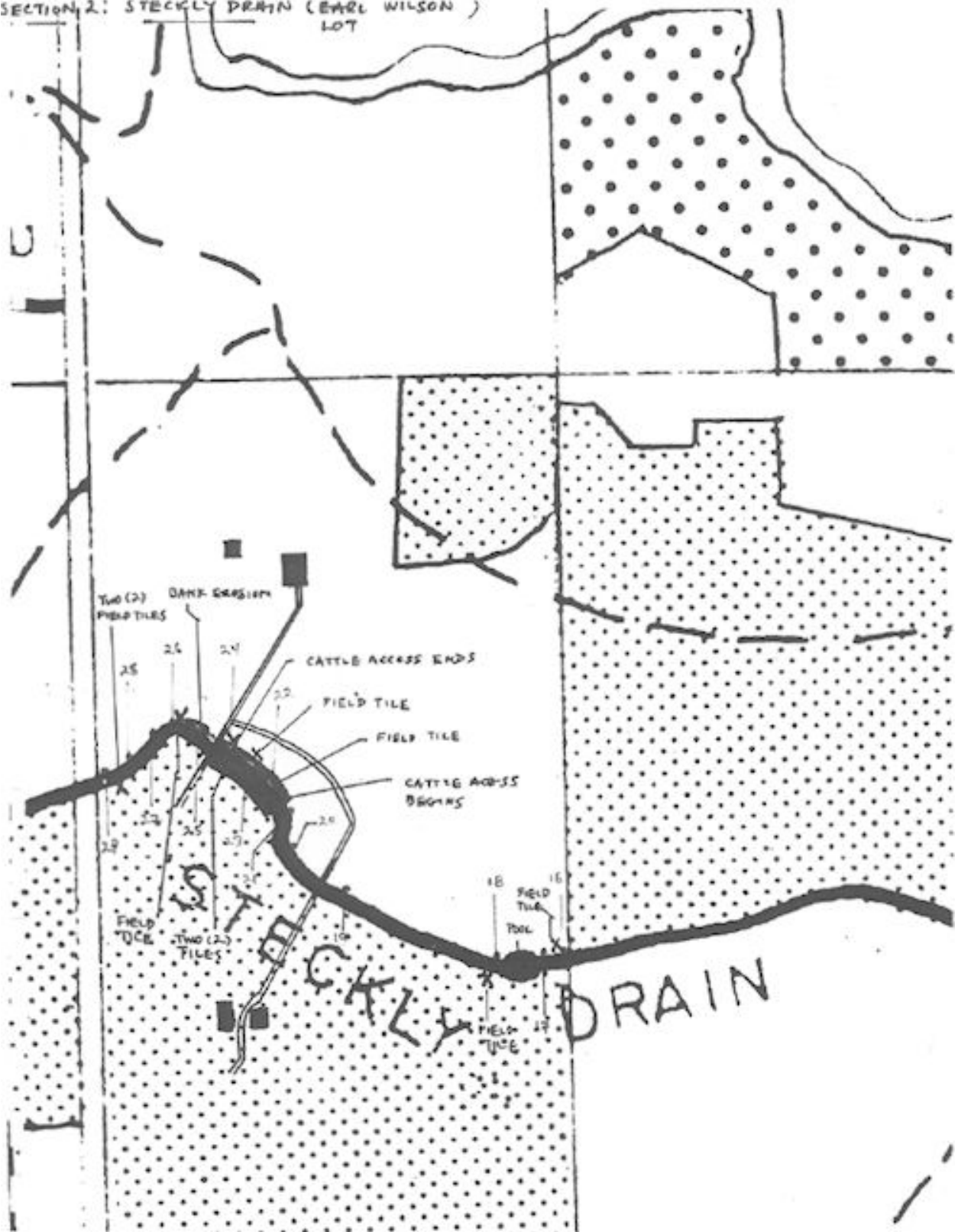
STECKLY DRAIN : SAMPLE SITES



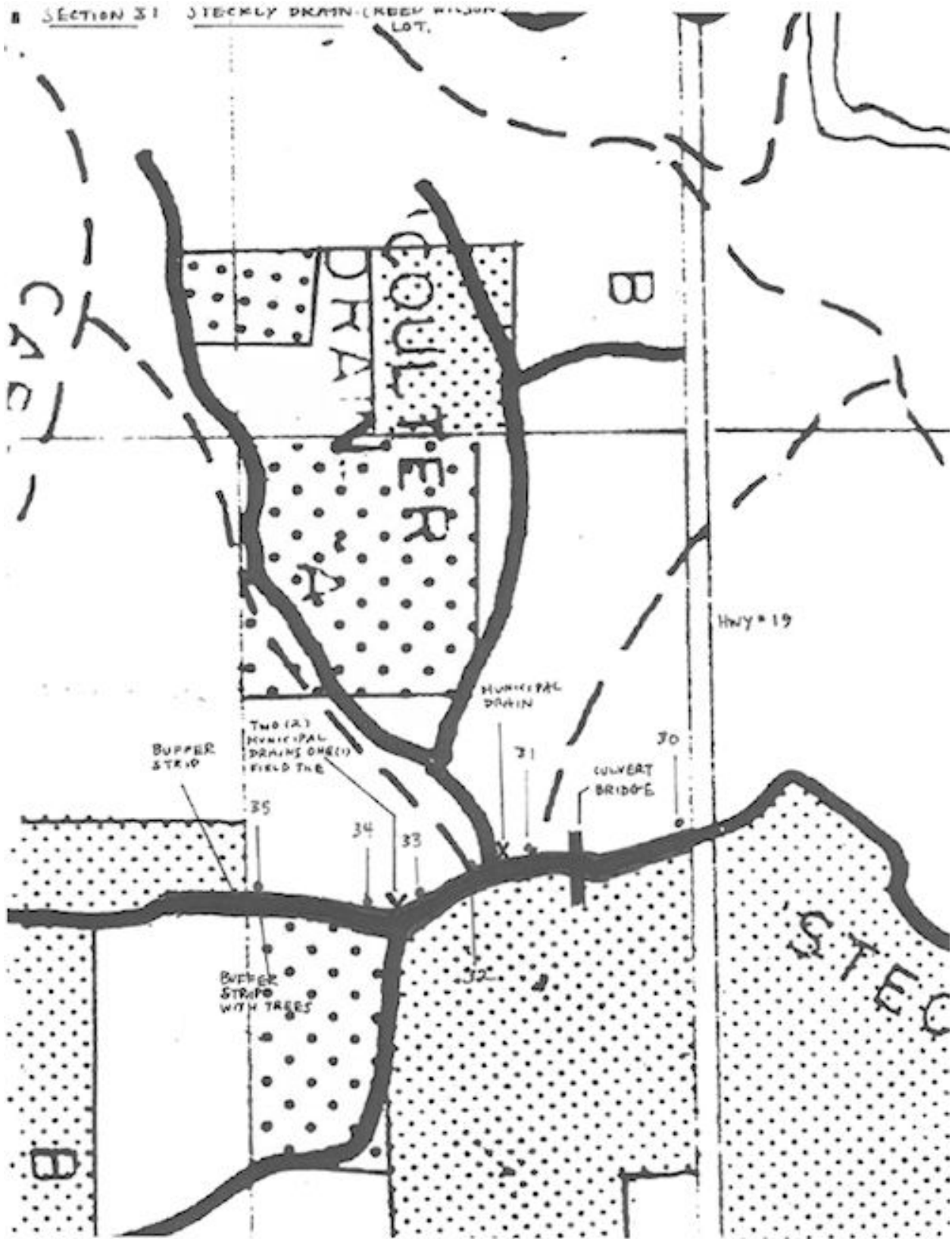
SECTION 1: STECKLY DRAIN (JOHN ROE LOT)



SECTION 2: STECKLY DRAIN (EARL WILSON)  
LOT



SECTION 31 STECKLY DRAIN (CREEK W/IN LOT)



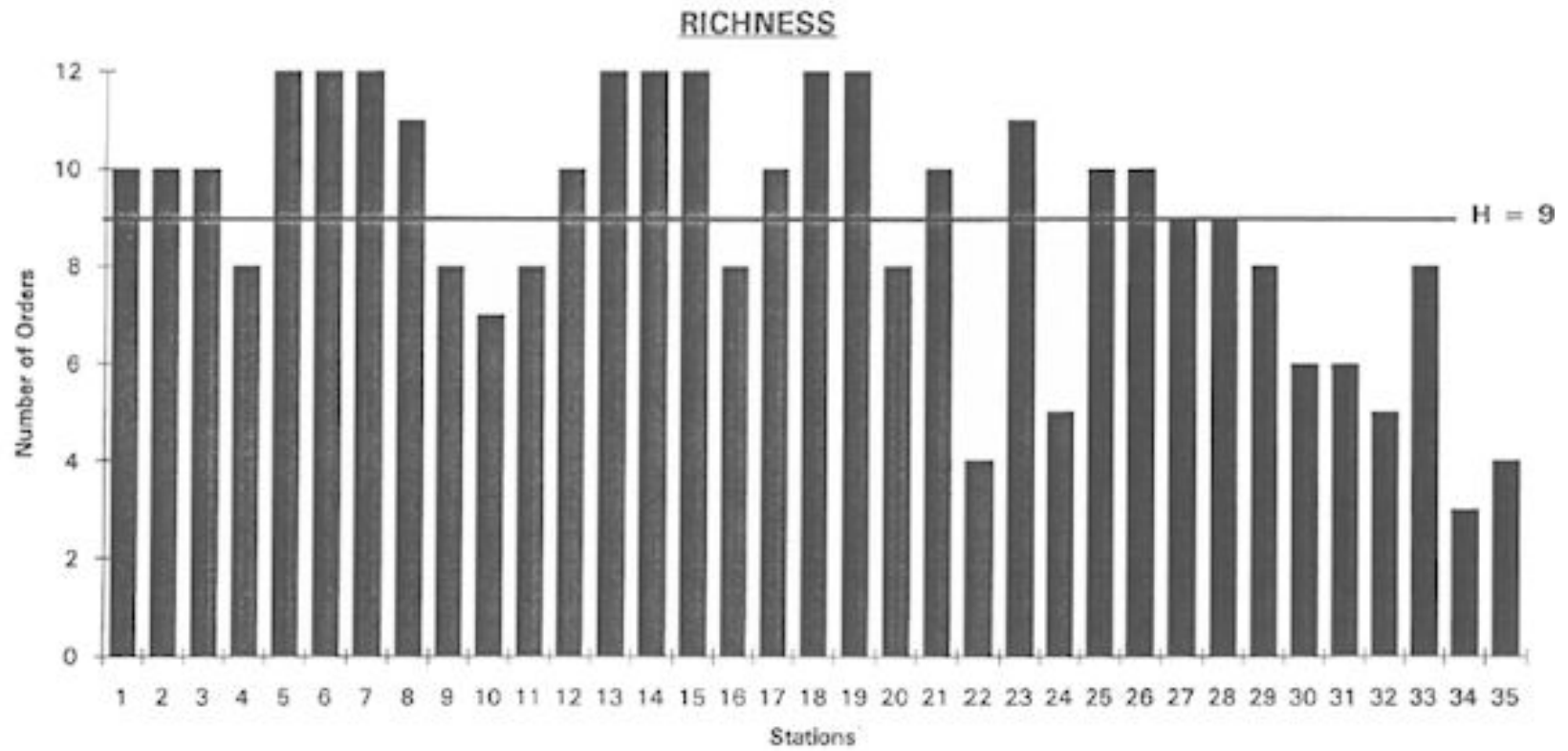
## **APPENDIX 2**

### **RICHNESS**

- Richness for Each Station
- Allocation of Taxa at Each Station



APPENDIX 2: Steckly Drain



**APPENDIX 2: Steckly Drain**

	STATION									
	1	2	3	4	5	6	7	8	9	10
Trichoptera			3							
Plecoptera								4		
Megaloptera						7	8			
Ephemeroptera	28	60	25	6	23	20	17	16	3	8
Plecoptera										
Heterodonata	1	1					1			
Coleoptera	5	13	11	30	4	5	18	6	6	3
TOTAL	34	74	39	36	27	32	44	26	9	11
Decapoda			1	1	4	1	1	1		
Odonata					2					
Amphipoda	2	12	13	2	2	16	26	15		
Isopoda										
Diptera - general		2	2		1	3	4	11	1	
Hemiptera	4	16	1	27	12	31	16	1	18	5
TOTAL	6	30	17	30	21	51	47	28	19	5
Haplotaxida	50	50		50	45	55	55	55	29	55
Pharyngobdellida	7	1	2		8	6	15	4	4	6
Diptera - midges	6	4	50	3	1	1	3	6	8	12
Mesogastropoda	3	3	5	2	3	11	7	3	1	4
Basommatophora	2				1	3				
TOTAL	68	58	57	55	58	76	80	68	42	77
GRAND TOTAL	108	162	113	121	106	159	171	122	70	93
minnows				1	3					

Steckly Drain : APPENDIX 2

	STATION									
	11	12	13	14	15	16	17	18	19	20
Trichoptera							1		2	1
Plecoptera	2									
Megaloptera	1	1	2	1				1	1	
Ephemeroptera	21	5	31	26	6	33	8	27	10	
Plecoptera										
Heterodonata				1	13				1	1
Coleoptera	23	14	16	6	5	14	15	8	31	
TOTAL	47	20	49	34	24	47	24	36	45	2
Decapoda			2	1	1			2	2	
Odonata										
Amphipoda	8	6	8	8	6	18	3	2	5	
Isopoda										
Diptera - general			1	2	2	1	17	2	1	5
Hemiptera	6	6	1	30	7	9		17	2	4
TOTAL	14	12	12	41	16	28	20	23	10	9
Haplotaxida	55	35	55	47	50	50	87	60	51	7
Pharyngobdellida	2	4	18	7	10	11	8	7	3	1
Diptera - midges	12	11	11	3	29	4	2	1	11	26
Mesogastropoda	2	4	5	2	3		2	1		3
Basommatophora		1	2		2		1	1		1
TOTAL	71	55	91	59	94	65	100	70	65	38
GRAND TOTAL	132	87	152	134	134	140	144	129	120	49
minnows										
										frog

**APPENDIX 2: Steckly Drain**

	STATION									
	21	22	23	24	25	26	27	28	29	30
Trichoptera										
Plecoptera										
Megaloptera										
Ephemeroptera	10		4		11	19	33	9	10	
Plecoptera										
Heterodonata	1		3							
Coleoptera	24	2	5		17	13	3	18	4	
TOTAL	35	2	12	0	28	32	36	27	14	0
Decapoda					1		1		1	
Odonata		1				2	1			
Amphipoda	1		3		12	8		29		3
Isopoda										
Diptera - general	4		5			3	2	8		2
Hemiptera	2		10		7	5	44	8		
TOTAL	7	1	18	0	20	18	48	45	1	5
Haplotaxida	28	1	31	3	36	73	54	69	50	10
Pharyngobdellida	3		4	2	3	1	4	14	4	
Diptera - midges	5		22	20	9	16	35	8	53	14
Mesogastropoda	2	1	4	3	6	4			1	
Basommatophora			1	3	2			1	1	
TOTAL	38	2	62	31	56	94	93	92	109	24
GRAND TOTAL	80	5	92	31	104	144	177	164	124	29
minnows	1	1								

**APPENDIX 2 : Steckly Drain**

	STATION					TOTAL
	31	32	33	34	35	
Trichoptera						7
Plecoptera						6
Megaloptera						22
Ephemeroptera					2	471
Plecoptera						0
Heterodonata						23
Coleoptera	4			1	1	325
TOTAL	4	0	0	1	3	854
Decapoda						20
Odonata						6
Amphipoda		5	2	1		216
Isopoda						0
Diptera - general		1				80
Hemiptera	4	2		1		296
TOTAL	4	8	2	2	0	618
Haplotaxida		4	18		3	1321
Pharyngobdellida		2	3	1	1	166
Diptera - midges	2	2	3	5	6	404
Mesogastropoda		2	2			89
Basommatophora		1	2	2	1	28
TOTAL	2	11	28	8	11	2008
GRAND TOTAL	10	19	30	11	14	3480
minnows				6	3	15



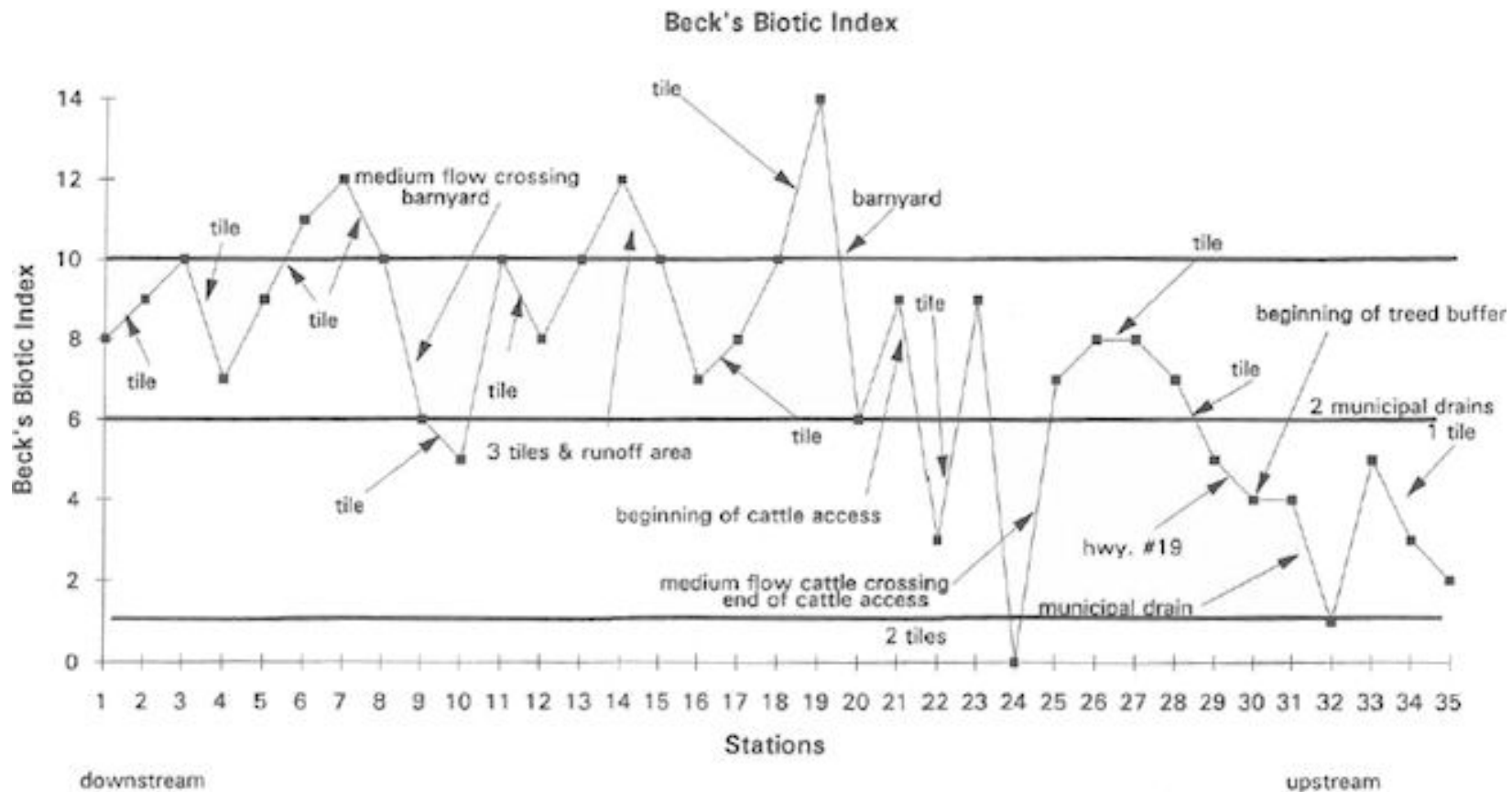
## **APPENDIX 3**

### **BECK'S BIOTIC INDEX**

- Line Graph
- Scatter Plot

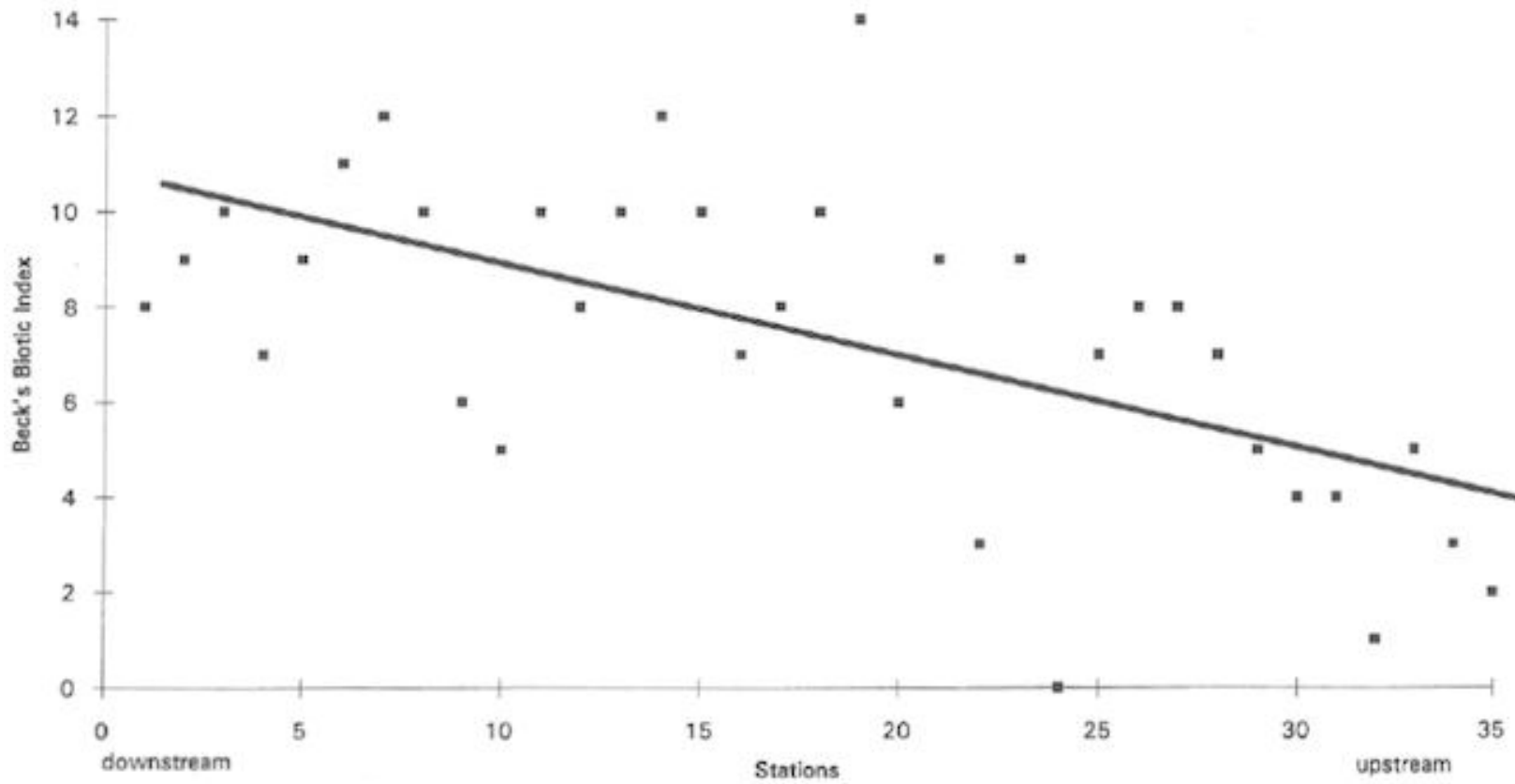


APPENDIX 3: Steckly Drain



B.I. = 0-1 grossly polluted; 1-6 moderately polluted; 6-10 stream clean but monotonous habitat and velocity; 10+ clean

### APPENDIX 3 : Steckly Drain



B.I. = 0-1 grossly polluted; 1-6 moderately polluted; 6-10 stream clean but monotonous habitat and velocity; 10+ clean

## **APPENDIX 4**

### **SAVE OUR STREAMS** **STREAM QUALITY** **SURVEY**

- Summary Stream Quality Survey
- Table of Data Collected in Stream Quality Surveys
- Stream Quality Surveys for Each Station



## SAVE OUR STREAMS Stream Quality Survey

The purpose of this form is to aid you in gathering and recording important data about the health of your stream. By keeping accurate and consistent records of your observations and data from your macroinvertebrate count, you can notice and document changes in water quality. Refer to the SOS insect card and instructions to learn how to trap and identify the organisms.

Stream Steckly Drain Station 1-35  
 County Perth State \_\_\_\_\_ Location Concession 5, Mornington  
 Group or individual Group Number of participants 2  
 Weather conditions varied warm → hot, sunny → overcast  
 Stream width (Average) 2.4 km (1-2.95m) Stream depth (in riffle) 15.9 cm (5-45cm)  
 Flow rate: high \_\_\_\_\_ low \_\_\_\_\_ normal  (0.092, varied 0 - 0.2 m/sec)  
 You should select a riffle where the water is not running too fast (ideal depth is 3 - 12 inches), and the bed consists of cobble-sized stones or larger.  
 Monitored riffle area (should be 3 foot square) \_\_\_\_\_ Water depth (inches) 15.9 cm Water temperature 22°C (min. - 16°C max. - 28°C)  
 Date June 9-28 Time 10:30-15:00 Sample Number \_\_\_\_\_  
 Type of test: \_\_\_\_\_ macroinvertebrate count \_\_\_\_\_ chemical test \_\_\_\_\_ other

### MACROINVERTEBRATE COUNT

Use the stream monitoring instructions to conduct a macroinvertebrate count. Use letter codes (A = 1 - 9, B = 10 - 99, C = 100 or more) to record the numbers of organisms found in a 3 foot by 3 foot area. Then add up the number of letters in each column and multiply by the indicated index value. The following columns are divided based on the organism's sensitivity to pollution.

SENSITIVE	SOMEWHAT-SENSITIVE	TOLERANT
C/258 diving beetle	A/2 water strider	C/1371 aquatic worms
A/7 caddisfly larvae	beetle larvae	bladder larvae
O/22 hellgrammite	B/26 clams	C/176 leeches
C/491 mayfly nymphs	crane fly larvae	C/354 midge larvae
gilled snails	B/20 crayfish	C/113 pouch (and other) snails
riffle beetle adult	A/13 damselfly nymphs	
stonely nymphs	B/1 dragonfly nymphs	
water penny larvae	C/208 scuds	
B/68 coleoptera	sowbugs	
	fishfly larvae	
	alderfly larvae	
	atlix	
	C/254 water boatman	
	B/76 dipteran	
<input type="text" value="3"/> # of letters times 3 = <input type="text" value="9"/> index value	<input type="text" value="3"/> # of letters times 2 = <input type="text" value="6"/> index value	<input type="text" value="1"/> # of letters times 1 = <input type="text" value="1"/> index value

Now add together the three index values = 16 total index value.

Compare this total index value to the following numbers to determine the water quality of your stream. Good water quality is indicated by a variety of different kinds of organisms, with no one kind making up the majority of the sample.

### WATER QUALITY RATING

- Excellent (> 22)       Good (17 - 22)  
 Fair (11 - 16)       Poor (< 11)

Note: You should test at least 3 different riffles within a 24-foot area to ensure that you have a truly representative sample which includes all key organisms. Record results from the sample which gives the best diversity.

**Fish water quality indicators:**

- scattered individuals
- scattered schools
- trout (intolerant to pollution)
- bass (somewhat-tolerant to pollution)
- catfish (tolerant to pollution)
- carp (tolerant to pollution)

**Barriers to fish movement:**

- beaver dams
- dams
- waterfalls
- other
- none

**Surface water appearance:**

- brownish
- clear
- colored sheen (oily)
- foamy
- milky
- muddy
- brown
- black
- grey
- other ( \_\_\_\_\_ )

**Odor:**

- rotten egg
- musky
- oil
- sewage
- none

**Stability of stream bed:**

- Bed sinks beneath your feet in:
- no spots
  - a few spots
  - many spots

**Stream bed deposit (bottom)**

- grey
- orange/red
- yellow
- black

- brown
- silt
- sand
- other ( \_\_\_\_\_ )

**% bank covered by plants, rocks and logs (no exposed soil) is:**

	Good >70%	Fair 30% - 70%	Poor <30%	(> = greater than, < = less than)
Stream bank (sides)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Top of bank (slope and floodplain)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Stream bank vegetation composition: 5 % shrubs 95 % grasses \_\_\_\_\_ % trees

Stream bank erosion: \_\_\_\_\_ >80% severe  50%-80% high, \_\_\_\_\_ 20%-49% moderate, \_\_\_\_\_ <20%-0% slight

**Bed composition of riffle:**

- 5 % silt (mud)
- 25 % sand (1/16" - 1/4" grains)
- 60 % gravel (1/4" - 2" stones)
- 10 % cobbles (2" - 10" stones)
- \_\_\_\_\_ % boulders (> 10" stones)

**Algae color:**

- light green (*floating*)
- dark green
- brown coated
- matted on stream bed
- hairy

**Algae located:**

- everywhere
- in spots
- \_\_\_\_\_ % bed cover

**Land uses in watershed:** Record all land uses observed in the watershed area upstream and surrounding your sampling site. Indicate whether the following potential land uses have a high (H), moderate (M), or slight (S) potential for impact. Refer to the SOS stream survey instructions to determine how to assess H, M, or S values.

- |  |  |   |
|--|--|---|
| <input type="checkbox"/> Oil & gas drilling        | <input type="checkbox"/> Sanitary landfill           | <input type="checkbox"/> Refuse dump                  |
| <input type="checkbox"/> Housing developments      | <input type="checkbox"/> Construction                | <input checked="" type="checkbox"/> Fields            |
| <input checked="" type="checkbox"/> Forest         | <input type="checkbox"/> Mining (types)              | <input checked="" type="checkbox"/> Livestock pasture |
| <input type="checkbox"/> Logging                   | <input type="checkbox"/> _____                       | <input type="checkbox"/> Other ( _____ )              |
| <input type="checkbox"/> Urban uses (parking lots) | <input checked="" type="checkbox"/> Cropland (types) | _____   |

Are there any discharging pipes?  no  yes if so, how many? 1  
What types of pipes are there?  runoff (field or stormwater runoff) 200 cm diameter tile, 1.5m from water surface, front of tile blocked by grasses  
\_\_\_\_\_ sewage treatment, \_\_\_\_\_ Industrial: type of industry \_\_\_\_\_

Did you test above and below the pipes to determine any change in water quality and were changes noticed? \_\_\_\_\_

Describe % and type of litter in and around the stream: 2% - dead grasses

Comments: Indicate what you think are the current or potential future threats to your stream's health: \_\_\_\_\_

**APPENDIX 4: Steckly Drain, Stream Quality Survey Summary**

station	width	depth	flow - t	flow - n	temp.	type	d. beetle	caddis.	hellgr.	mayfly	colept.	stonefly	w.stry	w.boat	diptera	clams	cray
1	2.9	20	n	0	23	run	5			28			4			1	
2	1.8	20	n	0.143	23	riffle	13			60			16		2	1	
3	1.6	5	n	0.2	24	riffle	11	3		25			1		2		1
4	2.9	15	n	0	26	run	5			16	25		27				1
5	2	28	n	0	26	run	4			23			12		1		4
6	3	27	n	0.1	19	run	5		7	20			1	30	3		1
7	2.2	15	n	0.167	20	run	18		8	17			1	15	4	1	1
8	2.1	5	n	0.25	21	riffle	6			16	4		1	1	11		1
9	2.7	30	n	0	20	run	6			3			18		1		
10	2.5	15	n	0.111	20	run	3			18			5				
11	2.7	15	n	0	23	riffle	23		1	21	2		6				
12	2.7	10	n	0.2	22	riffle	14		1	5			6				
13	2.4	10	n	0.125	23	riffle			2	31	16		1		1		2
14	1.9	18	n	0.105	21.5	run	6		1	26			30		2	1	1
15	1.9	15	n	0.083	22	run	5			6			7		2	13	1
16	1.7	12	n	0.125	23	riffle	14			33			9		1		
17	1.1	5	n	0.125	26	riffle	15	1		8					17		
18	2.2	20	n	0.083	24	riffle	8		1	27			17		2		2
19	1.9	10	n	0.143	26	riffle	30	2	1	10	1		2		1	1	2
20	2.6	5	n	0.111	23	riffle		1					4		1	1	
21	1.9	5	n	0.083	25	riffle	4			10	20		2		4	1	
22	1	20	n	0	25	run	1				1						
23	1.35	10	n	0.111	24	riffle				4	5		10		5	3	
24	5.7	45	n	0	22	pool											
25	3	5	n	0.2	24	riffle	17			11			7				1
26	1.6	12	n	0.071	25	run	13			19			5		3		
27	2	15	n	0.063	27	riffle	3			33			44		2		1
28	2	7	n	0.125	28	run	18			9			8		8		
29	3.6	35	n	0	26	pool	4			10							1
30	2.1	20	n	0.091	16	run	1			2							
31	2.8	20	n	0.071	16	run	1						1				
32	2.5	15	n	0.091	16	run											
33	2.5	15	n	0.138	16	pool	1						2		1		
34	3.95	20	n	0.035	16	run	4						4				
35	2.5	12	n	.0.083	16	riffle									2		
avg ./T	2.38	15.886		0.0924	22.214		258	7	22	491	68	6	2	294	76	23	20

**APPENDIX 4 : Steckly Drain, Stream Quality Survey Summary**

station	damsel	dragon	scud	sow a.	worm	leech	midge	snail	fish q.	barrier	wat app	odor	stabilit	station	%cov	bed dep	erosion
1			2		50	7	6	5		n	b	n	n	1	g	b,si,sa	h
2			12		50	1	4	3		n	b,c	n	n	2	g	b,sa	sl
3			13		50	2		5		n	c	n	n	3	g	b,sa	m
4			2		50		3	2	si	n	b,c	n	f	4	g	b,si,sa	sl
5	2		2		45	8	1	4	si	n	b	n	n	5	g	b,si,sa	sl
6			16		55	6	1	14		n	b,c	n	n	6	g	b,si,sa	sl
7			26		55	15	3	7	si	n	c	n	n	7	g	b,sa	sl
8			15		55	4	6	3		n	c	n	n	8	g	b,sa	sl
9					29	4	8	1	si	n	b,c	n	n	9	g	b,sa	sl
10					55	6	12	4		n	b,c	n	n	10	g	b,sa,si	sl
11			8		55	2	12	2		n	b,c	n	n	11	g	b,sa	sl
12			6		35	4	11	5	si	n	b,c	n	n	12	g	b,sa	sl
13			8		55	18	11	7	si	n	b,c	n	n	13	g	b,sa	sl
14	8				47	7	3	2		n	b	n	f	14	g	b,sa,si	sl
15			6		50	10	29	5		n	b	n	f	15	g	b,sa,si	sl
16			18		50	11	4			n	c	n	f	16	g	b,sa, si	sl
17			3		87	8	2	3		n	c	n	n	17	g	b,sa	sl
18			2		60	7	1	2		n	c	n	f	18	g	b,sa,si	sl
19			5		51	3	11		si	n	c	n	n	19	g	b,sa	sl
20					7	1	26	4		n	c	n	n	20	g	b	sl
21			1		28	3	5	2	si	n	b,c	n	n	21	g	b,sa	sl
22	1				1			1	si	n	b,c	n	f	22	f,g	b,sa,si	h
23			3		31	4	22	5		n	c	n	f	23	g	b,sa,si	h
24					3	2	20	6	ss	n	b,mi.mu	n	f	24	f	b,sa,si	h
25			12		36	3	9	8		n	c	n	f	25	g	b,sa,si	sl
26	2		8		73	11	16			n	b,c	n	f	26	f,g	b,sa,si	m
27		1			54	4	35			n	b,c	n	f	27	g	b,sa,si	m
28			29		69	14	8	1		n	b,c	n	f	28	g	b,sa,si	sl
29					50	4	53	2	si	n	b,mu	n	f	29	g	b,sa,si	sl
30					3	1	6	1	si	n	c	n	f	30	g	b,sa,si	sl
31			1			1	5	2	si	n	c	n	f	31	g	b,sa,si	m
32			2		18	3	3	4		n	c	n	f	32	g	b,sa,si	sl
33			5		4	2	2	3		n	c	n	f	33	g	b,sa,si	sl
34							2			n	c	n	f	34	g	b,sa,si	sl
35			3		10		14			n	c	n	f	35	g	b,sa	sl
	13	1	208	0	1371	176	354	113									

**APPENDIX 4: Steckly Drain, Stream Quality Survey Summary**

station	shrubs	grasses	trees	silt	sand	gravel	cobbles	boulders	algae l.green	algae d.green	algae b.coat	algae matted	algae hairy	algae every	algae spots	algae cover	tiles
1	5	95		5	25	60	10		1		1	1	1	1			1
2	5	95			15	80	15		1	1	1	1	1		1	80	
3		100		5	10	80	5		1	1	1	1	1		1	80	1
4		100		10	40	50			1		1	1	1	1			
5		100		5	5	80	10		1		1	1	1	1			1
6		100		10	70	10	10				1	1	1		1	90	
7		100		10	20	60	10				1	1	1		1	95	1
8		100		5	15	70	10		1		1	1	1		1	70	
9		100		10	80	10			1	1	1	1	1		1	90	1
10		100		5	15	70	10		1	1	1	1	1	1			
11		100		5	20	70	5		1		1	1	1		1	70	1
12		100		5	20	70	5				1	1	1		1	70	
13		100		5	20	10	65		1	1	1	1	1		1	80	
14	2	98		20	20	40	20		1	1	1	1	1		1	80	3
15		96	4	40	10	40	10		1	1	1	1	1		1	20	
16		100		10	30	50	10		1	1	1	1	1		1	80	1
17		100		10	15	50	25		1	1			1		1	60	
18	25	25	50	15	15	50	20		1	1	1	1	1		1	95	1
19	5	95		5	30	30	35		1	1	1	1	1		1	80	
20		100			10	90				1					1	60	
21		100		5	10	85				1			1		1	70	
22		100		30	35	35				1	1	1	1		1	70	1
23		100		30	35	35				1	1	1	1		1	60	
24		100		40	20	30	10				1	1	1		1	60	2
25		100		30	35	35			1	1	1	1	1		1	70	
26		100		30	30	40			1	1	1	1	1		1	90	1
27		100		40	30	30				1	1	1	1		1	80	
28		100		40	10	50				1	1	1	1		1	70	1
29	2	96	2	60	10		30				1	1	1	1			
30		90	10	30	70				1		1	1	1		1	60	
31		100		50	40	10			1			1	1		1	60	1
32	5	95		60	40				1			1	1		1	30	
33		100		35	30	35			1			1	1		1	40	3
34		100		60	40				1			1	1		1	40	
35	10	90		60	40				1			1	1		1	50	
	1.6857	96.429	1.89	22.3	27.429	41.571	9		24	19	28	32	34	5	30	68.33	20



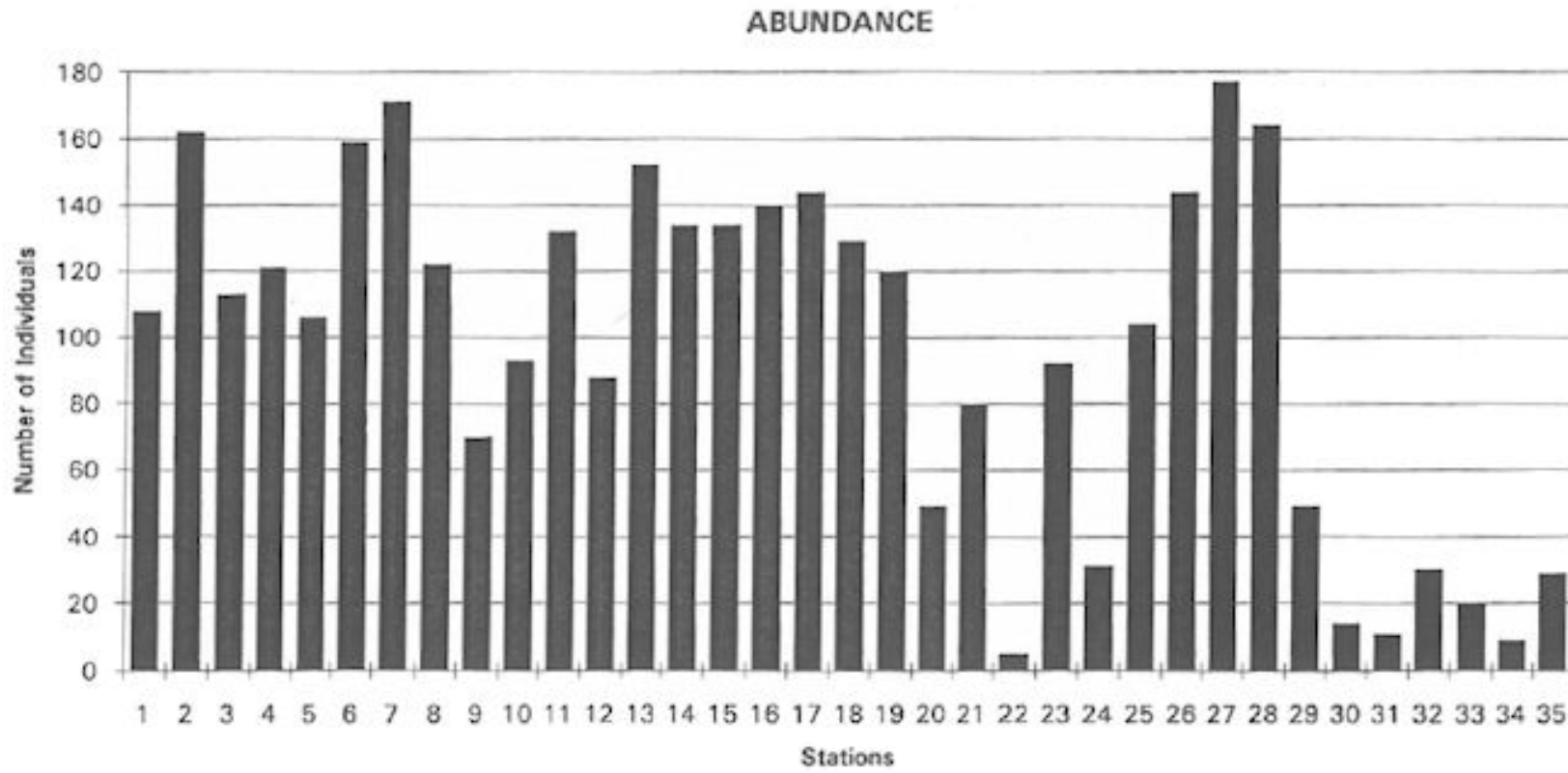
## **APPENDIX 5**

### **ABUNDANCE**

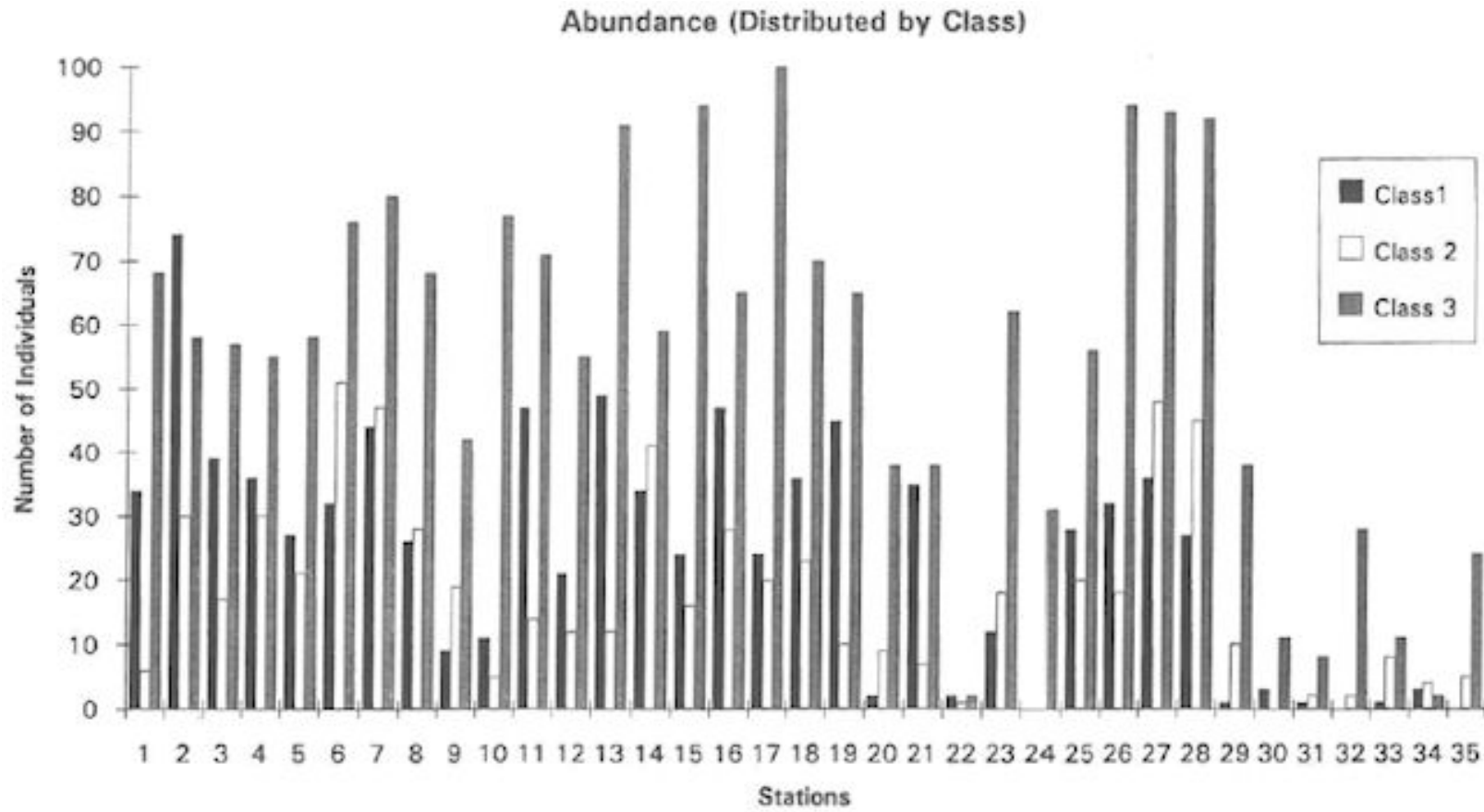
- Overall Abundance
- Abundance Distributed by Class
- Abundance of Class 1 Individuals
- Abundance of Class 2 Individuals
- Abundance of Class 3 Individuals



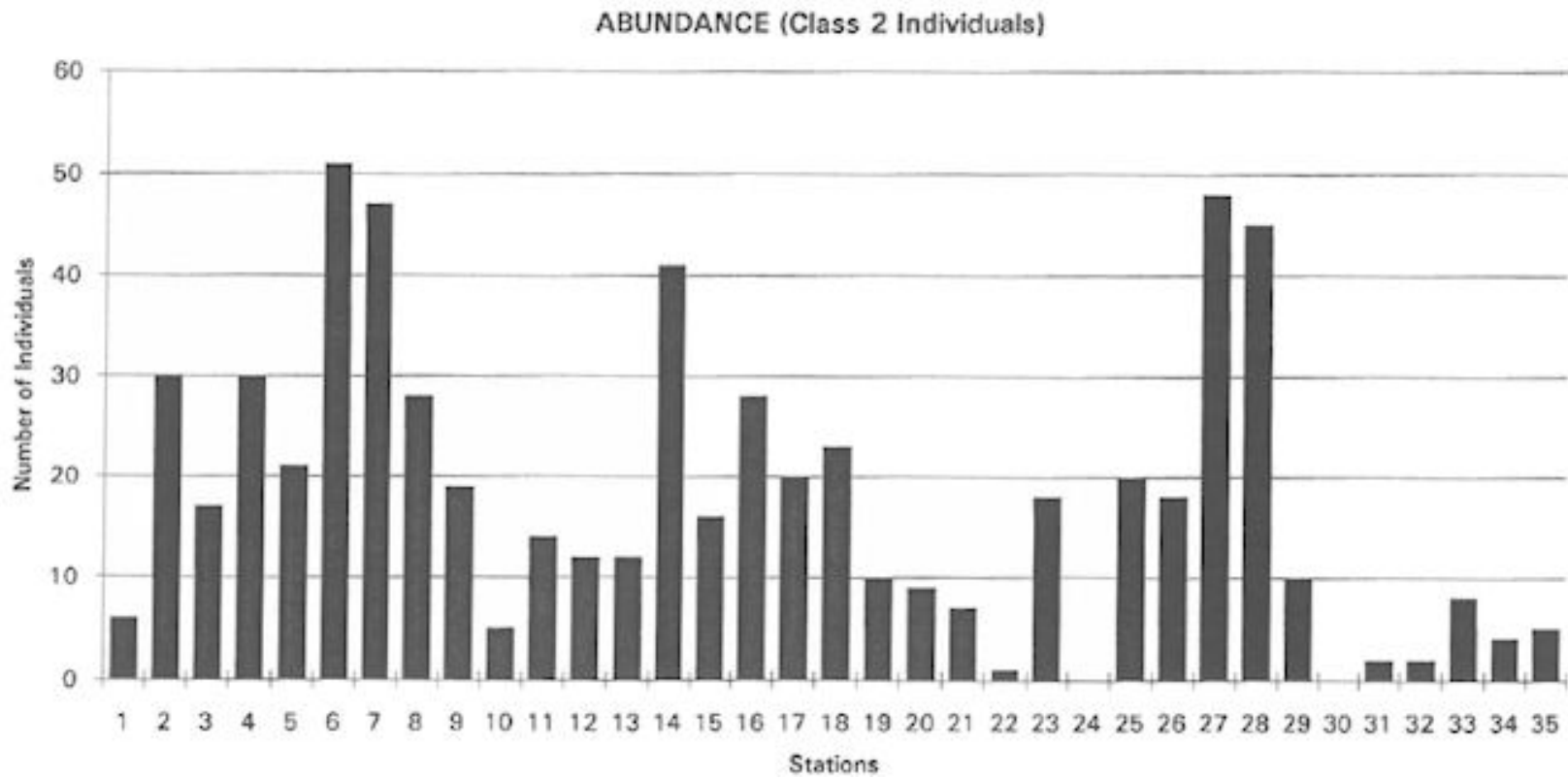
APPENDIX 5: Steckly Drain



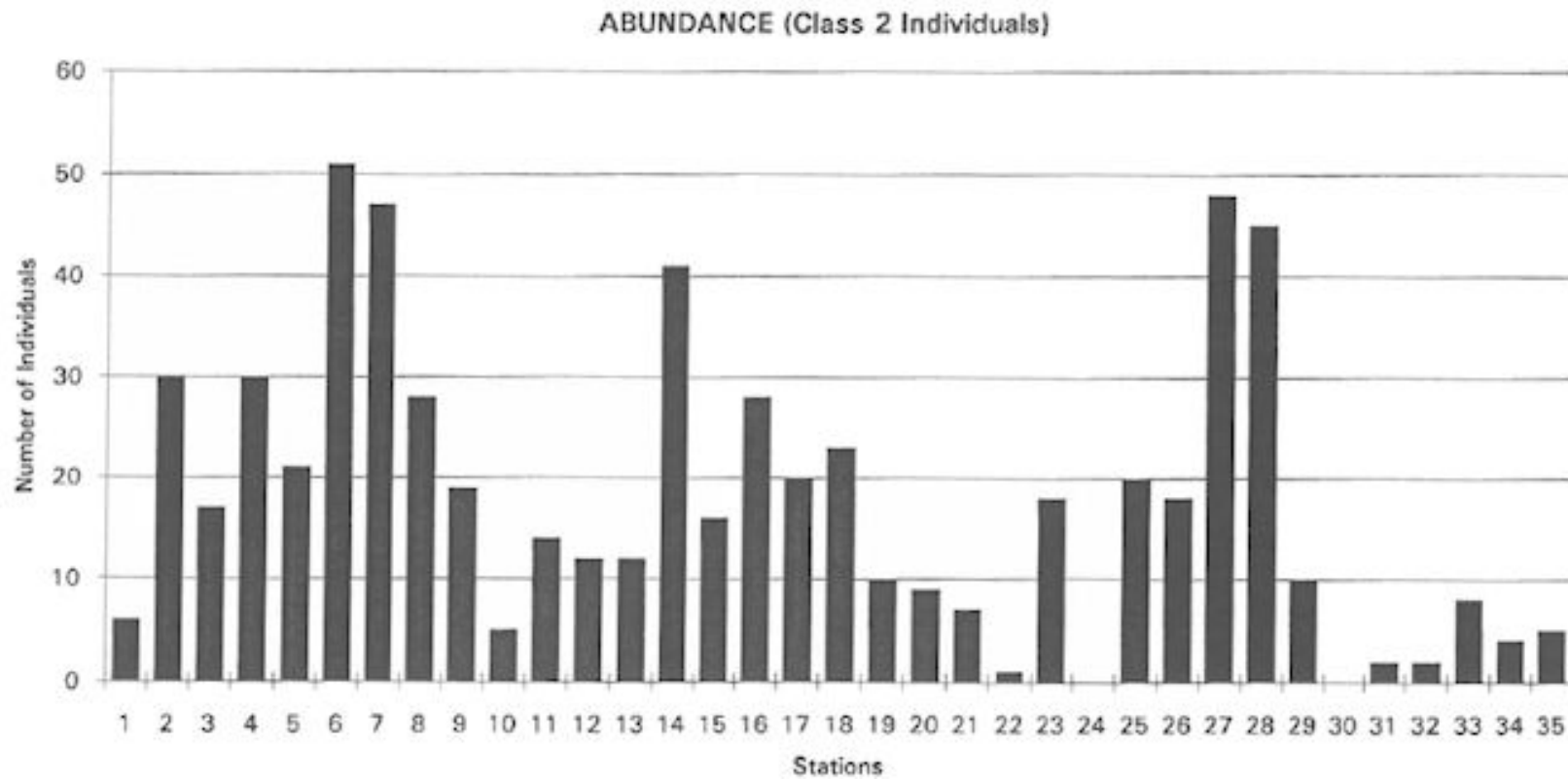
APPENDIX 5: Steckly Drain



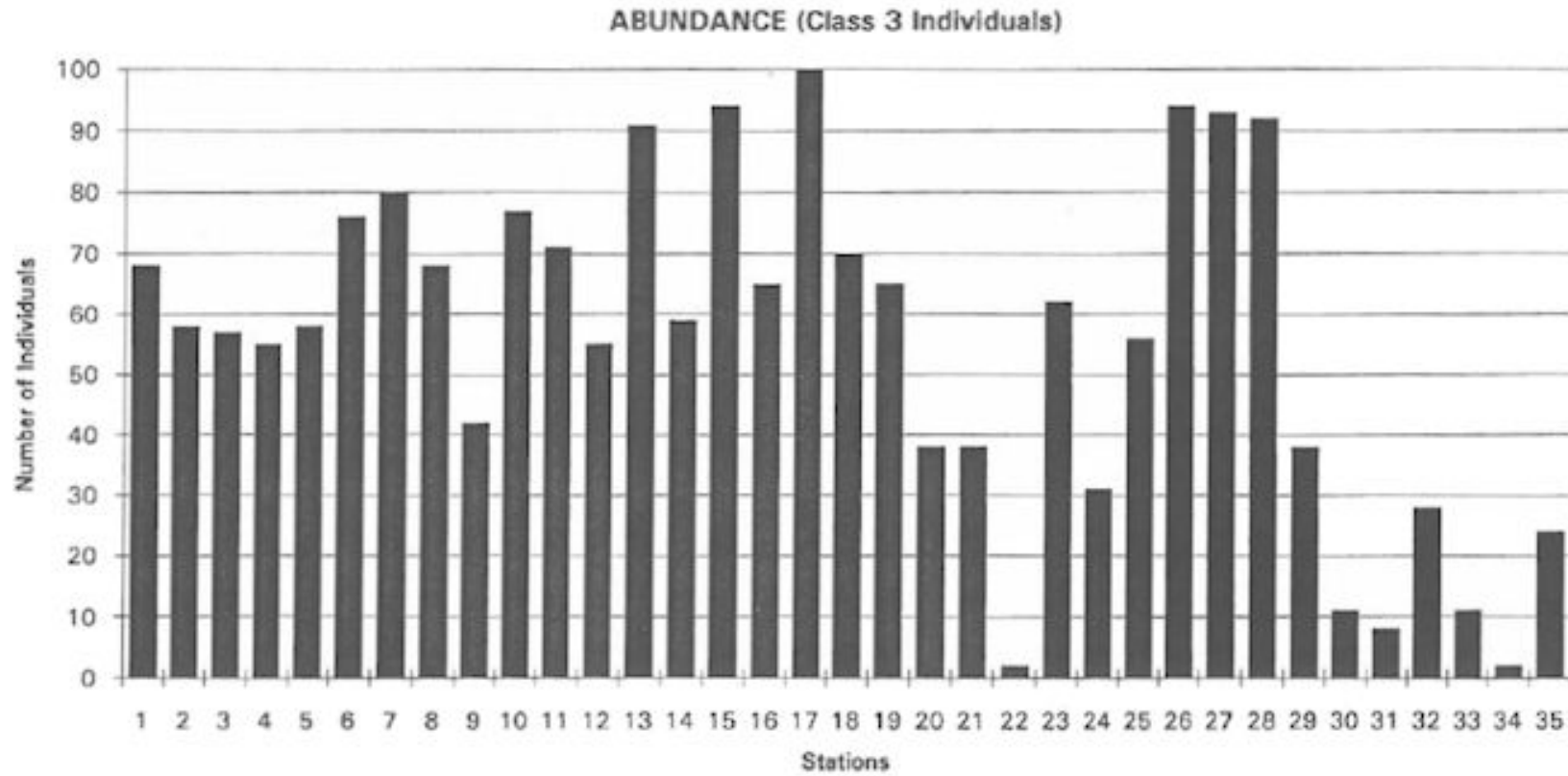
APPENDIX 5: Steckly Drain



APPENDIX 5: Steckly Drain



APPENDIX 5: Steckly Drain





**APPENDIX 6**

**WATER QUALITY DATA**



**APPENDIX 6: Steckly Drain, WATER SAMPLING DATA**

Parameters	15-Jun		27-Jun	
	BELOW	ABOVE	BELOW	ABOVE
Conductivity	580	456	667	642
pH	8.53	8.5	8.51	8.36
Chloride	30	19.5	32.1	25.8
Turbidity	2.45S6+	7.68S6+	4.90S6+	2.63S46
Phosphorous, Total	0.084	0.17	0.118	0.116
Phosphates	0.034	0.029	0.07	0.0785
Nitrogen, Total Kjeld	1.18	1.7	0.98	0.98
Ammonium	0.126	0.22	0.054	0.074
Nitrates	3.63	4.05	4.25	4.87
Nitrite	0.133	0.095	0.17	0.119
Dissolved Org. Carbon	5	5.5	6.2	5.9
Fecal Streptococcus	120<=>	40<=>	110	190
Pseud. Aeruginosa	4	<4<	2	6
E. Coli	10000	200	350	750
Fecal Col.				

Parameters	25-Jul	
	BELOW	ABOVE
Conductivity	764	708
pH	8.2	8.45
Chloride	48.2	42
Turbidity	2.49S46	2.74S46
Phosphorous, Total	0.06	0.086
Phosphates	0.022	0.0375
Nitrogen, Total Kjeld	0.74	0.76
Ammonium	0.03	0.032
Nitrates	4.94	5.15
Nitrite	0.076	0.079
Dissolved Org. Carbon	4.2	4.1
Fecal Streptococcus	220	170
Pseud. Aeruginosa	4	<2<A3C
E. Coli	2700	450
Fecal Col.		



## **APPENDIX 7**

### **VEGETATION**

- Summary of Vegetation for the Drain
- Vegetation Present at Each Station



## APPENDIX 7: Steckly Drain

### VEGETATION PRESENCE

Vegetation	No. of Sites	Vegetation	No. of Sites
goldenrod	27	apple tree	2
sweet flag	35	basswood	1
horsetail	30	bird's foot treefoil	9
burdock	32	grapevine	1
thistle	5	wild mustard	19
anemone	27	teasel	6
buttercup	11	bedstraw	4
milkweed	23	Carex sp.	7
brome grass	13	Panicum sp.	15
raspberry	3	curled dock	6
hawthorn	1	toadflax	5
fleabane	9	timothy	12
wild carrot	4	goat's beard	3
climbing nightshade	4	moss	4
fern	1	willow	3
mullein	1	spruce	5
Russian olive	4	skunk cabbage	3
elderberry	1	speedwell	27
dandelion	21	St. John's wort	28
jewel weed	34	stinging nettle	4
orchard grass	25	dogwood	3

## APPENDIX 7: Steckly Drain

### VEGETATION PRESENT AT EACH STATION

station 1	station 2	station 3	station 4	station 5
speedwell	speedwell	speedwell	speedwell	speedwell
St. John's wort	St. John's wort	St. John's wort	St. John's wort	St. John's wort
jewel weed	jewel weed	jewel weed	jewel weed	jewel weed
orchard grass	orchard grass	orchard grass	orchard grass	orchard grass
goldenrod	goldenrod	goldenrod	goldenrod	goldenrod
sweet flag	sweet flag	sweet flag	sweet flag	sweet flag
horsetail	horsetail	horsetail	horsetail	horsetail
wild mustard	wild mustard	burdock	burdock	burdock
teasel	milkweed	thistle	thistle	thistle
burdock	fleabane	dandelion	brome	brome
anemone	Carex sp.	milkweed	milkweed	milkweed
buttercup	Panicum	anemone	anemone	anemone
milkweed	burdock	curled dock	curled dock	Panicum sp.
skunk cabbage	dogwood	cow vetch	cow vetch	bedstraw
raspberry	stinging nettle	Panicum sp.	Panicum sp.	wild mustard
hawthorn			bedstraw	bird's foot treefoil
fleabane	15	15	buttercup	
Carex sp.				16
Panicum sp.			17	
curled dock				
20				
station 6	station 7	station 8	station 9	station 10
speedwell	speedwell	speedwell	jewel weed	speedwell
St. John's wort	St. John's wort	St. John's wort	orchard grass	St. John's wort
jewel weed	jewel weed	jewel weed	goldenrod	jewel weed
orchard grass	orchard grass	orchard grass	sweet flag	orchard grass
goldenrod	goldenrod	goldenrod	burdock	goldenrod
sweet flag	sweet flag	sweet flag	brome	sweet flag
horsetail	burdock	burdock	horsetail	burdock
burdock	brome	brome	anemone	brome
brome	milkweed	horsetail	toadflax	horsetail
milkweed	wild mustard	anemone	wild mustard	anemone
buttercup	bird's foot treefoil	Panicum sp.		Panicum sp.
bird's foot treefoil	anemone	Carex sp.	10	Carex sp.
fleabane	Panicum sp.	toadflax		toadflax
toadflax		timothy		timothy
	13			curled dock
14		14		bird's foot treefoil
				fleabane
				dandelion
				wild carrot
				climbing nightshade
				20

## APPENDIX 7: Steckly Drain

station 11	station 12	station 13	station 14	station 15
speedwell	speedwell	speedwell	speedwell	speedwell
St. John's wort	St. John's wort	St. John's wort	St. John's wort	St. John's wort
jewel weed	jewel weed	jewel weed	jewel weed	orchard grass
orchard grass	orchard grass	orchard grass	orchard grass	goldenrod
goldenrod	goldenrod	goldenrod	goldenrod	sweet flag
sweet flag	sweet flag	sweet flag	sweet flag	burdock
brome	brome	burdock	burdock	horsetail
milkweed	milkweed	brome	horsetail	anemone
bird's foot treefoil	bird's foot treefoil	horsetail	anemone	dandelion
bedstraw	wild mustard	anemone	dandelion	bird's foot treefoil
	curled dock	dandelion	Panicum sp.	bedstraw
11	anemone	wild carrot	milkweed	fleabane
	buttercup	toadflax	fleabane	Carex sp.
	13	milkweed	raspberry	apple tree
		goat's beard	buttercup	
		Panicum sp.		14
		16	15	
station 16	station 17	station 18	station 19	station 20
speedwell	speedwell	speedwell	St. John's wort	St. John's wort
St. John's wort	St. John's wort	St. John's wort	jewel weed	jewel weed
jewel weed	jewel weed	jewel weed	orchard grass	orchard grass
orchard grass	orchard grass	orchard grass	sweet flag	sweet flag
goldenrod	goldenrod	goldenrod	horsetail	speedwell
sweet flag	sweet flag	sweet flag	wild mustard	wild mustard
burdock	burdock	horsetail	burdock	burdock
horsetail	horsetail	wild mustard	brome grass	anemone
anemone	anemone	buttercup	cow vetch	milkweed
dandelion	milkweed	burdock	thistle	timothy
Panicum sp.	fleabane	brome grass	dandelion	stinging nettle
milkweed	wild mustard	cow vetch	anemone	dandelion
climbing nightshade		thistle	climbing nightshade	fern
Carex sp.	12	dandelion	curled dock	
14		apple tree	raspberry	13
		basswood		
		bird's foot treefoil	15	
		grapevine		
		18		

## APPENDIX 7 : Steckly Drain

station 21	station 22	station 23	station 24	station 25	station 26
speedwell	speedwell	speedwell	speedwell	speedwell	speedwell
St. John's wort	St. John's wort	St. John's wort	St. John's wort	St. John's wort	St. John's wort
jewel weed	jewel weed	jewel weed	jewel weed	jewel weed	jewel weed
goldenrod	goldenrod	sweet flag	sweet flag	sweet flag	sweet flag
sweet flag	sweet flag	horsetail	timothy	timothy	timothy
horsetail	horsetail	burdock	milkweed	milkweed	milkweed
wild mustard	burdock	timothy	anemone	anemone	burdock
burdock	anemone	milkweed	fleabane	fleabane	dandelion
anemone	timothy	wild mustard	burdock	burdock	horsetail
timothy		dandelion	dandelion	dandelion	orchard grass
dandelion	9			horsetail	Carex spp.
		10	10	stinging nettle	Panicum spp.
11				orchard grass	
				buttercup	12
				goldenrod	
				15	
station 27	station 28	station 29	station 30	station 31	station 32
speedwell	speedwell	speedwell	anemone	sweet flag	sweet flag
St. John's wort	St. John's wort	St. John's wort	sweet flag	wild mustard	wild mustard
jewel weed	jewel weed	jewel weed	wild mustard	jewel weed	jewel weed
sweet flag	sweet flag	sweet flag	mullein	teasel	teasel
timothy	timothy	timothy	burdock	climb. nightshade	milkweed
milkweed	burdock	burdock	horsetail	moss	burdock
burdock	horsetail	horsetail	willow	milkweed	dandelion
horsetail	orchard grass	orchard grass	spruce	willow	horsetail
orchard grass	goldenrod	goldenrod	Russian olive	spruce	anemone
Panicum spp.	dandelion	buttercup	dandelion	Russian olive	spruce
goldenrod	buttercup	wild mustard	jewel weed	dandelion	elderberry
bird's foot trefoil		dogwood		burdock	skunk cabbage
goat's beard	11	moss	11		goldenrod
		Panicum spp.		12	
13		anemone			13
		15			

## APPENDIX 7: Steckly Drain

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station 33	station 34	station 35
sweet flag	sweet flag	sweet flag
wild mustard	wild mustard	wild mustard
jewel weed	jewel weed	jewel weed
milkweed	milkweed	dandelion
burdock	burdock	horsetail
dandelion	dandelion	anemone
horsetail	horsetail	moss
anemone	anemone	teasel
spruce	spruce	Russian olive
goldenrod	buttercup	wild tarot
buttercup	moss	stinging nettle
skunk cabbage	teasel	dogwood
	Russian olive	brome
12	cedar	goldenrod
	wild carat	willow
	15	15

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