EIS AND LEVEL 2 NATURAL ENVIRONMENT REPORT: PROPOSED MOUNTSBERG QUARRY

DRAFT FOR DISCUSSION

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1.0 Introduction

Stantec Consulting Ltd. (Stantec) was retained by Lowndes Holdings Corp. on October 1, 2003 to complete an Environmental Impact Statement (EIS) and Levels 1 and 2 Natural Environment Reports that would accompany applications for Amendments to the Town of Flamborough Official Plan and Zoning By-law No. 90-145-Z and for a Category 2, Class "A" Below Groundwater Quarry License under the Aggregate Resources Act.

The subject lands included in this draft EIS/Level 2 Natural Environment Report occupy 158.2 hectares on Part of Lot 1, Lots 2 and 3, Concession 11, geographic Township of East Flamborough, City of Hamilton, and are shown on Figure 1. The site is underlain by a significant Amabel dolostone deposit up to 40 metres in depth, and has been designated as a mineral aggregate area. Extraction of this resource is planned to produce crushed rock. The proposed quarry will be developed in phases, which will be progressively rehabilitated. Extraction will be below the water table and will require dewatering.

Category 2 Class 'A' licenses are for quarries with excavation of bedrock below the established water table. A Level 2 Natural Environment Technical Report is required by the Provincial Standards (1997) of the Aggregate Resources Act, if significant natural features exist on and/or within 120m of the site. The report is required to determine the degree of impact on the natural features or ecological functions and propose any preventative, mitigative or remedial measures that may be necessary. In addition, the Provincial Policy Statement and the Official Plans of the City of Hamilton require an EIS for developments proposed within or adjacent to such features.

As part of the Level 1 background review and Preliminary Level 2 Natural Environment Report (Stantec Consulting Ltd., 2004) prepared for this site, significant natural features were determined to occur either on or within the 120 m surrounding the proposed extraction site. This EIS/Level 2 Natural Environment Report, once updated and finalized, will serve as both the EIS and the Level 2 Natural Environment Report to satisfy both the Official Plan requirements of the City of Hamilton as well as the requirements of the ARA.

The quarry site plan reviewed as part of this reporting (Long Environmental Consultants, 2004) involves a 67 ha extraction footprint. This footprint was decreased by about 42%, from an original proposed area of 96 ha, through the early review and consideration of ecological data collected and impact assessment discussions amongst team members. The proposed limit of extraction has been revised in this reporting to reflect the recent policy requirements of the Greenbelt Plan as well as the results of natural heritage fieldwork on the site in 2005. A more detailed description is provided in Section 6.1 and in Figure 10.

This report has benefited from formal comments on the Preliminary Level 2 Natural Environment Report (Stantec Consulting Ltd., 2004) by Conservation Halton and the Environmentally Significant Areas Impact Evaluation Group (ESAIEG) (October 27, 2004). It has also benefited

from ongoing technical reporting and discussions amongst other technical members of the Lowndes Holding Corp., project team.

The intent of releasing this updated report at this time is to provide current technical information and analyses to the City and agencies in order to facilitate an on-going dialogue. This report release is also intended to offer time for the City and agencies to review current data with regard to seasonal observations. Any additional thoughts/comments from the City and agencies that relate to the need to examine specific ecological features and functions can be highlighted in the near-term, prior to the onset of the 2006 ecological data collection season.

It is useful to note that agencies have offered additional comments on related technical work and activities (e.g. ongoing hydrogeological work being completed by Gartner Lee Limited on behalf of the Lowndes Holdings Corp.). We recognize that this ongoing earth science work will affect some aspects of this reporting, especially sections related to potential effects and mitigation. This report will be reviewed and updated as earth science data/interpretations are finalized.

1.1 ENVIRONMENTAL POLICY CONTEXT

Provincial Policy Statement

The Provincial Policy Statement (PPS) that applies to this application, was issued under Section 3 of the Planning Act, and came into effect on May 22, 1996. Planning authorities shall have regard to policy statements issued under the Planning Act. The PPS includes policies on development and land use patterns, resources, and public health and safety. The PPS was revised (2005) and has been considered in the production of this report. The planning application for this project was submitted under the 1996 PPS. This report deals with Policy 2.3, which addresses protection and management of natural heritage resources.

Seven types of natural heritage features are defined in the PPS:

- Significant wetlands (PSWs)
- Significant portions of the habitat of endangered and threatened species
- Fish habitat
- Significant woodlands
- Significant valleylands
- Significant Areas of Natural and Scientific Interest (ANSIs)
- Significant wildlife habitat

Aggregate Resources Act

Category 2 Class ‘A’ licenses are for quarries with excavation of bedrock below the established water table. The Provincial Standards of the Aggregate Resources Act (ARA) require a Level 1 Natural Environment Technical Report to determine whether any of the features listed above exist on and/or within 120 metres of the site. If any of the above features are present, then a Level 2 Natural Environment Technical Report is required to:

- Determine the degree of impact on the natural features or ecological functions; and
- Propose any preventative, mitigative or remedial measures that may be necessary.

Greenbelt Act

The Greenbelt Act was approved by the Provincial legislature on February 24, 2005, permitting the establishment of a Greenbelt Plan, which was passed by Order in Council on February 28, 2005. Key elements of the Plan are to protect greenspace and contain urban sprawl in the Greater Golden Horseshoe. The proposed quarry is located within areas designated as "Protected Countryside" and "Natural Heritage System" within the Greenbelt Plan.

The Greenbelt Plan recognizes that the establishment of mineral aggregate operations can be considered throughout the Natural Heritage System, subject to the specific policies in Section 4.3 of the Greenbelt Plan. No new mineral aggregate operation will be permitted in significant wetlands, significant habitat of endangered or threatened species or significant woodlands, unless the woodland is occupied by young plantation or early successional habitat. In the case of mineral aggregate resources, the Plan does not permit Official Plans and Zoning By-laws to be more restrictive than the Greenbelt Plan.

1.1.1 City of Hamilton

The site falls within the planning area of the former Municipality of Flamborough in the City of Hamilton. Portions of the site are identified as Environmentally Significant Areas (Mountsberg Wetlands East ESA and Carlisle North Forests ESA). The Regional Official Plan for the former Regional Municipality of Hamilton-Wentworth designations include: Core Natural Area, (including both Environmentally Significant Area [ESA] and Provincially Significant Wetland [PSW]), Mineral Aggregate Resource area, and some prime agricultural lands (Hamilton–Wentworth Official Plan, April 1998). The Plan provides that land use changes, within and adjacent to ESAs, will be permitted where the changes will not adversely affect, degrade or destroy the area qualities which are the basis of the designation, will not cause any significant water quality or quantity impacts, and will not adversely affect resource protection policies or plan implementation (Section C.1.2.2c). Applications for land use changes within and adjacent to ESAs are referred to Environmentally Significant Areas Impact Evaluation Group (ESAIEG) for review.

1.2 STUDY PURPOSE AND CONTENTS

An EIS is a study that assesses the potential impact of a development proposal on the natural environment. Such a study allows the applicant to create a development plan that avoids, minimizes and/or mitigates against negative environmental effects and which assists planners in determining whether the proposal is in compliance with municipal and provincial policy. The EIS also serves as a source of important information to the landowner (City of Hamilton, 2004). This EIS has been prepared to meet the requirements of the City of Hamilton and the Provincial Policy Statement, consistent with the Greenbelt Plan (2005). Additionally this EIS is extended to comprise a Level 2 Natural Environment Report for an application under the Aggregate Resources Act.

This draft EIS/Level 2 Natural Environment Report:

- Describes the proposal;
- Identifies the desktop sources, research and field work methods and analyses used;
- Describes the existing on-site and surrounding environment;
- Identifies and assesses the potential negative impacts of the proposal on natural heritage features and functions; and,
- Identifies positive effects of the proposal (enhancement, restoration).

As noted above (section 1.0), this report is intended to support continued dialogue with review agencies, by providing current and updated data and analyses for consideration. The final EIS/Level 2 Natural Environment Report document will reflect comments from review agencies and the City's peer reviewers on this document and related hydrogeological and hydrological reports. It will also more fully evaluate feasible mitigation measures and will present detailed adaptive management, rehabilitation and monitoring plans, as required.

1.3 STUDY TERMS OF REFERENCE

Detailed Terms of Reference for this report were prepared with reference to the Environmental Impact Statement (EIS) Guidelines (City of Hamilton, July 2004), and submitted to the City of Hamilton on March 3, 2005 (Appendix C). Comments were provided by Conservation Halton on June 28, 2005. In June 2005, the City of Hamilton retained Dougan & Associates and C. Portt & Associates as its Natural Environment Peer Review Consultant. They completed a review of the Terms of Reference included as Appendix C to this report. Dougan & Portt issued their: "Peer Review Terms of Reference For Environmental Impact Statement" on September 13th, 2005, which was accompanied by comments from the City's Natural Heritage Planner, on October 20th, 2005. This professional input has enabled Stantec to refine certain technical approaches to optimize this technical program.

2.0 Approach

The "Approach" section provides detailed information on background data sources and the field methods used to survey:

- Vegetation and flora;
- Wetland boundaries;
- Winter wildlife surveys;
- Amphibians and reptiles;
- Breeding birds;
- Butterflies and other wildlife;
- Surface water monitoring;
- Fish habitat assessment; and,
- Benthic invertebrates.

The following sub-sections address various aspects of ecology. Throughout this technical program, discussions were held with experts involved in other disciplines (e.g. Gartner Lee Limited – hydrogeology). These discussions complemented the use of formal technical reports prepared by these experts (i.e. Section 2.1 and Section 8.0).

2.1 BACKGROUND RESOURCES

A variety of background resources were consulted to characterize the site and assess the significance of features, including:

- Natural Heritage Information Centre (NHIC) database (accessed January, May and November 2004);
- Bronte Creek Watershed Study (Conservation Halton, 2002);
- Nature Counts Project: Hamilton Natural Areas Inventory Vol. I and II (Hamilton Naturalists Club, 2003);
- Hamilton-Wentworth Region Environmentally Sensitive Areas Study (Ecologistics, 1976);
- Halton Region Environmentally Sensitive Areas Study (Geomatics International Inc, 1993);
- Ecological Survey of the Niagara Escarpment Biosphere Reserve (Riley *et al.*, 1996); and,
- Ministry of Natural Resources (Provincially Significant Wetlands, deer wintering areas, Areas of Natural and Scientific Interest).

Additionally, detailed site-specific studies of soils, geology, hydrology and hydrogeology were reviewed and incorporated:

- Agricultural and Surficial Soil Report (Stovel and Associates, 2004);
- Surficial Soils and Microdrainage (Stovel and Associates, 2006);
- Draft Hydrogeological Level 2 Report Volumes 1-3 (Gartner Lee Ltd., 2005);
- Geological Investigation (JEGEL, 2004); and,
- Draft Hydrological Report (Stantec Consulting Ltd. 2006, in preparation).

2.2 VEGETATION AND VASCULAR PLANTS

2.2.1 Vegetation Communities and Vascular Plants

Field investigations for this project were conducted to confirm and assess the character of existing conditions. The work included Ecological Land Classification (ELC) of vegetation communities and a floristic survey of the subject lands and immediate vicinity. Stantec completed vegetation surveys through three seasons, spanning the period from October 2003 to July 2005:

- Spring (May 13 and 14, 2004);
- Summer (June 13 and 20, July 15 and 18, 2005; July 19, 2004); and,
- Autumn (September 10, 2004; October 16 and 23, 2003).

Vegetation communities were delineated on aerial photographs (November 2003, 1:20,000) and checked in the field; community characterizations (ecosites and ecotypes) were then based on the Ecological Land Classification for Southern Ontario (ELC) (Lee *et al.*, 1998). Common and scientific nomenclature of plant species generally follows Newmaster *et al.* (1998).

Natural heritage information collected from the subject lands was evaluated to determine potential significance at a number of different levels. Provincial significance of vegetation communities was based on the draft rankings assigned by the Natural Heritage Information Centre (Bakowsky, 1996). Local significance of plants was determined from Goodban (2003). Identification of potentially sensitive plant species is based on assignment of a coefficient of conservatism (CC) to each native species in southern Ontario (Oldham *et al.*, 1995). The value of CC, ranging from 0 (low) to 10 (high), is based on a species' tolerance of disturbance and fidelity to a specific natural habitat.

2.2.2 Wetland Boundary Delineation

Wetland communities were examined in accordance with the Southern Manual of the Ontario Wetland Evaluation System (OMNR, 1993). Boundaries were flagged and marked with a Global Positioning System in the field on June 15 and 27, July 12 and 26, August 31, September 7, and October 7, 2005. Subsequently, boundaries were compared and refined based on detailed soils work provided by Stovel and Associates (2006).

2.3 WILDLIFE

Background materials, such as the Hamilton-Wentworth Natural Areas Inventory and the Bronte Creek Watershed Study, were reviewed to identify potentially important habitats. Seasonal, site-specific studies were carried out to characterize the wildlife communities and assess habitat function. Studies are summarized in Table 1 and are described in detail in the following sections.

2.3.1 Winter Wildlife Surveys

Winter surveys were conducted on February 27, March 1, March 4, 2004 and February 11, 2005. The primary goal of the survey was to determine the suitability of these areas as deer wintering habitat. In order to assess the function of the deer wintering area and its importance to the local population an intensive survey was completed.

The survey methodology consisted of walking transects through the wooded portions of the site at designated intervals. Transects were walked in a northwest and southeast fashion throughout the MNR designated deer wintering area on the main portion of the site. Each transect was walked by two observers at 50-80 metre intervals. Six transects were walked in total. In addition to these transects, two stations were observed. These stations were located along Milburough Road and 11 Concession East, adjacent to the eastern white cedar swamp. A transect was not conducted across this feature due to its very wet nature and uniformity. Observation stations were considered important to monitor the potential for deer movement in and out of this area. The following site-specific details were noted on each transect:

- Severity of deer browse (deciduous);
- Evidence of deer tracks and movement trails;
- Scat evidence;
- Number of deer beds;
- Availability of cover (coniferous); and,
- Ecological Land Classification (ELC) vegetation communities.

All of these factors contribute to the determination of the quality of a deer wintering area and the degree of importance of this area to the local population.

The Ministry of Natural Resources does not collect snowfall data in this district. This is due to the generally low snowfall amounts for this region and therefore the low deer mortality related to this issue.

2.3.2 Amphibians and Reptiles

Salamander surveys were completed for this site on April 14 and 15, 2004 and April 26 and May 4, 2005. The surveys consisted of a wandering transect method to inspect all vernal pools for the presence of amphibian egg masses, with special attention to potential Jefferson salamander

egg masses. This method was approved by the MNR and has been used in cooperation with the MNR on numerous other sites in southern Ontario. A Scientific Collectors Permit for the collection of egg masses, was issued by the Ontario Ministry of Natural Resources (OMNR).

Frog call surveys were completed for this site on April 14, May 12 and June 16, 2004 and April 21, May 24, and June 14, 2005. Four locations were visited on each evening survey during 2004, with an additional four sites added for the 2005 season.

A survey was conducted on April 14, 2005 to detect snakes emerging from hibernacula. All of the fencelines were walked and closely searched for snakes. As well, a small foundation near the western road entrance, the barn in the southeast, Tributary A near the northwest corner of the site, and some of the wetland areas in the northern and southeastern portions of the subject lands were checked. Additionally, incidental observations were recorded during all site visits, with particular attention to flipping logs and examining rock piles during the butterfly surveys on May 12 and July 13, 2005 and during the forestry surveys on August 16 and 29, 2005.

2.3.3 Breeding Birds

An owl call survey was completed on the night of April 14, 2004 at two locations on the subject lands. The taped callback method is effective for large areas of forest and was therefore completed in the southeast and northern portions of the property.

Red-shouldered Hawk surveys were completed for this site on May 12, 2004 and April 26, 2005. A tape-recorded call, developed by Bird Studies Canada for the purpose of surveying for Red-shouldered Hawks, was played at eight stations located in the wooded portions of the site. Trees were surveyed for the presence of stick nests that might support breeding woodland raptors.

Breeding bird surveys were conducted on June 2, 4, 21 and 23, 2005 and July 1 and 2, 2004. Surveys were initiated between 05:45 and 06:15 and were completed by 10:00 or whenever bird activity song significantly slowed, whichever was earlier. All surveys were conducted during suitable weather conditions, with winds either calm or very light (Beaufort scale 1), cool temperatures ranging from 12-19°C and generally clear skies, with overcast skies on June 4, 2005 and July 2, 2004.

Each survey consisted of an ecologist surveying the entire site in a systematic manner recording any bird species that were either seen or heard. A conservative approach to determining breeding status was taken; all birds seen or heard in appropriate habitat during the breeding season were assumed to be breeding.

2.3.4 Butterflies and Other Wildlife

Butterfly surveys were conducted on the Lowndes property on May 12, 2005 (11:00-17:00, very sunny with no clouds, but cool at 10°C and a moderate breeze with much calmer conditions in sheltered areas of forest clearings and field edges) and on July 14, 2005 (09:00-15:30, cloud

cover ranging from 10% to 40%, temperatures of approximately 32°C with calm winds increasing to gentle breeze [Beaufort scale 0-3] as the survey progressed). The early survey was timed to coincide with peak potential West Virginia white activity, and the later survey was intended to capture the flight seasons of the locally significant butterflies noted in the Natural Areas Inventory report (Hamilton Naturalists Club, 2003).

The early survey focused on potential West Virginia white habitat. During the second survey, the Pollard Walk (Pollard, 1977) was used to survey for general abundance. Three line transects of 900 metres, 700 metres and 550 metres were established, running northwest to southeast through the site, spaced approximately 300 meters apart. All butterflies observed within 2.5 metres on either side of and 5 metres above the transect were counted. Significance of species in Ontario was determined from the NHIC and in the City of Hamilton from Wormington and Lamond (2003).

2.4 AQUATIC RESOURCES

2.4.1 Surface Water Monitoring

A surface water monitoring program was established for this site in the fall of 2003 in association with Gartner Lee Limited. This program included measurements for flow, temperature and water levels in the watercourses surrounding the site. Water levels and flows were monitored at all of the locations during the pump tests in April and November 2004, and as part of the fisheries program.

Samples of surface water collected in November 2004, February 2005, June 2005 and September 2005 were analyzed for water quality. Baseline levels of dissolved oxygen, conductivity, pH, alkalinity, total suspended solids, total dissolved solids, nitrogen, major ions by ICP-MS and anions (chloride, phosphate, bromide, sulphate, nitrate, nitrite) were established. Temperature dataloggers were strategically placed at five locations within the vicinity of the subject lands to determine the thermal regime of surface water features that have the potential to be cool/cold water.

The surface water monitoring program was expanded in September, 2005 and included continuous sampling of water levels and temperature at additional locations across the site. Details are provided in the Hydrological Report (Stantec, 2006. in preparation).

2.4.2 Fish Habitat Assessment

A review of available background information on Flamboro and Mountsberg Creeks within the vicinity of the subject lands was completed. Information sources included fish “dot” (survey point inventory) data obtained from the OMNR, the Bronte Creek Watershed Study (BCWS) (Conservation Halton, 2002) and a search of the Natural Heritage Information Centre (NHIC) database to identify any significant species. Field investigations were also conducted to supplement existing data and to provide baseline sampling locations for future ecological monitoring.

Field investigations completed by Stantec include redd surveys, fisheries community inventories, aquatic habitat assessments and benthic invertebrate sampling for the surface water features located on and adjacent to the subject lands, with particular emphasis on the tributary in the northwest corner of the subject lands. The redd surveys were performed on November 25, 2003. Habitat assessments were performed on October 30, 2003 and on June 15, 17 and 18 of 2004. Fisheries community inventories were completed on June 15, 17 and 18, 2004 and June 1, 2005. A site visit to Tributary B in January 2004 was performed to assess year round flow conditions.

Fisheries community inventories were performed at fifteen stations on tributaries of Mountsberg and Flamboro Creeks. The inventories were performed with a Smith-Root Model 12 electro-fisher used to target all habitat types with a single pass to determine the species present and relative abundance. Gill nets and minnow traps were also used in the pond located on the property. Fish habitat notes were recorded at each of the fifteen stations. Habitat assessments included observations on the following stream attributes:

- In-stream Cover;
- Percent Cover;
- Bank Stability;
- Substrate Type;
- Stream Dimensions and Morphology;
- Riparian Vegetation;
- Canopy Cover;
- Adjacent Land Use; and,
- In-situ Water Quality (dissolved oxygen, pH and conductivity).

In addition to these habitat observations, the following information was also recorded at each station:

- Descriptive Location;
- UTM coordinates;
- Water and Air Temperature;
- Time;
- Recent Weather Conditions; and,
- Length of Stream Surveyed.

Stream classifications were assigned to the surveyed streams using the results of the habitat assessments and fishery inventories.

2.4.3 Benthic Invertebrates

Benthic samples were collected in early June 2004. Samples were collected in triplicate using a Surber sampler where coarse substrates were present, and an Ekman dredge in depositional

areas with fine sediments. Where possible, Surber samples were the preferred method as coarser substrates generally support a more diverse community of benthic organisms. All samples were sieved in the field using a 500 µm mesh and placed in 1litre wide mouth plastic jars labeled with the project number, station number, and number of jars collected per station. The samples were preserved in the field using 10% buffered formalin and delivered to a qualified taxonomist for sorting and identification (Zaranko Environmental Assessment Services).

Benthic invertebrate sorting was facilitated by applying rose bengal to the sample, which stains only the organisms. The sample was sieved to remove formalin and all animals washed from the sieve into a plastic sorting tray. Organisms were sorted from the tray using a 10X stereomicroscope. Chironomids and oligochaetes were mounted on glass slides in a clearing medium prior to identification. Following detailed identification, organisms were re-preserved in 70-80% ethanol with 5% glycerol and labeled by station and replicate.

Sub-sampling is generally required when samples contain a large quantity of organic matter or high densities of macro-invertebrates. When this was the case, any relatively large, less common organisms were removed by sieving the sample through a large mesh sieve (3.36 mm, No. 6 mesh). The material retained on a 500 µm sieve was then sub-sampled by evenly distributing the sample material on the sieve. One half of the material was removed and set aside while the remaining half was distributed evenly on the sieve and again divided in two. A minimum sub-sample volume of 25% and/or a coefficient of variation less than 20% among sub-sampled fractions were the data quality objectives established for this project. Generally, only taxa with densities greater than 100 individuals were sub-sampled.

Benthic community parameters were chosen to best describe the current benthic macroinvertebrate data and to allow for future comparisons with these data (i.e., to establish baseline conditions). Because each sample may contain hundreds of individuals and numerous different taxa, indices that incorporate various community attributes have been developed to compare different stations. Several community measures and indices were used to interpret the benthic macroinvertebrate data. The following indices were determined for the quantitative samples:

- Total abundance (# of organisms);
- Taxa richness (total # of taxa);
- Relative abundance of selected taxonomic groups, including annelids, insects (excluding chironomids and EPT organisms - as defined below), chironomids, EPT organisms, molluscs, and all remaining organisms grouped together; and,
- EPT index (# of EPT taxa / total # of taxa), which is based on the presence of pollution-sensitive ephemeropterans (“E”), plecopterans (“P”), and trichopterans (“T”; or mayflies, stoneflies and caddisflies).

Diversity was calculated as the total number of unique taxa (lowest taxonomic resolution) in each sample. Typically, higher diversity is an indication of greater habitat quality. Similarly, extremely low macroinvertebrate organism abundance may indicate toxic conditions, whereas

excessively high abundance may indicate nutrient enrichment. These two parameters are used as general indicators of habitat quality.

The relative abundance of the major groups of macroinvertebrates was also compared for each station, to compare differences in the overall structure of each of the benthic communities. Because some groups are more tolerant than others to disturbance, domination by a single group or species can be indicative of either a stressed or sensitive community. For example, chironomids and oligochaetes tend to be quite tolerant of nutrient enrichment or polluted conditions. Often in highly contaminated sites, these two taxa are the only remaining invertebrate taxa (Pinder, 1986).

Generally, members of the ephemeropteran, plecopteran, and trichopteran orders are the most sensitive to anthropogenic environmental stressors (i.e., as an aquatic environment becomes impacted, the number of these EPT taxa tends to decrease). The EPT index (% EPT) for each replicate was calculated as the number of unique taxa within these orders, divided by the total number of organisms.

3.0 Regional Context – Overview of Natural Features

3.1 LANDSCAPE SETTING

3.1.1 Geology

A complete characterization of the site geology is provided by John Emery Geotechnical Engineering Ltd. (JEGEL) (2004). The site is located near the eastern edge of a major geological structure, the Michigan Basin. The boundary of this feature to the east is the Niagara Escarpment. An average overburden of 2.4 metres (ranging in depth from 0-7.9 metres) overlies a high quality Amabel Formation dolostone, which ranges in thickness from 27-40 metres (JEGEL, 2004). On a regional basis, the bedrock surface slopes gently to the southwest at a rate of approximately 2-3m/km (Gartner Lee Ltd., 2005). Land surface topography and present-day drainage features generally follow the bedrock topography.

3.1.2 Surficial Geology and Soils

The area surrounding and including the subject lands is located within the Flamborough Plain physiographic region (Chapman and Putnam, 1984). It is predominantly bouldery till with bedrock ridge outcrops. To the west, there are large areas of dolomite at the surface. Generally, where bedrock is covered, the overlying material is outwash gravel. Agriculture is a dominant land-use in the physiographic region but much of the land within a 3 kilometre radius is forested. There are also local wetlands with pockets of peat and muck.

3.1.3 Hydrology

A detailed overview of the regional hydrology is provided in the Hydrological Report (Stantec, 2006. in preparation).

The subject lands are located within the upper Bronte Creek Watershed. Subwatershed boundaries and watercourses are shown in Figure 2. The majority of the site falls within the Mountsberg Creek subwatershed, except for the southeast corner, which is part of the Flamboro Creek subwatershed. The headwaters of a tributary of Mountsberg Creek are located in the wetlands in the northern portion of the subject lands, and flow offsite into Mountsberg Creek. This subwatershed includes the settlement areas of Brookville, Carlisle, Darbyville and Moffat and covers an area of 46.7 km^2 within the Bronte Creek Watershed. The Flamboro Creek watershed encompasses an area of 8.7 km^2, originating in the Carlisle North Wetland complex/ESA of the Flamborough Plain and flowing into Bronte Creek downstream of Progreston.

The headwater areas of Bronte Creek near Morriston contain a significant number of wetland areas that, along with the physiography and soil types, are the determining factors for stream flow response. In addition to these wetlands, a number of man-made ponds and reservoirs,

including the Mountsberg Reservoir, affect streamflow. The headwaters of Mountsberg Creek originate within the Badenoch-Moffat Swamp complex PSW and ESA. Summer creek temperatures upstream of the Mountsberg Reservoir suggest a mix of marginal coolwater/warmwater temperatures from the headwaters downstream to Moffat (Conservation Halton 2002). Flows in this reach can become intermittent during drought conditions. West of Moffat, five tributaries are found between Town Line and Watson Road. These tributaries are associated with the Galt Moraine and contribute permanent baseflow, and, where unimpeded by on-line ponds, cold water to the main branch of Mountsberg Creek.

Flamboro Creek originates in the Carlisle North Wetland complex/ESA of the Flamborough Plain and flows into Bronte Creek downstream of Progreston. Downstream of the wetland system, the creek becomes deeply incised within the Bronte Creek Escarpment Valley, and extends downstream to Bronte Creek. Summer temperatures in Flamboro Creek suggest coolwater and marginal coolwater/warmwater habitats (Conservation Halton 2002). Groundwater discharge contributes to coolwater conditions in the headwaters, while a large, on-line pond associated with the Carlisle Golf and Country Club results in downstream warming, which is mitigated by considerable groundwater discharge found within the Bronte Creek valley.

3.1.4 Hydrogeology

The Amabel Formation is a regionally significant aquifer extending from north Hamilton to the Bruce Peninsula. The thickness of the Amabel Formation ranges from 27 metres in the eastern portion of the study area to over 40 metres in the west. The permeability of the aquifer is primarily due to the dissolution of dolomite along fractures and bedding planes. Fracture patterns can be highly variable, and, therefore, hydraulic conductivity can vary greatly. This information is being updated and will be revised in reporting, which is expected to be issued later in 2006.

3.1.5 Climate

The regional groundwater gradient follows a general north to south trend, and the on-site groundwater gradient generally follows the regional gradient. Upward hydraulic gradients and discharge conditions are commonly found in low-lying areas throughout the watershed, while downward gradients and recharge conditions are found at topographic highs. Where bedrock is at or close to surface, connectivity between the Amabel Formation, and the local streams, tributaries, and wetlands is evident, although highly variable (Gartner Lee Ltd., 2005).

A detailed description of the local climate, derived from Gartner Lee (2005), is provided in the Hydrological Report (Stantec, 2006. in preparation). Climate normals for the period 1971-2004 indicate that average summer temperatures (June to August) range between 18.0°C and 20.8°C. Average winter (December to February) temperatures range between -6.0°C and -2.7°C. The average annual number of frost-free days is 223.

Average annual precipitation is 910.1mm, with 764.8mm of this amount falling as rain. Precipitation is evenly distributed throughout the year, with approximately 53% of average

annual precipitation falling between the months of May and October, inclusive. Water budget data demonstrate that the annual water surplus can vary considerably from year to year.

3.1.6 Vegetation

The site is located within the Bronte Creek Watershed, above the Niagara Escarpment in Site District 6E-1 (Jalava *et al.*, 1997). This area of the watershed is dominated by sugar maple forests. White ash, beech, ironwood, black maple and red oak are occasional co-dominants (Conservation Halton 2002). Other less dominant elements include white oak, black cherry, bitternut hickory and basswood. Successional areas may be dominated by white birch, trembling aspen or large-toothed aspen. Dominant shrub cover consists of prickly gooseberry, chokecherry, purple-flowering raspberry and alternate-leaved dogwood.

3.2 DESIGNATED FEATURES

An assessment of regional features was conducted for a 3 kilometre-radius area surrounding the site. This assessment identified local natural features that create the environmental setting for the site, such as significant woodlots, wetlands and specialized habitat for supporting wildlife or fish populations. Designated natural features in this zone, including Environmentally Significant Areas, Provincially Significant Wetlands, Areas of Natural and Scientific Interest (ANSIs) and deer wintering areas identified by the MNR, are shown on Figure 3.

3.2.1 Provincially and Locally Significant Wetlands

A Provincially Significant Wetland, the Lower Mountsberg Creek Complex-Wetland, occupies the headwaters of tributaries to Mountsberg Creek, and Flamboro Creek, at the north and east portions of the subject lands (Figure 3). This wetland complex totals over 285 hectares in wetland area and is 95% swamp (MNR, 1998). Although no significant species or other special features were confirmed in the wetland evaluation, it supports locally significant winter cover for deer and other wildlife.

Approximately 2 kilometres west and southwest of the subject lands is the locally significant Freelton Esker Wetland Complex. This silver maple swamp appears along the sides of the 4 kilometres long, northwest oriented Freelton Esker lying with a group of eskers in the Freelton area. Similar to the wetlands closer to the subject lands, the upper reaches of the Bronte Creek, known for coldwater fisheries and a heronry, drain this wetland (NHIC).

The locally significant Kilbride Swamp is a 17.9 hectares feature situated to the southeast of the subject lands. It is listed as a regionally significant Life Science ANSI. The wetland area is a non-provincially significant wetland complex made up two individual wetlands, composed of a single wetland type (100% swamp). The upland areas are forested predominantly with sugar maple with some red oak.

3.2.2 Environmentally Significant Areas

Mountsberg East Wetlands ESA

The Mountsberg East Wetlands ESA contains aquatic, wetland and terrestrial communities. The ESA is listed as having deer wintering habitat and several uncommon to rare flora and fauna. The ESA is a network of interconnected natural areas totaling 818 hectares and contains the Provincially Significant Lower Mountsberg Creek Complex-Wetland. Generally, the naturally vegetated areas lie on shallow stony soils amongst a group of large drumlins. The lowest wetland areas have peat and muck soils that provide for some groundwater recharge. Other sections of the wetlands likely obtain water by a combination of overland drainage flow and local groundwater discharge. The natural wetland vegetation helps to maintain the water quality of the eventual receiver, the upper Bronte Creek (Hamilton Naturalists' Club, 2003).

The Mountsberg East Wetlands ESA was designated because it met criteria for significant ecological function (it serves as a link between other natural areas, provides habitat for significant species, and contains forest interior habitat at least 200 metres from the edge) and significant hydrological function (it assists groundwater recharge, maintains surface water quality, and regulates stream flow in the upper Bronte Creek system) (Hamilton Naturalists' Club, 2003).

Carlisle North Forests

The Carlisle North Forests ESA, extending south of the subject lands, is a natural area situated on rocky soils with many outcrops and boulders of Amabel geologic formation dolostone. It contains deer wintering habitat. The upland forest is composed mainly of deciduous trees with a few provincially and regionally significant species and many regionally uncommon species. There are three creek headwaters that begin in this forest that eventually feed the upper Bronte Creek. The Carlisle North Forests ESA is situated in a rural area with a mix of active and abandoned agricultural lands, natural areas, and rural residential developments (Hamilton Naturalists' Club, 2003). Within this ESA is the North Carlisle Swamp, a locally significant wetland. Compared to other wetland complexes in the area, it is relatively small (11.0 hectares).

The Carlisle North Forests ESA was designated because it met criteria for significant ecological function (it serves as a link between other natural areas, provides habitat for significant species, and contains forest interior habitat 100-200 metres from the edge) and significant hydrological function (natural vegetation maintains surface water quality) (Hamilton Naturalists' Club, 2003).

Guelph Junction Woods ESA

Halton Region's Guelph Junction Woods ESA is located approximately 1.5 kilometres east of the subject lands. It is situated on this soil over dolomite bedrock with extensive rocky outcrops. The feature contains extensive mixed forest and wetlands including sugar maple-mixed forests, red maple-red oak forests, red maple swamps and larch-eastern white cedar swamps. The Guelph Junction Woods ESA is a headwater region for the Bronte Creek (Region of Halton, 2005).

3.2.3 Natural Heritage System and Linkages

The subject lands occur within a broad area of about 41,000 hectares, defined by Chapman and Putnam as the Flamborough Plain. This Plain is a tract of shallow glacial drift located away from the Niagara Escarpment, northwest of the Hamilton and Burlington Area. The Flamborough Plain is bounded on the northwest by the Galt Moraine and on the south by the silts and sands of glacial Lake Warren. A few drumlins are found scattered over this dolostone plain. In the low poorly-drained areas, wetlands are more frequent.

The plain has been swept bare in places by glacial action, exposing Amabel or Guelph Formation bedrock. Because of the proximity of bedrock to the land surface, the soil materials in this area are bouldery, stony, or sandy in nature.

Because of the generally wet and stony nature of the soils, large areas of the Flamborough Plain have been maintained in, or returned to forest cover. A well-defined system of forested and non-forested lands can be seen in which the higher, deeper and better-drained soils are cleared for cultivation, and many of the shallower, wetter soils are forested or are returning to a forested condition. Ecologically, this plain can be described as having:

- An abundance of large forest and wetland complexes;
- A well defined, connected system of forests and wetlands being consolidated and enhanced through increases in forest cover over the last 30 to 40 years; and,
- An abundance of isolated, smaller forest patches that provide habitat for a variety of plant and animal species that are common to the Southern Ontario landscape.

The larger, more important linkages on the landscape are those associated with the Niagara Escarpment to the east of the subject lands, and the natural areas concentrated in the Horseshoe Moraine complexes of Southern Ontario, west and north of the subject lands.

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4.0 Existing Conditions

4.1 SURFICIAL GEOLOGY AND SOILS

The shallow overburden on-site is comprised of sandy gravel and sandy silt till (JEGEL, 2004). The majority of soils on the subject property have developed from a stony, morainal till deposit. Some outwash deposits, lacustrine deposition and organic soils were also identified (Stovel and Associates, 2004). The subject lands contain Class 2-7 soils, with only 12 hectares of Class 2 or 3 soils, with the remainder of the site (approximately 91%) in Class 4-7 and organic soils. Seven soil series were present on the site (Dumfries, Killean, Lily, Burford, Toledo, Farmington and Muck). The well-drained Dumfries series occupies the majority of the site. Imperfectly to poorly-drained soils and muck are located on wetter parts of the property (Stovel and Associates, 2004).

The northern and eastern portions of the site, extending off-site to the north east, is an area of north-trending ridges, where the bedrock is at, or near the surface. This area is covered with a veneer of cobbly, silty sand till or deposits of organic material. This type of terrain is unsuitable for agriculture; as a result, these areas have remained uncultivated and generally support woodlands and wetlands.

The area in the cultivated center of the Subject Lands and immediately to the west is characterized by glaciofluvial outwash deposits of variable thickness and historically was cleared for crops or pasture.

To the west of the Subject Lands, are areas characterized by a densely packed, heterogeneous mix of silt, sands and stones with occasional boulders and smaller amounts of clay. Most of these areas are in crops or pasture (Gartner, pers. comm. 2005).

4.2 HYDROGEOLOGY

The north and east portions of the site where the bedrock is at or near the surface, shallow groundwater flows provide base flow for the drainage (Gartner, per. Comm. 2005). The cultivated center of the Subject Lands has a high recharge potential and acts to enhance recharge to the underlying Amabel aquifer. The shallow groundwater table in both units is expected to fluctuate seasonally (Gartner, pers. comm. 2005).

Hydrogeological investigation suggests that the PSW and streams on the north and southeastern portions of the property are directly connected to the water table, because the water levels in the wetland fairly closely match the ground water table elevations (Gartner Lee Ltd., 2005).

Gartner Lee Limited is currently involved in ongoing groundwater monitoring. Additional data and/or interpretation that arise from that monitoring will be incorporated into subsequent environmental reporting.

4.3 VEGETATION

4.3.1 Vegetation Communities

The subject lands are located in the Niagara Section of the Deciduous Forest Region (Rowe 1972). The vegetation communities identified on the site, based on the Ecological Land Classification (ELC) system (Lee *et al.*, 1988), are shown on Figure 4. The subject lands are generally comprised of the centrally located agricultural lands surrounded by various forest communities. The fields are divided in many places by treed hedgerows. An abandoned barn and ruins of other farm building foundations were located in the southern sector of the lands.

Areas withdrawn from active agricultural use, in particular old pastures scattered amongst white pine forests, were covered by regenerating old field meadows, dominated by Canada goldenrod, and various forbs and grasses.

Based on their origin, the forests can be divided into two major groups: naturally-occurring and regenerating. The first are either deciduous (e.g. red maple, elm) or mixed (e.g. white cedar, ash, elm) swamps located along the northern boundary, or upland forests (e.g. sugar maple, trembling aspen, elm, ash, white birch) along the eastern boundary. The second group of forests is represented by the variously composed mixed communities (white pine, white cedar, sugar maple, aspen, birch) that have reclaimed the formerly cleared land in the north-central portion of the lands or that are associated with historical plantations through natural succession. The soil is generally thin in the majority of the communities, as the site is strongly bedrock-controlled. The vegetation community types are described in Table 2.

4.3.2 Vascular Plants

Three-hundred-and-eighty-six species of vascular plants were recorded from the subject lands during the inventories (Appendix D). Of these, 100 species (26%), are non-native, which reflects the anthropogenic nature of the past and present land use and ongoing disturbances, in the form of access, use for agriculture, crop field abandonment and subsequent succession to cultural old field meadows. Most of the native species (286, or 74%) occur in the deciduous and mixed forests and swamps, as well as meadow marshes.

Two-hundred-and-sixty native species are ranked “S5”, i.e. very common in Ontario and demonstrably secure, and 22 species are “S4”, i.e. uncommon to locally common in Ontario. No nationally or provincially rare, threatened or endangered species were found on the subject lands, with the exception of butternut. Butternut has been recently classified as “endangered” federally and “endangered unregulated” provincially.

Eight locally rare plant species were also found. Table 3 lists these along with their locations and abundance on-site.

The average Co-efficient of Conservatism (CC) of the plants observed on-site was 4.4 out of 10. No plant species of highest sensitivity (CC 9 to 10) were observed on the subject lands. The majority of the plants with CC values of 7 to 8 have affinities for wetlands, or mature woodland communities and were observed in such locations.

4.4 WILDLIFE

A review of the background information indicates that the subject lands contain portions of two locally significant deer wintering areas (Figure 3) - Guelph Junction and Hilton Falls-Speyside. The forested areas at the north end of the subject lands were flagged as containing interior forest habitat (Conservation Halton, 2002) and as such, have the potential to provide habitat for area sensitive and forest interior bird species.

Figure 5 depicts the locations of survey stations and routes for the seasonal wildlife surveys. A complete list of the wildlife observed is provided in Appendix E. Nine species of amphibians, two reptiles, 74 birds (66 breeding species), 24 butterflies and 16 mammals were recorded from the site. Results are discussed in detail in the following sections.

4.4.1 Deer Wintering Areas

Given the identified locally significant deer wintering areas, a more detailed field program was implemented. The locations of winter survey transects are noted on Figure 5. Details of the results from each survey are summarized below.

Transect 1 passed through both deciduous forest (FOD) and swamp (SWD) and a small amount of mixed swamp thicket (SWT 3-15). Six to ten trails were noted to cross this transect. Very little scat was noted along these trails, one pile was observed. The browse was light (some near the southern portion of the transect) and no beds were recorded.

Four vegetation communities were traversed during Transect 2 including cultural meadow (CUM 1-1), a small portion of eastern white cedar forest (FOC 4-1), mixed forest (FOM2-2) deciduous swamp (SWD 4-6, SWD 4-5) and mixed swamp (SWM 1-1). There were moderate trails crossing this transect. Six beds were recorded, as was a large amount of scat. The beds were located together in groups of four and two. Browse was recorded along this transect and especially in the deciduous swamp, near the mixed swamp.

Transect 3 traversed four vegetation communities: a cultural woodland (CUW 1-3), cultural pine plantation (CUP 3-2), mixed forest (FOM 2-2), mixed swamp (SWM1-1) and deciduous swamp (SWD 3-2). Use of this area was concentrated at the interface between the mixed forest and deciduous swamp and in the scattered clumps of eastern white cedar and hemlock within the mixed forest. A moderate number of trails were noted along this transect. Four beds were recorded scattered in this area; three were noted together, one alone.

Transect 4 crossed six vegetation communities including white pine cultural woodland (CUW 1-3), white pine plantation (CUP 3-2), mixed forest (FOM 2-2), mixed swamp (SWM1-1) thicket swamp (SWT2), deciduous swamp (SWD 3-2) and white pine coniferous forest (FOC 5-1). The heavy and multiple use of trails were noted throughout the vegetation communities during this transect. More than seventy piles of scat were noted along this transect, mostly fresh. Heavy browse of red osier dogwood was observed within the thicket swamp. Ten beds were observed, five together in each grouping.

Sugar maple deciduous forest (FOD 5-4) and silver maple deciduous forest (SWD 3-2) were the two vegetation communities associated with Transect 5. Scattered trails were noted throughout all of the communities. Heavy browse was observed in the deciduous swamp on elderberry and red osier dogwood. Four beds were noted together and approximately twenty-five piles of scat along the transect (from one to two days old).

Traversing Transect 6, three vegetation communities were recorded: cultural meadow (CUM 1-1), sugar maple deciduous forest (FOD 5-4), silver maple deciduous swamp (SWD 3-2) and deciduous forest (FOD5-1). There were few trails observed in this location. Some leatherwood browse was noted in the sugar maple forest and fourteen piles of scat were noted along the line. Four beds were observed, two together in a grouping.

White pine cultural savanna (CUS 1-4*), white pine plantation (CUP 3-2), mixed forest (FOM 2-2) and green ash deciduous swamp (SWD 2-2) were the four vegetation communities walked through during Transect 7. A few trails were noted here, none in the open area near the creek. Twenty-five piles of scat were recorded and six beds. These beds were grouped together in fours and twos.

Observation points A and B were located adjacent to the deer wintering area on Concession 11 East and Milburough Road. Observations were made from these points instead of transects due to the depth of water throughout this vegetation community and the thin layer of ice which covered it. Browse was noted of the red osier dogwoods along observation point B. A heavily used deer trail was noted from station A, with deer traveling south. Scat was noted along this trail but no beds or browse was noted.

In summary, coniferous cover in the main deer wintering area (the northern portion of the site) on the subject lands was good. The mixed forest (FOM 2-2, Figure 4), centrally located on the site, provided varied coniferous cover and included such species as eastern hemlock and eastern white cedar. These coniferous species provided between 40% and 50% canopy cover in various areas. An eastern white cedar hardwood mixed swamp (SWM 1-1, Figure 4) located at the northern edge and extending beyond the property boundaries likely provided cover for deer in winters with high snowfall. Deer beds were noted along transects 2 through 7, inclusive, which traversed this mixed forest community (Figure 4). These were generally located beneath clumps of eastern white cedar or hemlock trees. The other wintering area between Milburough Road and 11 Concession E was composed of dense eastern white cedar and, as with the swamp community (SWM 1-1), would likely be used in harsh winters for cover and feeding.

In the winter deer must subsist on low quality food. The major food source at this time of year includes the woody twigs and buds of deciduous trees and shrubs and conifer leaves such as eastern white cedar and hemlock. This site presents a good mix of coniferous and deciduous forage. Deer browse of the deciduous cover was noted throughout the deciduous swamps and upland forest areas, and consisted mainly of red osier dogwood and leatherwood.

Through the number of beds noted, scat counted and trails crossed in 2004 it is likely that the deer wintering area surveyed supported a population of between 10 and 20 deer. This approximate number is for a mild winter, in which other less suitable areas were probably also in use in the surrounding landscape. It is likely that deer off site also use the deer wintering areas in varying seasonal conditions.

4.4.2 Amphibians

A complete list of amphibians observed is found in Appendix E. Frog counts were conducted in favourable conditions ranging from clear skies to light drizzles, light winds and temperature ranging from 7°C during spring surveys to 17°C in later surveys. The evening call count surveys recorded eight common amphibian species, including wood frog, spring peeper, grey tree frog, pickerel frog, leopard frog, American toad, western chorus frog and green frog. All of the frog call count locations correspond to areas identified as either wetland or watercourse/pond (Figure 5). Frog calling activity was observed at all locations. All locations had high activity of spring peeper during the April 21, 2005 observations. The May 24, 2005 observations have little to no calls at locations B, C, D and E, but spring peeper activity was still observed at A, F, G and H. Northern leopard frogs and green frog activity was observed during the June 15, 2005 survey at locations C, F and G. All frog species are ranked S5, very common and demonstrably secure in Ontario, except the pickerel frog, which is ranked S4, common and apparently secure. The pickerel frog is considered to be locally rare in the Hamilton area (Hamilton Natural Areas Inventory, 2003). Pickerel frog calls were heard during the April 21st, 2005 evening call count at location E (Figure 5).

Many frog species utilized terrestrial habitat during non-breeding life stages. Moist forests used by wood frogs are generally associated with the breeding wetlands on the subject lands and can be found in the northern third and in the east end, along Flamborough Creek. Moist forests could also be found south of the subject lands near Tributary D. Spring peepers would utilize similar areas. The non-breeding habitat for grey treefrogs includes shrubby areas next to wetlands. Green frog generally utilizes the wetlands themselves in the non-breeding seasons. The western chorus frog, northern leopard frog and pickerel frog will often move into grassy or weedy fields during the non-breeding summer season. While many frog eggs were noted, only one salamander egg mass was encountered during the 2004 spring survey of all vernal pools. This egg mass was collected from the site and raised at the University of Guelph, with the result of no viable larvae. Although the presence of Jefferson/blue-spotted salamander polyploids could not be ruled out as a result, it is also possible the eggs might have been non-viable spotted salamander eggs. The location of the collection is shown on Figure 5.

In 2005, only one live salamander egg mass was observed. There were 4 or 5 viable larvae within the egg mass, but most of the eggs were non-viable. This egg mass had thick gelatin around it, typical of a spotted salamander egg mass, and was not collected. An additional 67 dead egg masses of spotted salamanders were seen in the main pond.

4.4.3 Birds

A complete list of the birds observed is found in Appendix E. A conservative approach to determining breeding status was taken; all birds seen or heard in appropriate habitat during the breeding season were assumed to be breeding.

Seventy-four species of birds were observed, with 66 species likely breeding on-site. All the species are ranked S5, very common and demonstrably secure in Ontario, or S4, common and apparently secure, except for the European Starling which is SE, exotic and not a native component of Ontario's fauna.

Nine area-sensitive forest breeding birds, including three locally significant species discussed below, (Ruffed Grouse, Broad-winged Hawk, Whip-poor-will, Yellow-bellied Sapsucker, Pileated Woodpecker, Ovenbird, Northern Waterthrush, Mourning Warbler and Scarlet Tanager) were observed during the breeding season. These species require a minimum of between 20 hectares to 100 hectares of suitable forest habitat for breeding. All of these species were observed in the northern part of the subject lands, in the wooded upland and lowland habitat associated with Tributary A. Additionally, numerous Ovenbirds and one Scarlet Tanager were noted in the upland habitat on the east side of the property. Several Northern Waterthrushes were adjacent to Flamboro Creek. Pileated Woodpeckers were observed crossing cleared parts of the site in several locations, between wooded features. Additional information regarding "interior habitat" is contained in Section 5.7.4 of this report.

Three species of breeding birds are considered to be locally significant ("rare", with 20 or fewer estimated breeding pairs in the City of Hamilton) (Curry, 2003): Broad-winged Hawk, Whip-poor-will and Yellow-bellied Sapsucker.

The Yellow-bellied Sapsucker is a species of deciduous and mixed forests and was assumed to be breeding in the forest in the northern and eastern portions of the Subject Lands. The Whip-poor-will is also a forest nesting species, which shows a preference for open woodlands and forest edges.

The Broad-winged Hawk, while provincially common, is a forest-nesting raptor, which is relatively more sensitive to disturbance and requires specialized nesting habitat (MNR, 2000). This species was observed in the white pine coniferous plantation (CUP 3-2) and the deciduous swamp (SWD 3-2) in the northwest corner of the subject lands (Figure 4).

4.4.4 Butterflies

Twenty-four butterfly species were observed on the subject lands, a complete list can be found in Appendix E. Most species observed are ranked S5, very common and demonstrably secure in Ontario, or S4, common and apparently secure in Ontario. The Hickory Hairstreak is ranked S3S4, rare to uncommon and the Giant Swallowtail is ranked S2, at risk due to its rarity in Ontario. In addition the European skipper and cabbage white are ranked SE, exotic and not native to Ontario. The Painted Lady is an inconsistent summer migrant into Ontario and is ranked SZB, no clearly definable occurrences of breeding.

Two species (coral hairstreak and hickory hairstreak) are recognized as locally uncommon permanent residents (Hamilton Natural Areas Inventory, 2003). A single hickory hairstreak was observed in the center of the subject lands, along the woodland edge between the southeastern end of the FOD5-4 and the AG. This species was once considered to be rare in the southern part of Ontario; however, recent fieldwork has found it to be more common in southern Ontario (including the Hamilton area). The Hamilton Natural Areas Inventory (2003) states that due to this recent fieldwork the hickory hairstreak should probably no longer be considered rare in the province. The hickory hairstreak was observed at a density of approximately one individual per hectare on the subject lands. Several coral hairstreaks were seen along woodland edges throughout the site. They are ranked S4 and are secure in Ontario. Their density on the subject lands was approximately two individuals per hectare.

Two observations of giant swallowtails were made in mid-August. The Giant Swallowtail is considered to be a locally uncommon permanent resident in the Hamilton area. The two observations were made in the swamp surrounding Tributary D and the FOD5-1 woodlands just east of the agricultural fields.

4.5 AQUATIC RESOURCES

The location of surface monitoring, benthic invertebrate and fish inventory and/or habitat assessment stations are provided in Figure 6. The results of the electrofishing inventories conducted in late June 2004 are presented in Appendix F. Additional electrofishing inventories were conducted for on-site Mountsberg tributaries B, C and D and in Flamboro Creek on June 1, 2005 to supplement 2004 results. Stream discharge and standing water levels in 2005, were higher than noted during the 2004 surveys.

Detailed aquatic habitat descriptions at each location are provided in Appendix F. The following sections describe each watercourse on or adjacent to the subject lands.

4.5.1 Flamboro Creek

Conservation Halton (2002) determined in the Bronte Creek Watershed Study that the headwaters of Flamboro Creek between the CPR tracks and 10th Concession, one concession south of the Subject Lands, is supported by significant groundwater discharge and provides suitable coldwater habitat for brook trout (see North Carlisle Swamp location on Figure 3).

There are no sampling records for brook trout in this reach, however anecdotal reports from local anglers suggest their presence in the headwater area. Just upstream of Carlisle Road, south of the subject lands, the creek flows into a large on-line pond within a golf course.

Conservation Halton (2002) found that with the exception of a warmwater fish community below the Carlisle Golf and Country Club pond, coldwater fish community and temperature regimes throughout most of the subwatershed are consistent with the expectations for first and second order streams on the limestone plain and glacial spillway features. Conservation Halton (2002) has designated the creek at 10th Concession as marginal coolwater habitat with high aquatic ecosystem health.

The other branch of Flamboro Creek headwaters, which flows through the eastern corner of the Subject Lands, is designated as warmwater, forage fish with high aquatic ecosystem health at the 10th Concession (Conservation Halton, 2002). Anecdotal reports from landowners report that brook trout have also been caught in this reach in an on-line pond located between the 10th and 11th Concessions (south of the subject lands). Through communication with local residents it was also determined that a potential barrier to fish migration may exist in the form of a falls.

In 2004, aquatic surveys were conducted within this reach at the 11th and 10th Concession road crossings. Three benthic sampling locations, four fisheries inventory/habitat locations and a temperature logger were located on this watercourse (Figure 6). In 2005, additional electrofishing was conducted in reaches F3 and F4. Only one fish, a single blacknose dace, was captured north of the 11th Concession (F4). Immediately south of 11th Concession (F3), blacknose dace (94 in 2004 and 20 in 2005, including some gravid females) and brook stickleback (5 in 2004) were captured. Slightly downstream (F2), 8 blacknose dace and brook stickleback were captured, but no fish were present at 10th Concession (F1).

Diffuse groundwater seepage was observed entering the wetlands surrounding Flamboro Creek in the southeast portion of the Subject Lands (Figure 7). Some plant species with special habitat requirements, such as calcareous seeps, were present in this portion of the wetland. Additional ecological work is planned for 2006 in this area.

4.5.2 Mountsberg Creek and Tributaries

Mountsberg Creek supports a diverse fish community. Within the vicinity of the subject lands, which is below the Mountsberg Reservoir, the creek is classified as warmwater sportfish. The presence of the reservoir and other on-line ponds has had a warming effect on the creek, with summer temperatures in the approximate range of 28°C to 13°C. This has allowed for the introduction of some centrarchid species (sunfish family) more typical of lake environments (Conservation Halton, 2002). A single brown trout was captured by Conservation Halton, in 1999, at the 11th Concession road crossing and anecdotal reports indicated that small pockets of brook trout and brown trout might persist in this reach (Conservation Halton, 2002).

Mountsberg Creek is associated with the site in a few different locations. A tributary originates in the PSW at the north end of the Subject Lands as a diffuse flow through the wetland and then

consolidates into a more defined watercourse (Tributary A on Figure 6) as it leaves the site. At the extreme west corner of the site Mountsberg Creek crosses the property boundary at the confluence with Tributary A. Conservation Halton (2002) reports that groundwater is added to the system throughout this section resulting in a marginal cooling of Mountsberg Creek, which is classified as warmwater as it leaves Mountsberg Reservoir. However an on-line pond downstream of Concession 11 contributes to further warming. Approximate summer temperatures of Mountsberg Creek range from 28°C to 17°C.

Three benthic sampling locations, three fisheries inventory/habitat locations and two temperature loggers were surveyed on Mountsberg Creek in 2004 (Figure 6). Nineteen different species of warmwater fish were caught during the field inventory (Appendix F).

All of the remaining watercourses on and adjacent to the subject lands are much more diffuse with poorly defined channels and seasonal flows, including the outlet from the pond at the south end of the property. These are described below.

Tributary A contained two benthic sampling stations, two fisheries inventory/habitat stations and a temperature logger. Three species of fish were captured during the inventory, white sucker, pearl dace and central mudminnow in 2004. Groundwater seeps were observed which seasonally direct flow to the wetlands on the Subject Lands surrounding Tributary A (Figure 7). These are the subject of ongoing monitoring.

Tributary B contained one benthic sampling station and three fisheries inventory/habitat stations. Most of tributary B (stations B2 and B3) contained no water during the 2004 survey; as a result sampling was restricted to an area immediately upstream of the 11th Concession (station B1). Noticeable, although shallow, flow was present during the 2005 survey. No fish were captured or observed in this tributary.

Tributary C contained one benthic sampling station and one fisheries inventory/habitat station. No fish were captured in this tributary. Despite higher water levels in 2005, the two culverts and the land draining into them were completely dry.

Tributary D contained two benthic sampling locations, three fisheries inventory/habitat locations (including the on-line pond) and a temperature logger. One fish species, brook stickleback, was captured during the 2004 inventory. Hundreds of brook stickleback of all age classes were observed in the pond in 2005. Damp areas were the only signs of water upstream of the pond in 2005.

4.5.3 Benthic Macroinvertebrates

A summary of the benthic macroinvertebrate community analysis is provided in Table 4, and explained below. Raw data are included in Appendix G. Where appropriate, the results of the fisheries surveys and habitat assessments were taken into consideration when describing the results of the benthic community indices. All aquatic survey station locations are illustrated on Figure 6.

The benthic community data range from indicating good quality habitat conditions in the main channel of Mountsberg Creek (Stations M1, M2, and M3) to fairly poor habitat conditions in Flamboro Creek and tributaries to Mountsberg Creek (most notably, Stations A2, B1, C1, and D2). Further details follow.

The total abundance of organisms was highest at the Mountsberg Creek Stations M2 and M3 (i.e., with a mean of 987 and 1,077 organisms at Stations M2 and M3, respectively) and was lowest at Stations B1 and F1 (i.e., 109 organisms at both stations). While a low abundance of organisms is generally indicative of limited habitat potential, it should be noted that a high abundance of organisms only indicates good water quality if the community composition is diverse and the species present are generally pollution intolerant. The relative abundance of major taxonomic groups is summarized in the last five columns in Table 4. As discussed below, Stations M2 and M3 support diverse benthic macroinvertebrate communities.

Stations A2 and B1 are dominated by molluscs, with > 55% of these communities belonging to this group. Approximately 60% of the community at B1 comprises mollusc organisms. Benthic communities may be indicative of environmental stress when a single species or group comprises > 60% of the total community assemblage. Therefore, given that these stations are both dominated by tolerant, filter feeding molluscs, they are clearly stressed communities. The fisheries habitat assessment field investigations confirm these findings; only two tolerant warmwater fish species were captured within Tributary A (i.e., pearl dace, brook stickleback), and Tributary B is an intermittent watercourse where no fish were captured.

Stations C1, F1, F3, and M1 are dominated by the pollution tolerant chironomid family (i.e., comprising 56.4%, 56.2%, 51.0% and 44.6%, respectively). With the exception of station M1 (which is co-dominated by sensitive benthic organisms, as discussed below), aquatic habitat is deemed to be limited in these reaches on the basis that the dominant organisms at these stations are among the most tolerant benthic macroinvertebrates. These data also correspond with the fisheries data. Tributary C is an intermittent tributary to Mountsberg Creek and is not known to support fish habitat, while Tributary F is the main channel of Flamboro Creek where only two tolerant warmwater baitfish species were captured (i.e., blacknose dace, brook stickleback).

Stations D2 and F4 are both dominated by organisms grouped as “other” in Table 4. These species include a combination of tolerant nematodes, annelids, ostracods, and amphipods. All of these groups are considered to be relatively insensitive organisms that can tolerate degraded habitat conditions. As described above, the fisheries catch results for Flamboro Creek support these data. Similarly, only one tolerant warmwater baitfish species (i.e., brook stickleback) was captured in Tributary D at Station D1, while no fish were captured at Station D2.

Conversely, stations M1, M2 and M3 indicate good habitat conditions, as many of the taxa are the pollution sensitive mayflies (from the order Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) (i.e., ranging from means of 12 to 14 EPT taxa). EPT taxa richness at all other stations is poor, ranging from 0 to 4. However, while only 4 EPT taxa occur at station D1, they account for 48.8% of the total community. These sensitive EPT organisms

characterize the study reaches of Mountsberg Creek in particular as an intolerant benthic community that is vulnerable to potential environmental impacts. Similarly, station M3 demonstrates the highest taxa richness (i.e., mean of 54 taxa) and, therefore, supports a well balanced community, with good representation by many benthic groups. This observation is supported by the fisheries data, where the main channel of Mountsberg Creek is known to provide habitat for warmwater sportfish species.

4.5.4 Surface Water Quality

General trends within the historical Provincial Water Quality Monitoring data for the Bronte Creek watershed suggest that total phosphorus concentrations regularly exceeded (51% of the time) the Provincial Water Quality Objective (PWQO) for total phosphorus of 0.03 mg/L (Conservation Halton 2002). High concentrations of *E. coli* and other fecal coliforms were found throughout the watershed. Non-point surface runoff from agricultural operations is believed to contribute to elevated bacteriological levels (Conservation Halton 2002). Although metal concentrations were generally found to meet PWQOs, aluminum, iron, and zinc concentrations exceeded PWQOs at several points within the watershed.

Historical mean water quality for Mountsberg Creek reflects the water quality trends of the Bronte Creek watershed. Mountsberg Creek water quality generally met PWQOs, with the exception of *E. Coli* (135 counts per 100 ml) and zinc (0.025 mg/L) at Highway 401, and total phosphorus (0.032 mg/L) at County Road 18. No Provincial Water Quality Monitoring data are available for Flamboro Creek (Stantec, 2006. in preparation). However, Conservation Halton (2002) collected data in Mountsberg and Flamboro Creek at stations M1 and F1 over the period 1999-2001. Mean water quality at these Flamboro Creek locations met PWQOs with the exception of aluminum (0.102 mg/L) and total phosphorus (0.069 mg/L).

Surface water samples were collected at stations A1, M2, M3 and F4 and were analyzed for quality. The results are provided in Appendix G and Table 5. The following discussion is summarized from Stantec (2006. in preparation).

On-site water quality sampling results demonstrate that average water quality at stations M2 and M3 in 2004 and 2005 along Mountsberg Creek was similar to that observed at the historical Provincial Water Quality Monitoring station at County Road 18. Similar nutrient and total suspended solids levels were also noted between all three stations. This suggests that the upstream Provincial Water Quality Monitoring station at County Road 18 can serve as a long-term monitoring station for background water quality characterization.

Total dissolved solids are greater in groundwater than in surface water (Gartner Lee Ltd., 2005). The patterns observed in total dissolved solids levels from November 2004 to September 2005 suggest that Tributary A receives a greater proportion of groundwater input than Mountsberg or Flamboro Creek. The seasonal pattern of change in total dissolved solids levels suggests that groundwater input to Tributary A occurs from fall to spring, as levels remained above 400 mg/L. However, by September, total dissolved solids levels in Tributary A (168 mg/L) were similar to those at M2 in Mountsberg Creek (190 mg/L). The pattern of decreasing total dissolved solids

levels from spring to summer was also observed at the two Mountsberg Creek stations. The pattern observed for Flamboro Creek appears to suggest that the creek is maintained by shallow groundwater into the spring until flows are no longer observed during summer.

Although groundwater discharged from the Badenoch Moffat Swamp Complex sustains coldwater conditions upstream of the Mountsberg Reservoir, it is recognized that warm water discharged from the Mountsberg Reservoir during the summer results in significant degradation of coldwater habitat in reaches downstream of this point (Conservation Halton 2002). On Flamboro Creek, the tributary crossing at the 10th Concession provides permanent coolwater flow extending downstream to the on-line pond on the Carlisle Golf Course. Warmwater conditions are present downstream of this pond, with groundwater inputs from the downstream valley slopes allowing for gradual regeneration of coolwater conditions (Conservation Halton 2002).

The temperature data collected on-site suggest that Flamboro Creek is most responsive to ambient air temperatures, while Tributary A and Mountsberg Creek demonstrate slightly different daily maximum temperatures, but considerably different daily minimums. Observed temperatures in Mountsberg Creek demonstrate a lower degree of variability than temperatures in Tributary A or Flamboro Creek, likely a result of the larger flow volumes.

The maximum temperatures reached in Tributary A appear to be buffered as a result of some groundwater input during the summer months. Flamboro Creek is characterized by the greatest temperature fluctuations as a result of the very low flow rates, which allow its waters to be influenced by ambient temperatures (Stantec, 2006. in preparation).

5.0 Analysis

This section addresses how features and functions on, and connected to, the subject lands should be treated in terms of the key components of the PPS:

- Significant Wetlands;
- Significant Habitat of Endangered and Threatened Species;
- Areas of Natural and Scientific Interest (ANSIs);
- Fish Habitat;
- Significant Woodlands;
- Significant Wildlife Habitat; and,
- Environmentally Significant Areas (ESAs).

5.1 SIGNIFICANT WETLANDS

A portion of the Provincially Significant Lower Mountsberg Creek Complex Wetland (PSW) is located on the subject lands. The entire complex, which extends some distance from the subject lands, totals more than 285 hectares, of which treed swamps cover the majority. Mapping from the MNR (1998) as well as the detailed boundary assessment completed by Stantec in 2005 are shown on Figure 7.

On-site, this wetland extends along the length of Tributary A of Mountsberg Creek, at the north end of the property. Another node of this wetland complex is located along a reach of Flamboro Creek within the southeast corner of the site. The detailed boundary assessment conducted by Stantec indicated that a narrow extension of wetland connects two pockets of wetland to the main Tributary A, earlier identified as isolated by the MNR (Figure 7). Additionally, in the northwest corner of the site, work by Stantec extends the wetland boundary west of the MNR's western limit, to the confluence of Tributary A with Mountsberg Creek (Figure 7). An additional wetland community was also noted along 11th Concession (Tributary D).

Lower Mountsberg Creek Provincially Significant Complex-Wetland was last evaluated in 1998 (OMNR, 1998), using the third edition of the Wetland Evaluation Manual for Southern Ontario (OMNR, 1986). A review of relevant material suggests that the scoring and complexing have been fairly completed, and updated as new data become available. Redside Dace has been recorded within the wetland complex, according to historical records, but this species has been removed from the final score in the evaluation, pending confirmation of the historical records.

Seeps seasonally direct shallow groundwater flow to the Tributary A portion of the wetland, and diffuse seasonal shallow groundwater seepage enters the Flamboro Creek portion of the wetland along most of the northeastern edge (Figure 7). These seeps are subject to ongoing observation and data collection.

The Tributary A portion of the wetland is characterized by deciduous swamp, with some mixed swamp and swamp thicket, on mineral soils. The Flamboro Creek portion of the wetland is dominated by mixed swamp and willow swamp thicket, and appears to have deeper organic deposits. Some plant species with special habitat requirements, such as calcareous seeps, were present in the Flamboro Creek portion of the wetland.

5.2 SIGNIFICANT HABITAT OF ENDANGERED AND THREATENED SPECIES

A search of the NHIC database indicates that there are several records of one Threatened species, redside dace, in the vicinity of the site through the 1970's. The most recent records from 1995 are in the lower reaches of Mountsberg Creek at or downstream from Concession 10, downstream from the subject lands. Available data from the Bronte Creek Watershed Study indicates a decline of the species in Mountsberg Creek. The effects of Mountsberg Reservoir and the introduction of northern pike and other non-indigenous species into the watershed could have contributed to the demise of redside dace in Mountsberg Creek (Conservation Halton, 2002).

Jefferson's salamander, a Threatened species, is known to occur in similar wetland habitat in neighboring regions. An analysis of a salamander egg mass collected from the site in 2004 was not sufficient to confirm the species; the non-viable eggs may have been from a Jefferson/blue-spotted salamander polyploidy but could also have been from another species. Additional surveys in 2005 indicated the presence of many spotted salamanders, but no evidence of Jefferson's salamander was observed.

Neither Threatened species can conclusively be determined to be present on or in the vicinity of the site. However, their habitats (fish habitat and wetlands) are discussed in Sections 5.4 and 5.1, respectively.

One "Endangered, not regulated" species, butternut, was observed at several locations on-site. This species is widely distributed in Ontario but is at risk due to an introduced fungal pathogen.

5.3 AREAS OF NATURAL AND SCIENTIFIC INTEREST

There are no ANSIs present within the subject lands or adjacent to them (i.e. within 120m of the lands).

5.4 FISH HABITAT

Fish habitat is defined as the spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes (OMNR, 1999). Fish habitat occurs on and adjacent to the subject lands. Characteristics of this habitat are depicted on Figure 8.

All reaches of **Mountsberg Creek** support good warmwater fish habitat including several sport fish.

Tributary A, which originates in the Lower Mountsberg Creek Complex-Wetland PSW, also provides fish habitat. The fish community is limited to a couple of fish species tolerant of low oxygen, i.e. pearl dace and central mudminnow. The juvenile white suckers found here were caught near the confluence with Mountsberg Creek and it is unlikely that they move very far up Tributary A. This lower reach of Tributary A may also provide spawning habitat for northern pike. The entire tributary also indirectly contributes base flow (which is potentially coldwater) and food/nutrients to Mountsberg Creek. The degree to which groundwater plays a role in the support of these fisheries is subject to ongoing hydrogeological investigations and temperature monitoring currently being completed by Gartner Lee Limited and Stantec Consulting.

Tributaries B and C are not expected to support fish habitat. Both of these tributaries are intermittent and likely contribute limited base flow to Mountsberg Creek.

Fish were identified in **Tributary D** below the 11th Concession and in the on-site Pond. The Pond likely functions as a refuge for fish during periods when Tributary D is not flowing. However, the fish community here is limited to the extremely tolerant brook stickleback, suggesting that the habitat conditions are sub-optimal. Flows within the tributary are likely intermittent with small pools remaining below the culvert and possibly further downstream to sustain the small number of fish found here. Flows have been observed in Tributary D during spring and summer storm runoff.

The **Flamboro Creek** headwaters located on the subject lands also support limited fish habitat. Upstream of the 11th Concession the diffuse nature of the watercourse and limited flow results in low levels of dissolved oxygen and the low number of fish found in this reach is representative of these conditions. There is some seepage in this area that provide baseflow to the creek. The degree to which groundwater plays a role in the support of this reach is subject to ongoing hydrogeological investigations and temperature monitoring being completed by Gartner Lee Limited and Stantec Consulting.

The reach downstream of the 11th Concession, (F3), was characterized by a more defined channel, however dissolved oxygen was still low. Several blacknose dace were captured in this reach, which appears to be permanently flowing, however the majority were found just below the culvert where a change in elevation has concentrated flows.

Excellent habitat conditions are present further downstream from Concession 11 (Reach F2, Figure 6). However, very few fish were found here. The low numbers of fish found throughout this reach may be due to the presence of a reported falls, creating a barrier to fish migration. Anecdotal evidence of this barrier being located between F2 and the on-line pond was obtained from local residents. Local residents also report evidence of brook trout in the pond.

All three of these upper reaches of Flamboro Creek may contribute coldwater base flow to downstream sections of Flamboro Creek. However, the existence of an on-line pond between Concession 10 and 11 appears to restrict the flows downstream. Below the 10th Concession the creek displays evidence that flows are intermittent, such as a lack of a defined channel.

Conservation Halton (2002) defined this branch of Flamboro Creek at Concession 10 as warmwater forage fish. During the June survey, no fish were found in this reach and flows appeared to be intermittent. The potential for fish habitat is limited in this reach.

5.5 SIGNIFICANT WOODLANDS

5.5.1 Definition of Woodlands

The definition of woodland in both the Provincial Policy Statement (2005) and the Greenbelt Plan (2005) is as follows: "Woodlands means treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products. Woodlands include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels."

Some municipalities, including the City of Hamilton through its 2005 Review of Significant Woodland Criteria discussion paper, have attempted to make this very general woodlands definition more precise by referring to the definitions based on the Provincial Forestry Act, and including any area of land (sometimes a minimum area is specified, often as small as 0.5 hectares) having a density not less than 1000 trees/ha (400 trees/ac) of any size, OR 750 trees/ha (300 trees/ac) more than 5 cm dbh, OR 500 trees/ha (200 trees/ac) more than 12 cm dbh, OR 250 trees/hectare (100 trees/ac) more than 20 cm dbh. Trees are defined as species that have the potential to reach more than 4 metres in height at maturity, but can be small saplings or even seedlings. In its strictest application, this approach can result in the inclusion of meadows with no tree cover or even visible trees.

As a result, the PPS (2005) and Greenbelt Plan (2005) definition was used to identify and delineate woodlands. This was further interpreted (based upon an understanding of the forest cover in the Flamborough Plain and more local, detailed observations) to exclude culturally derived ELC communities with tree cover of less than 60% and young plantations and successional lands.

5.5.2 Definition of Woodland Significance

The Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement (OMNR, 1999) indicates that the designation and evaluation of significant woodlands is a planning authority responsibility, however, general guidelines for determining significance of these features are presented in the Natural Heritage Reference Manual. Criteria suggested by the manual for designating significant woodlands include woodland size, shape, proximity to other woodlands or natural features, linkages, species diversity, uncommon characteristics, and economic and social values. In the case of woodland size, the suggested criteria change depending on the amount of forest cover in the planning area. For instance, where there is less than 5% forest cover, it is suggested that woodlands 2 hectares in area or larger should be evaluated for significance compared to 4 hectares in areas with 5 to 15% forest cover and 40

hectares for areas with 15 to 30% forest cover. No size threshold is suggested for landscapes with more than 30% forest cover.

A technical guidance document for defining significant woodlands in the Greenbelt Plan Area context is currently being prepared by the Province. A working technical document (Stantec and ECS, 2005) was reviewed with MNR in September 2005 to enable discussions regarding the definition of significant woodlands on the Flamborough Plain Physiographic Region where woodlands overlap with significant mineral aggregate resources. The Flamborough Plain Physiographic Region occupies more than 40,000 hectares and is 37% forested, with an additional 9% of the area covered in wetland (mostly treed swamp) (Stantec and ECS, 2005). Criteria suggested in this document for the identification of candidate significant woodlands at a landscape level of analysis included hydrological function (as indicated by the presence of PSWs or coldwater fish habitat), significant forest interior habitat (12 hectares or more of continuous habitat more than 100 metres from an edge), and the presence of significant woodland features (as indicated by the presence of a Life Science ANSI designated for significant woodland features, or the presence of a woodland-dependent Threatened or Endangered species). These potentially significant woodlands at the physiographic region scale were recommended for site-specific work to validate the presence of these key features and functions

Finally, the City of Hamilton (2005) has released a technical discussion paper regarding the identification of significant woodlands. It is suggested that woodlands that meet two or more of the following criteria should be considered significant in the City of Hamilton: size (variable criterion according to forest cover in the planning unit); the presence of interior forest located more than 100 metres from an edge; location within 50 metres of a significant natural area (wetlands 0.5 hectares or greater in size, ESAs, PSWs and Life Science ANSIs); location within 30 metres of streams, headwater areas, wetlands or lakes; presence of trees that are 100 years old or more; and the presence of threatened, endangered, special concern, provincially or locally rare plant or wildlife species. These criteria are generally similar to those selected by Stantec and ECS (2005), but the thresholds for significance are considerably lower. The Hamilton document was not prepared to be specific to the determination of woodland significance for a particular physiographic unit, nor was it prepared for the purposes of balancing important and perhaps, overlapping resources. The Hamilton paper is based upon municipal jurisdictional boundaries and is intended to be relevant to all forms of development. The City's technical discussion paper provided input to the recently released partial Draft Official Plan Policies for Natural Heritage (City of Hamilton 2006).

Small, irregular and/or elongated wooded features that are appended to larger woodlands present a special resource management challenge. Termed "Peripheral Forest Edge Habitat" (PFEH) by Stantec and ECS (2005), these wooded areas would be included in significant woodlands because of their continuity with a larger woodland unit. Functionally, however, they contain only "edge habitat" because they have size and/or shape configurations that provide no interior habitat. Furthermore, as a result of their position or shape, these wooded areas do not

contribute significantly to the provision of interior habitat in the blocks to which they are attached.

Stantec has been advised that requiring the maintenance of these areas as woodland habitat would present significant operational challenges (Stantec and ECS, 2005). Working around these irregular wooded areas would require the setting aside of lands much larger in area than the actual footprint of the feature. Stantec and ECS (2005) recommended that PFEH be excluded from significant woodland where:

- The PFEH does not contain any interior habitat (100 metres from the forest edge; i.e 200 metres minimum width);
- The removal of the PFEH would affect less than 0.5 hectares of interior habitat in an adjacent woodland, or the net effect of removal plus rehabilitation on interior habitat is neutral or better; and,
- The PFEH does not support any of the other features or functions that are indicative of significant woodland (hydrologic function, features that resulted in a provincial Life Science ANSI designation, or the habitat of Endangered or Threatened species).

The criteria used by this report to identify significant woodlands include:

- Forest Size (25 hectares minimum size recommended to represent forest function);
- Significant Forest Interior (more than 12 hectares forest interior habitat);
- Hydrological function (as indicated by the presence of PSWs or coldwater fish habitat);
- Hydrologic Function:
  (a) Presence of Provincially Significant Wetland; or,
  (b) Presence of coldwater fish habitat;
- Presence of designated Provincially Significant features:
  (a) Life Science ANSI; or,
  (b) Significant Habitat for Threatened or Endangered Species; and,
- Exclusion of PFEH as defined above.

Areas identified as Significant Woodlands, but occupied by young plantations and early successional forest habitat were excluded as stated by the Greenbelt Plan (2005).

These potentially significant woodlands at the physiographic region scale were recommended for site-specific work to validate the presence of these key features and functions.

5.5.3 Delineation of Significant Woodlands on the Mountsberg Quarry Site

Figure 9 depicts the significant woodlands identified by Stantec Consulting, on the Subject Lands. The woodland communities on the eastern and northern portions of the site are contiguous with an extensive wooded area extending through to the Niagara Escarpment Plan Area. This woodland supports a substantial area of forest interior habitat, and this was confirmed through field observations of a diverse community of area-sensitive forest birds. As

well, low-lying parts of this wooded community are designated PSW and have important hydrological function. As a result, this woodland should be considered significant. No Endangered or Threatened species or provincially significant woodland features (such as significant vegetation communities, very old trees or specialized habitats) were noted.

Cultural meadow, savanna, thickets and woodland were excluded from the large significant woodland because their treed canopy cover was too low. Patchy treed communities on the western edge of the site were not considered as potentially significant because they were all of cultural origin, with low treed canopy cover.

Extending into the eastern portion of the central cultural area of the Subject Lands is an elongated, irregularly shaped FOD5-1 community. This community has been identified as PFEH due to a lack of interior habitat, lack of features associate with significant woodlands and the evidence of historical disturbances such as forestry practices. This community was therefore not identified as significant woodland.

Some young plantations and early successional communities were excluded from the areas of significant woodlands as stated in the Greenbelt Plan (2005) for non-renewable resources. A small poplar deciduous forest (FOD8-1) located just west of the property boundary was excluded, based on its small size and limited woodland function. Some white pine cultural plantations were also excluded, because of their young age and lack of significant regeneration (Figure 9).

5.6 SIGNIFICANT VALLEYLANDS

No significant valley lands have been identified on or within 120 metres of the subject lands. Any watercourses located within or adjacent to the study area are small tributaries without significant valley features associated with them. The more substantial local valley feature associated with Mountsberg Creek is to the west of the site, but falls outside of the 120 metres area of influence, except for a small portion in the very northwest portion of the subject lands.

5.7 SIGNIFICANT WILDLIFE HABITAT

Significant wildlife habitat is one of the more complicated natural heritage features to identify and evaluate. The Natural Heritage Reference Manual includes criteria and guidelines for designating significant wildlife habitat. The Significant Wildlife Habitat Technical Guide (OMNR, 2000) may be used to help decide what areas and features should be considered significant wildlife habitat. There are four general types of significant wildlife: seasonal concentration areas, migration corridors, rare or specialized habitat, and species of conservation concern. All types of significant wildlife habitat in relation to the subject lands are discussed in more detail below.

5.7.1 Seasonal Concentration Areas

Seasonal concentration areas are those sites where large numbers of a species gather together at one time of the year, or where several species congregate. The following is a partial list of numerous potential examples: deer yards, amphibian breeding ponds, snake and bat hibernacula, waterfowl staging and moulting areas, raptor roosts, bird nesting colonies, shorebird staging areas, and passerine migration concentrations. Only the best examples of these concentration areas are usually designated as significant wildlife habitat. Areas that support a species at risk, or if a large proportion of the population may be lost if the habitat is destroyed, are examples of seasonal concentration areas which should be designated as significant.

The ESAs and the Lower Mountsberg Creek Complex-Wetland PSW on and adjacent to the subject lands contain amphibian breeding pools and portions of the locally significant Guelph Junction and Hilton Falls-Speyside deer wintering areas. While these areas do provide habitat for various organisms, population sizes observed are limited and are not deemed to be significant seasonal concentrations at a provincial scale. Local significance should be attached to these occurrences within the subject lands.

5.7.2 Migration Corridors

Migration corridors are areas that are traditionally used by wildlife to move from one habitat to another. This is usually in response to different seasonal habitat requirements. Some examples are trails used by deer to move to wintering areas, and areas used by amphibians between breeding and summering habitat.

The larger, more important linkages on the landscape are those associated with the Niagara Escarpment to the east of the subject lands, and the natural areas concentrated in the Horseshoe Moraine complexes of Southern Ontario, west and north of the subject lands.

The work that has been completed on the subject lands has identified species of wildlife that range across a variety of habitats. There is undoubtedly localized movement across the subject lands by many species. Some movement (e.g. amphibians) is expected to occur within wetlands with vernal pools present, which occur within upland forest. Both habitat types are important to the survival of many amphibian species and movement patterns would be expected to occur within those areas (i.e. outside of areas proposed for extraction).

No movement areas were noted that would be considered to be provincially significant. Locally important movement areas were noted during deer surveys completed for this project. Many trails with varying degrees of use were noted. The Flamboro Creek corridor on the subject lands was observed to be well-traveled by deer. This corridor links natural areas to the south of the subject lands with wetland and ESA areas to the east and north.

5.7.3 Rare or Specialized Habitat

Rare and specialized habitats are two separate components. Rare habitats are those with vegetation communities that are considered rare in the province. SRANKS are rarity rankings applied to species at the "state", or in Canada at the provincial level, and are part of a system developed under the auspices of the Nature Conservancy (Arlington, VA). Generally, community types with SRANKS of S1 to S3 (extremely rare to rare-uncommon in Ontario), as defined by the Natural Heritage Information Centre (NHIC), could qualify. It is assumed that these habitats are at risk and that they are also likely to support additional wildlife species that are considered significant. Specialized habitats are microhabitats that are critical to some wildlife species. Potential examples include moose aquatic feeding areas, salt licks for ungulates, and groundwater seeps used by Wild Turkeys.

Specialized Habitat in the form of ground water seeps (Figure 7) was observed in the northern portion of the Subject Lands. Evidence of Wild Turkey was observed in this area during recent, winter 2005/2006 field work. The forested areas containing the seeps are outside of the proposed extraction footprint.

5.7.4 Species of Conservation Concern

The biggest group of significant wildlife habitat is habitat for species of conservation concern. This includes four types of species: those that are rare, those whose populations are significantly declining, those that have been identified as being at risk to certain common activities, and those with relatively large populations in Ontario compared to the remainder of the globe.

Rare species are considered at five levels: globally rare, nationally rare (with designations by the Committee on the Status of Endangered Wildlife in Canada or COSEWIC), provincially rare (with designations by the Committee on the Status of Species at Risk in Ontario, or COSSARO), regionally rare (at the Site Region level) and locally rare (in the municipality or Site District). This is also the order of priority that should be attached to the importance of maintaining species.

One provincially endangered and unregulated (butternut) plant species occurs on the subject lands and two provincially Threatened fish and wildlife species, redside dace and Jefferson's salamander, have some limited potential to occur on or near the site. Extensive field work conducted to date has not identified their presence. Their habitats (fish habitat and wetland) were discussed in Section 5.2. Nine locally significant plants and 12 locally significant birds were identified on the property and were concentrated in the northern portion of the site.

One provincially rare butterfly species, Giant Swallowtail was seen on the subject lands. This species is a common butterfly species in southern North America where its larval host plants are citrus trees. In the northern part of its range, where citrus is not available, giant swallowtail caterpillars feed on common hoptree or prickly ash. The giant swallowtail is at the northern extent of its range in Southern Ontario resulting in its rare provincial ranking. However, it has no

national ranking for rarity. In the Hamilton area it is ranked as a locally uncommon permanent resident. The locally uncommon ranking is based on 16 known locations where giant swallowtail has been observed in the Hamilton area. A recent increase in abundance of this species, in the Hamilton area, is part of a general northward expansion of the giant swallowtail within the Carolinian zone (Campbell *et al*. 1990).

Prickly ash, the giant swallowtails larval host plant, was observed in the cultural savanna (CUS1-4) along the western edge of the subject lands and in the south and west edges of the FOD5-4 community, north of the agricultural fields. Additional prickly ash was located west of the subject lands in a SWM1-1 community along Mountsberg Creek. It is possible that the giant swallowtail was breeding on the subject lands in the summer of 2005, the year it was observed. However, The Hamilton Natural Areas Inventory (2003) states that observations in the Hamilton area could be wandering individuals, and should not be considered to represent permanent populations. The observations on the subject lands are therefore unlikely to represent a perennial population of giant swallowtails.

The Pickerel frog, a locally rare amphibian species was recorded from the subject lands. Observations of this frog were in the wetlands in the northwest and southeast areas of the subject lands. Pickerel frogs breed and overwinter in wetland habitat, however they required terrestrial habitat, meadows and woodlands, during their non-breeding summer period.

Some species have been identified as being susceptible to certain practices, and their presence may result in an area being designated significant wildlife habitat. Examples include species vulnerable to forest fragmentation and species such as woodland raptors that may be vulnerable to forest management or human disturbance. A diverse community of area-sensitive forest bird species was recorded in the wooded portions of the site. Additionally, the Broad-winged Hawk, although considered common and widespread in Ontario, is also considered a sensitive forest raptor. It was observed in the northwest part of the property.

Based on the presence of this species as well as a diverse community of other area-sensitive forest birds and locally significant plant and bird species, the forested habitat on the northern third of the subject lands, may be considered to provide significant wildlife habitat for area-sensitive species. Much of this area is designated and protected as PSW and has been identified as significant woodlands by Stantec in this report.

5.8 ENVIRONMENTALLY SIGNIFICANT AREAS

The Hamilton Natural Areas Inventory program a system for designating Environmentally Significant Areas, which include both terrestrial and wetland habitats. All of the naturally wooded features and the majority of the cultural woodlands and savannahs on the subject lands have been designated as part of either the Mountsberg East Wetlands ESA or Carlisle North Forests ESA (Figure 3).

The Mountsberg East Wetlands ESA was designated based on the presence of a wooded riparian area, which serves as a link to other natural features in the area. In addition the ESA

provides habitat for significant species and contains interior forest habitat (a combination of woodland size and shape). The area helps to recharge groundwater supplies, maintain surface water quality and regulate stream flow in the upper Bronte Creek system (Hamilton Natural Areas Inventory, 2003). In addition this ESA includes the Lower Mountsberg Creek Complex-Wetland PSW.

The Carlisle North Forests ESA was designated based on presence of significant species [Ebony Spleenwort *(Asplenium platyneuron)*, Smooth-sheathed Sedge *(Carex laevivaginata)* and West Virginia White *(Pieris virginiensis)*] and interior forest habitat. The riparian area serves as a link between other natural features in the area. The natural vegetation in the area helps to maintain water quality in the coldwater stream (Hamilton Natural Areas Inventory, 2003).

5.9 SUMMARY

The application of these landscape level criteria needs to be revisited at the site scale with the application of some localized refinement criteria. These refinement criteria have been developed to refine the outcome of the initial criteria application exercise, to ensure that generalizations or errors at the broad landscape scale do not overestimate significance of natural heritage resources when balanced with mineral aggregate resources.

Localized Refinement Criteria are presented in the following:

Significant Woodlands should exclude:

- Woodlands < 20 hectares (subject to landscape-specific validation);
- Potentially woodlands of any size in a relatively heavily forested landscape (e.g. 30% forest cover), based upon a careful analysis of total landscape forest cover;
- Cultural communities as defined through the application of the ELC Manual (i.e. those with <60% canopy cover = non-woodlands);
- Plantations that are not integrated in an important manner to the ecology of indigenous woodlands; and,
- Woodlands that are <200 metres in width.

Species at Risk (i.e. and as defined through the *Significant Wildlife Habitat* component of the PPS), should exclude those:

- Ranked as less important than Endangered or Threatened (as defined by COSEWIC and NHIC); e.g. species of conservation concern or conservation priority; and,
- Threatened and Endangered but not Regulated species that have a high probability for successful impact avoidance, mitigation and enhancement through sequential rehabilitation.

The potential for extraction in limited areas of *Provincially Significant Wetlands*, where the wetland area:

- Has been disturbed or has resulted from anthropogenic factors (e.g. road and other infrastructure installation that has impeded drainage resulting in wetland area creation);
- Is small (e.g. < 2 hectares);
- Is isolated (and of limited functional importance) in terms of its position in a complex or within an larger wetland area; and,
- Is replicable and/or can be reasonably compensated for, given proven wetland creation / compensation techniques.

Fish habitat will continue to be subject to consideration for extraction, based upon:

- Proven mitigation and compensation planning and implementation effectiveness; and,
- Opportunities for the potential enhancement of some systems through the introduction of additional coldwater to downstream reaches.

6.0 Potential Impacts

6.1 DESCRIPTION OF THE PROPOSED QUARRY

The proposed Mountsberg Quarry site contains the Provincially significant Amabel dolostone deposit up to 40 metres thickness, and has been designated as a Selected Bedrock Resource Area (MNR/OGS, 1984). Extraction of this resource is planned to produce a variety of high specification crushed stone products for the Greater Golden Horseshoe. The proposed quarry will be developed in stages, which will be progressively rehabilitated. The initial stage will be centrally located, to maximize separation from surrounding land uses. This stage will be excavated to a shallow depth. An Adaptive Management Plan will be applied to the initial stage. This plan would comprise compliance and performance monitoring for a variety of parameters, both those specified in MOE Permits and natural heritage parameters, such as water levels and temperatures. The majority of the perimeter berms, buffers and revegetation would be developed as part of this initial stage. Subsequent quarry stages would be excavated to the full depth warranted and progressively rehabilitated. The rehabilitation plan is discussed in more detail in Section 6.8.

The limit of development from Long Environmental Consultants (2004) has been proposed for revision in this EIS to reflect the recent policy requirements of the Greenbelt Plan as well as the results of 2005 natural environment fieldwork. The recommended proposed quarry limits including the proposed entrance road occupy approximately 78.1 hectares (49%) of the 158 hectares site (Figure 10).

An entrance road is proposed to Milborough Line (Long Environmental Consultants, 2005) (Figure 10). This entrance road will be excavated into the shallow overburden and will slope up from the quarry floor to the existing grade at Milborough Line. The excavation below grade, will reduce the height and width of noise berms and therefore reduce the width of the footprint through the naturally vegetated area.

Extraction below the groundwater table is proposed, and will require dewatering. Mitigation will be required to avoid unacceptable impacts to the groundwater table, and by extension, to the wetlands and watercourses on the site and adjacent lands. Detailed discussions regarding the preferred mitigation strategy required to achieve this result are ongoing and will feed into the final EIS/Level 2 reporting. For purposes of this discussion, it is assumed that mitigation strategies will be developed that will address potential water-related effects. This assumption is being tested through ongoing work in 2006.

The groundwater mitigation system (under development), noise control berms and access roads are all assumed to be accommodated within the limit of development shown on Figure 10.

The analysis of the seven natural heritage features to be considered under the ARA have identified the following existing or potential significant environmental elements on, or adjacent to, the Subject Lands:

- provincially significant wetlands;
- potential habitat for Threatened and Endangered species;
- fish habitat;
- significant woodlands; and,
- significant wildlife habitat.

6.2 PROVINCIALLY SIGNIFICANT WETLAND

6.2.1 Potential Impacts

The proposed development limit does not intrude into the PSW. Additionally, the road and berms associated with the Milburough Line access will not result in development within the PSW. A minimum 30 metre setback, where possible, has been included as part of the development limit. Accordingly, there will be no direct displacement of wetland area within the PSW.

Potential indirect impacts to the PSW include:

- Changes to water balance and quality - reduction in groundwater discharge, altered groundwater table associated with drawdown and/or with mounding associated with extraction and progressive rehabilitation scenarios;
- Changes in surface water catchment, flows and delivery points, change in water temperature and quality;
- Removal of upland habitats that are adjacent to wetlands and are depended upon by wetland species for parts of their lifecycles; and,
- Other physical impacts from quarry operations - dust, disturbance, sedimentation.

Potential Changes to Water Balance and Quality

Given Gartner Lee's initial information, which identifies the wetlands on the subject lands as being directly connected to the water table. It is assumed that unmitigated extraction below the groundwater table would result in unacceptable levels of drawdown to the PSW. Gartner Lee is currently investigating impacts and potential mitigations, in their ongoing groundwater study.

Surface water quality observations (total dissolved solids discussion in Section 4.5.4) suggest that the Tributary portion of the wetland, located at the north end of the site, may be more heavily influenced by seasonal groundwater inputs. Since the groundwater gradient is from north to south, this part of the wetland may rely more on groundwater contributions from north of the site than from the site.

The seeps adjacent to the Flamboro Creek portion of the wetland may be supplied by shallow seasonal groundwater flow. These seeps supply groundwater to the wetland communities in

the southeast section of the subject land. These seeps are located several hundred meters from the proposed extraction area.

The area within the proposed extraction envelope is dominated by recharge, and little surface runoff from these areas is expected to support the wetlands (Gartner, pers. comm. 2005). The ongoing hydrological monitoring (described in Stantec, 2006. in preparation) will establish the degree of dependence of the wetland, if any, on surface runoff from the site.

Potential Change in Surface Water Catchment, Flows, Delivery Points, Water Temperature and Quality

The ongoing water resources investigations (Stantec, 2006. in preparation) and monitoring will provide the basis for addressing potential hydrologic impacts (e.g. surface catchment, flow path and delivery point changes, water temperature and quality effects).

Potential Removal of Adjacent Upland Habitat

A review of species dependent upon both upland and wetland habitat was completed to determine those species and populations that would be potentially affected by the removal of upland habitat adjacent to wetlands. Those more vulnerable to potential adjacent upland habitat loss include: amphibians (leopard frog, chorus frog, pickerel frog).

Some species of frogs move into terrestrial habitat during their non-breeding summer season. Western chorus frogs, observed in the northwest corner of the subject lands move into a wide variety, including more altered habitat such as mowed lawns. Leopard frogs and pickerel frogs move into grassy fields or weed covered areas. While populations of some of these species may be reduced by the removal of suitable adjacent upland habitat, the degree of effect can be mitigated by the retention of some successional habitats and cultural meadows in the vicinity of wetlands and the rehabilitation of berms and some setback areas into grassland.

Other Potential Physical Impacts

Certain construction and/or extraction-related impacts, such as dust generation, sedimentation and erosion, are mitigable through the use of standard site control measures. Mitigation measures for sediment erosion and dust control should be implemented in the immediate vicinity of the boundaries of the PSW to prohibit sediment and dust from entering watercourse, wetland and woodland areas during construction.

The primary principles associated with sedimentation and erosion protection measures are to: (1) minimize the duration of soil exposure, (2) retain existing vegetation, where feasible, (3) encourage re-vegetation, (4) divert runoff away from exposed soils, (5) keep runoff velocities low, and to (6) trap sediment as close to the source as possible. To address these principles, the following mitigative measures are recommended for inclusion in site planning:

- Extraction areas should be isolated from the wetland and watercourses;
- In order to isolate the work area from general runoff and to slow runoff velocities and reduce erosive forces, silt fencing will be required. The silt fences will be located at the limit of disturbance, inside a 5 metre no-touch zone, along all disturbed areas

adjacent to watercourses and the boundaries of the PSW. Additionally, rock checks or silt fence flow checks should be installed in all ditches immediately upstream of their discharge into any aquatic resources;

- All excavated materials requiring stockpiling should be kept away from any significant natural features; and
- Refueling of equipment should be carried out well away from any aquatic and wetland resources, to avoid potential impacts, in the event that an accidental spill occurs.

During extraction and/or construction of facilities, roads, berms and ditches adjacent to the wetland and riparian areas, heavy equipment could damage peripheral vegetation from contact, excavation and/or soil compaction. Dust coating vegetation can reduce photosynthesis, increase susceptibility to disease, and lead to death. Prior to heavy machinery working adjacent to these areas, a barrier for tree protection should be employed to protect PSW vegetation that is to be retained and is in the vicinity of exposure to damage by machinery. This involves permanent durable fencing of the vegetation at, or beyond, the treed drip-line outside of a 5 metre no-touch zone from the limit of disturbance. A dust control program should be implemented.

6.2.2 Net Effects – Provincially Significant Wetlands

Direct effects on the wetlands have been avoided through the development of a proposed extraction footprint that avoids impacts on wetland areas. Potential indirect effects related to wildlife impacts and impacts on vegetation related to mechanical works can be mimimized. Other potential indirect effects are associated with water.

The completion of this assessment will depend upon work currently ongoing regarding surface and ground water investigations on the subject lands. This work will address the pre and post extraction water balance on these lands and how the balance will change during various stages of extraction and in the rehabilitated state.

Assuming that the water levels and sources can be maintained through the mitigation and entrance road mitigation design, and that appropriate water temperature and chemistry can be maintained, adverse indirect impacts on PSW's are predicted to be limited.

6.3 HABITAT FOR THREATENED AND ENDANGERED SPECIES

Two threatened species, redside dace and Jefferson's salamander, were determined to have the potential to be present on or in the vicinity of the site. Neither has been confirmed through the detailed field investigations completed. The proposed quarry extraction footprint does conserve the required habitat for these species.

Salamander eggs were collected in a vernal pool in the northeast portion of the site, adjacent to the eastern property boundary. This area is not within the proposed extraction area, and is therefore distant from potential direct effects. The redside dace was recorded historically in

Mountsberg Creek, downstream of the subject lands. Maintenance of this habitat is discussed in Section 6.4. Assuming water-related mitigation measures result in negligible impacts to the wetland communities, any potential habitat for these two species should be maintained.

A process has been initiated with the MNR and City to develop a comprehensive management plan for the conservation of important butternut genetic material from the subject lands. The plan will call for the retention of selected healthy stems along with the use of other appropriate techniques (e.g. transplantation, forest management to favour butternut survival).

6.4 FISH HABITAT

6.4.1 Potential Impacts

The watercourses with confirmed fish habitat on-site are well buffered from direct effects associated with extraction. Potential indirect effects are similar to those identified for the PSW and include:

- Changes to water balance and quality - reduction in groundwater discharge, altered groundwater table associated with drawdown and/or with mounding associated with extraction and progressive rehabilitation scenarios;
- Changes in surface water catchment, flows and delivery points, change in water temperature and quality;
- Changes in water volume and quality as a result of quarry surplus discharge (Mountsberg Creek only); and,
- Other physical impacts from quarry operations - noise, dust, disturbance, and sedimentation.

6.4.2 Mitigation Options

The areas proposed for extraction are not expected to have significant surface runoff. However, the ongoing hydrological monitoring will assist in quantifying the surface water contribution from the site and the potential impacts of the extraction on surface water. Extraction below the groundwater table could result in unacceptable levels of drawdown on and adjacent to the site, potentially resulting in reductions to base flow to fish habitat. This water balance exercise and associated ground water issues are discussed further in Section 6.2.1 (above).

Any surplus water generated from quarry dewatering will be directly discharged into Mountsberg Creek. Modeled surplus volumes are expected to be small relative to the average flow in the creek. Relative volumes would, of course, be higher during low flow (summer) conditions. No information is currently available regarding the probable temperature of the surplus water, but if it is cooler than Mountsberg Creek flow, the discharge may enhance the summer flow conditions for fish in terms of volume and temperature.

Stantec (2006. in preparation) assessed the water quality impacts of mixing the direct discharge into Mountsberg Creek using a mass balance approach. Results suggest that unmitigated flows to the Mountsberg Creek would slightly increase the alkalinity and conductivity of the receiving

water, while concentrations of aluminum, iron, and zinc would be slightly lowered or remain essentially unchanged. The projected increases in alkalinity and conductivity levels are not predicted to have an impact on the habitat quality of Mountsberg Creek. With mitigation, surplus discharge would be substantially reduced and it is anticipated that impacts would be correspondingly substantially reduced. This work is being further assessed and will be described in Stantec's hydrology report (2006. in preparation).

Measures employed to mitigate other physical impacts from quarry operations on wetlands will also protect the watercourse.

6.4.3 Net Effects – Fish Habitat

Assuming that the groundwater levels and sources can be maintained, no adverse impact to groundwater levels and fish habitat is anticipated. The contribution of surface water will be further refined through the ongoing hydrological study by Stantec (2006. in preparation). Other indirect physical effects have the potential to be fully mitigated to acceptable levels.

6.5 SIGNIFICANT WOODLANDS

6.5.1 Potential Impacts – Quarry Footprint

The proposed development limit generally follows the limit of significant woodland. The Greenbelt Plan allows for the mineral aggregate operations in portions of significant woodlands where the habitat is young plantation or early successional. Accordingly, some early successional fringes or woodland projections have been included within the development limit proposed for extraction (Figure 10).

Small, irregular and/or elongated wooded features that are appended to larger woodlands present a special resource management challenge. Termed "Peripheral Forest Edge Habitat" (PFEH) by Stantec and ECS (2005), these wooded areas would be included in significant woodlands because of their continuity with a larger woodland unit. Functionally, however, they contain only "edge habitat" because they have size and/or shape configurations that provide no interior habitat (defined as habitat more than 100 metres from a forest edge). Furthermore, as a result of their position or shape, these wooded areas do not contribute significantly to the provision of interior habitat in the blocks to which they are attached.

Stantec has been advised that requiring the maintenance of these areas as woodland habitat would present significant operational challenges (Stantec and ECS, 2005). Working around these irregular wooded areas would require the setting aside of lands much larger in area than the actual footprint of the feature. Stantec and ECS (2005) recommended that PFEH be excluded from significant woodland where:

- The PFEH does not contain any interior habitat;

- The removal of the PFEH would affect less than 0.5 hectares of interior habitat in an adjacent woodland, or the net effect of removal plus rehabilitation on interior habitat is neutral or better; and,
- The PFEH does not support any of the other features or functions that are indicative of significant woodland (hydrologic function, features that resulted in a provincial Life Science ANSI designation, or the habitat of Endangered or Threatened species).

Several small parts of wooded communities, identified on Figure 10, meet these criteria, and have been included within the development limit proposed for extraction.

An estimated 8.7 hectares of natural and 8.3 hectares of cultural woodland features are proposed for removal within the development limit and entrance road. All natural and cultural woodlands within the development limits are considered to be PFEH. In addition to this direct loss of the wooded features, indirect impacts may affect the retained forest as a result of the following:

- Increased sunscald, desiccation, potential for windthrow, or the introduction of invasive species at the limit of the new edge;
- Disturbance due to dust, noise and vibration; and,
- Changes to surface water catchments, volumes, delivery points.

6.5.2 Potential Impacts – Entrance Road

The proposed entrance road, as shown in Figure 10, will occupy approximately 11 hectares or 7-% of the site. It traverses a portion of the significant woodland between the proposed quarry and Milburough Line (Figure 10). Portions of the mixed white pine-sugar maple forest/white pine coniferous plantation complex (FOM2-2/CUP3-2) (2.04 hectares) and cultural thicket (0.76 hectares), woodland (1.63 hectares) and meadow (0.31 hectares) will be affected. In addition to the direct loss of the woodland features, indirect impacts as a result of the creation of new forest edges and changes to grading will be the same as those identified in Section 6.5.1.

6.5.3 Mitigation Options – Significant Woodlands

The direct removal of woodland features can be mitigated in part through compensatory plantings as part of the rehabilitation plan. Opportunities for plantings include the berms along the entrance road and open cultural communities such as cultural meadows in buffer areas along 11th Concession.

Where determined by the presence of significant woodland, the development limit has been established at the dripline of the trees. As discussed above, it is understood that required groundwater mitigation, access road establishment and noise berms will be located within the development limit, outside of the conserved significant woodland. This will effectively ensure that active extraction will be at least 30 metres from the woodland edge. A no-touch zone, minimum of 5 metres (tree rooting structure protection zone), will be established between the drip line and any required mitigation structures.

The removal of some forest will result in the creation of new forest edges. Generally accepted mitigation techniques are available to address impacts common to any new forest edge (e.g. pre-stressing new edges, root and stem protection and proper pruning, microclimate management and buffer plantings). The 3:1 overburden cut slopes along the entrance road could be replanted in deciduous forest species, which would act as an early successional fringe to the more mature parts of the woodland. The berms and no-touch zone could be planted in shrub species; these areas would still be accessible for maintenance, but would provide buffering from increased light and exposure at the level of ground and understory flora. These measures will be outlined in more detail as final technical investigations are completed.

Certain construction and/or extraction-related impacts, such as dust generation, sedimentation and erosion, are mitigable through the use of standard site control measures. Mitigation measures for sediment erosion and dust control should be implemented in the immediate vicinity of the new edges to prohibit sediment and dust from entering woodland areas during construction.

The primary principles and mitigative measures associated with sedimentation and erosion protection measures are as discussed for PSWs in Section 6.2.1.

6.5.4 Net Effects

The proposed quarry will maintain approximately 90% of the natural woodlands on the subject lands, including all woodlands determined to be significant during detailed investigations. There will be no loss of range of function or diversity in the significant woodlands; there will be a removal of some non-significant wooded area. Approximately 7.7 hectares will be removed of the total 59 hectares of mature forest and swamp communities on the Subject Lands. With proposed compensatory plantings there will be no net loss of forested area.

6.6 SIGNIFICANT WILDLIFE HABITAT

This site contains areas that have been identified as deer wintering habitat and habitat for breeding amphibians. Based on the presence of “Species of Conservation Concern” (i.e. area-sensitive forest birds and locally significant species) and ground water seeps the forested habitat on-site in the northern third of the site is considered significant wildlife habitat.

The potential wildlife-related impacts from the proposed quarry operation would be caused by (1) direct removal of habitat, (2) increased ambient noise, (3) increased lighting and (4) disruption of wildlife movement, as outlined below.

The proposed maintenance of the PSW and the existing hydrologic regime will permit the retention of sufficient habitat for the rare and uncommon floral or faunal species known to occur on the site. Removal of relatively small areas of woodland (non-significant) should not adversely affect overall wildlife habitat functions. Less than 0.5 hectares of forest interior habitat will be affected; effects on area sensitive species are not expected to be measurable.

The existing ambient noise in the vicinity of the subject lands is quiet and dominated by natural sounds or infrequent human activity, at all times of the day and night (Aercoustics, 2004). Depending on the level and duration/frequency of the activity, an increase in ambient noise can have detrimental effects on wildlife through agitation and flushing responses. Frequent disturbance can cause increased energy consumption, decreased feeding time, physiological stress and decreased reproduction success due to increased predation on young while adults are flushed. Land uses associated with vehicular traffic and the daily presence of site machinery present a potential impact in this regard. Effects are expected to be associated with locally significant and/or sensitive forest birds as well as other common wildlife. The Noise Control Study (Aercoustics, 2004) indicates that the processing plant will be enclosed within an unexcavated rock wall, which will act as an additional sound barrier with the perimeter rock faces and earth berms. The noise from quarry activities will be lowered to standards meeting MOE sound level limits for rural residential ("Class 3") areas. .

It is anticipated that most species of wildlife will be able to adapt to these increases in noise. For those species that are unable to tolerate it, there is sufficient similar surrounding habitat to which to relocate, beyond their individual noise thresholds.

Lighting is useful to enhance safety and to discourage vandalism. However, the inappropriate and indiscriminate use of light can be a significant intrusion into the natural environment. Many animal species are only active at night (i.e., nocturnal species) and can be adversely affected by, or discouraged from, lit areas. Mitigation of long-term lighting impacts includes appropriate placement, shielding, and orientation of lighting structures (e.g., on roads) that are in proximity to natural areas can be used to reduce negative impacts.

Wildlife movement in the local landscape will be affected by the creation of the quarry and associated extraction. During the development of the quarry, wildlife will generally avoid active extraction areas in favour of natural areas, edges and rehabilitated lands and waters. The general landscape in the study area is well forested and local connections are abundant. The habitats proposed for removal are mostly cultural and agricultural. Wildlife movement across these areas will be displaced to other similar habitats nearby. The system of important natural areas around the proposed quarry will remain intact, facilitating most existing movement patterns.

Local deer movement between deer wintering areas and ESAs could be affected by the establishment and use of the proposed entrance road. Negative effects could be mitigated by using cut slopes along the proposed entrance route. Berms topped by 3 metre noise control fence may be required to mitigate noise. Such fencing would be staggered, leaving gaps to enable deer access. Additional details can be incorporated into rehabilitation planning.

6.7 ENVIRONMENTALLY SIGNIFICANT AREAS

6.7.1 Potential Impacts and Recommended Mitigation – Mountsberg East Wetlands ESA

The Mountsberg East Wetlands ESA was designated for achieving two criteria:

- Significant Ecological Function (i.e. linking riparian area, habitat for significant species and Interior forest habitat (at least 200 metres from forest edge); and,
- The ESA also satisfies the Significant Hydrological Function criterion (i.e. groundwater recharge, supplies, maintains surface water in the upper Bronte Creek system).

Significant Hydrological Function:

Mitigation will be required to alleviate potential impacts to the significant hydrological function of the ESA. Provided the mitigation systems function as intended, no adverse impacts are anticipated to the groundwater functions or the surface water in the upper Bronte Creek system. The ESA will continue to meet the significant hydrologic function criterion.

Significant Ecological Function / Interior Forest Habitat:

A small area of woodland (approximately 0.8% of total woodland in the Mountsberg East Wetlands ESA) is proposed for removal. Forest communities that will be affected include white pine cultural woodlands and cultural plantations. This type of vegetation is common in the context of the Flamborough Plain Physiographic Region (Chapman and Putnam, 1984). The remaining area will support the same habitat functions and diversity of species and communities.

No forest interior habitat will be affected as a result of the removal of wooded features in the Mountsberg East Wetland ESA. Indirect impacts to area-sensitive and locally significant plants and wildlife, as discussed in Section 6.6, can be satisfactorily mitigated. The ESA will still meet this interior forest habitat criterion.

6.7.2 Potential Impacts and Recommended Mitigation – Carlisle North Forests ESA

The Carlisle North Forests ESA was designated because it satisfies two criteria, Significant Ecological Function (i.e. significant species, interior forest habitat, and riparian links) and Significant Hydrological Function (i.e. maintains water quality in the coldwater streams).

Significant Hydrological Function:

Mitigation will be required to alleviate potential impacts to the significant hydrological function of the ESA. Provided the mitigation systems function as intended, no adverse impacts are anticipated to the groundwater functions or the surface water in the ESA. The ESA will continue to meet the significant hydrologic function criterion.

Initial analyses of the quality of surplus water proposed to be discharged to Mountsberg Creek indicates that there will be a negligible effect on quality in the creek (Stantec, 2006 in preparation). These analyses are ongoing in 2006. The ESA will continue to meet the significant hydrologic function criterion.

Significant Ecological Function:

A small portion of the total forested area of this ESA (approximately 2.6% of the Carlisle North Forests ESA) is expected to be removed. Forest communities that will be affected include sugar maple and sugar maple-white ash deciduous forest, cultural thicket and woodland. Less than 0.5 hectares of forest interior habitat located 100 metres from the edge will be affected in the Carlisle North Forests ESA. No unique vegetation communities or habitats were noted on-site. Indirect impacts to area-sensitive and locally significant plants and wildlife, as discussed in Section 6.6, can be satisfactorily mitigated. Therefore, the remaining area will still support the same habitat functions and diversity of species and communities.

Both ESAs were also identified as forming a linkage between natural areas in the region. The positioning of the proposed quarry on the landscape will not interrupt large-scale regional linkages (Figure 3). Linkages between the headwater areas of Mountsberg and Flamboro Creeks will be maintained east of Milborough Road and to the west of the site, along the Mountsberg Creek riparian corridor. The ESA will still meet this significant ecological function criterion.

6.8 REHABILITATION PLAN

The September, 2004 concept for rehabilitation of the quarry (Long Environmental Consultants, 2004) proposes the creation of revegetated perimeter buffers, permanent, naturally landscaped berms, and a water feature with a diversity of aquatic and wetland habitats. Areas of exposed cliff (i.e. specialized habitat) and areas of wetland and shallow and deep water systems were proposed. These created systems will relate to, and enhance, the retained terrestrial, wetland, and aquatic systems that will surround the water feature. Opportunities will be created for both education and interpretation.

The rehabilitation plan is a work in progress, undergoing revision to reflect the results of ongoing hydrologic and ecological data collection and analyses. This is an iterative process, involving key technical disciplines on the project team. From a natural heritage perspective, the rehabilitation plan must ensure that there will be no negative impacts on the significant natural heritage features identified in the surrounding landscape. The plan must include long-term management measures, preferably passive and low cost that will ensure any water management measures continue to be functional after the quarry is closed. The general restoration concept includes components that will address a range of natural heritage management goals. The final plan will include detailed methods and measures to achieve the following goals:

- Maintenance of groundwater flow (quality and quantity) to Tributary A and Flamboro Creek wetlands;

- Management of surface water and shallow groundwater flows to permanent and ephemeral ponds;
- Reforestation of open areas, buffer areas along 11th concession;
- Enhancement of plantation areas;
- Incorporation of components of the butternut management plan;
- Incorporation of a diversity of wetland and shallow water habitats into the water feature, which will result from below water table extraction;
- Creation of specialized cliff habitat for nesting birds and other wildlife; and,
- Bottom draw (colder temperature) release of surplus lake water to receiving streams.

Given the geometry of quarries, rehabilitation efforts inside the quarry footprint will be focused primarily on creating open water habitat and associated wetland margins. However the concept plan allows for enhancement of adjacent terrestrial habitat and creation of significant education and recreation opportunities. Open water habitat is generally limited on the Flamborough Plain. Creation of a diverse system of open water, wetland, cliff and shoreline habitats will enhance habitat and species diversity in the local area and on the Flamborough Plain.

Stantec will continue to collaborate with the Lowndes project team to advance the details of the rehabilitation plan and Adaptive Management Plan. As hydrologic and hydrogeological technical work advances in 2006, refinements to impact, mitigation and rehabilitation discussions will be addressed. Completion of the final rehabilitation plan will permit a full assessment of post-closure impacts and recommended mitigation.

6.9 RECOMMENDED SITE PLAN REFINEMENTS

The limit of development from Long Environmental Consultants (2004) has been the subject of extensive field analyses by Stantec and other members of the Lowndes technical team. Detailed soils, micro-drainage, vegetation, wetland and forest characterization field investigations have been completed in 2005 as input to the limit of development depicted on Figure 10 in this report.

The proposed limit on Figure 10 maintains the significant natural features and functions of the site and limits potential effects on features and functions in the surrounding landscape. The detailed site plan, will need to include consideration of the mitigation measures recommended in this document. The site plans will also need to address the rehabilitation measures identified in this report (Section 6.8) and listed below for clarity:

- Maintenance of groundwater flow (quality and quantity) to Tributary A and Flamboro Creek wetlands;
- Management of surface water and shallow groundwater flows to permanent and ephemeral ponds;
- Reforestation of open areas, buffer areas along 11th Concession;
- Enhancement of plantation areas;

- Incorporation of components of the butternut management plan;
- Incorporation of a diversity of wetland and shallow water habitats into the water feature; and,
- Creation of specialized cliff habitat for nesting birds and other wildlife.

With the refinement of these mitigation and rehabilitation measures potential negative effects of this proposed quarry would be limited. There are potential positive effects that can be created through the further refinement and development of a vision for the resultant post-rehabilitation landscape. That vision is the subject of ongoing dialogue with the City of Hamilton and government agencies; to date the discussions have centered around the creation and use of an open water body and the integration of wetland, aquatic and terrestrial habitats surrounding the water feature, in a manner that will optimize scientific and interpretive uses.

6.10 RECOMMENDED ADAPTIVE MANAGEMENT AND MONITORING PLANS

An Adaptive Management Plan (AMP) will be produced that assists in the management of the pre-extraction, extraction and post-extraction effects. The AMP has become an important component in the successful operation of an aggregate extraction facility. Key components include:

- Listing of potential effects
- Identification of mitigation and rehabilitation measures proposed
- Prediction of net effects after mitigation
- Identification of tolerance or target thresholds for net effects
- Establishment of triggers for the implementation of pre-determined corrective actions
- Ongoing monitoring requirements for key, measurable parameters; and
- Annual reporting and agency review.

The AMP is currently in preparation and will be refined base on ongoing surface water and ground water investigations.

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7.0 Summary and Conclusions

7.1 CONCLUDING REMARKS REGARDING NET EFFECTS

The proposed Mountsberg Quarry includes the extraction of stone from a 67 hectare parcel of land. That parcel occupies a position on the Flamborough Plain Physiographic Unit, a broad 41,000 hectare plain that is underlain by high quality Amabel or Guelph Formation bedrock. Amabel is considered Provincially Significant (ARIP). This stone is the highly sought after for the production of crushed stone to support infrastructure development and renewal. The stone deposit in the proposed quarry is relatively thick (up to 40 metres).

This report provides a detailed examination of the lands proposed for extraction as well as adjacent lands in terms of the potential for environmental effects associated with the proposal. Much data have been gathered since the initiation of technical studies in the fall of 2003. For almost three years, data have been collected regarding the ground and surface water conditions in and around these lands as well as information about the terrestrial and aquatic biological resources present and relationships amongst these features.

The biological work has included hundreds of hours of fieldwork by experts in a range of technical disciplines. These data have also been subject to substantial work in terms of integration (e.g. soils, micro-drainage, vegetation data interpreted to define precise wetland boundaries). The natural heritage resource characterization is now substantially completed (subject to comments regarding potential additional data required by agencies).

This report addresses the potential environmental effects associated with the proposed quarry and provides guidance and information related to mitigation options, rehabilitation planning and the need for adaptive monitoring. From the work to-date, it is clear that the proposed extraction footprint conserves:

- Provincially significant wetlands;
- Potential habitat for Threatened and Endangered species;
- Fish habitat;
- Significant woodlands; and,
- Significant wildlife habitat.

The extraction footprint will displace mostly active agricultural fields and some cultural and natural habitats. The important natural heritage features and functions will not be directly affected by the extraction operation. Minor amounts of natural forest cover are proposed for removal, without significant effects predicted on functions and features associated with the remaining heavily forested local landscape.

Forestry compensation and ecological rehabilitation is predicted to result in a net increase in forest cover and the introduction of a range of open water and aquatic habitats that will increase

local biodiversity. The effects have been limited by proposed refinements to the Site Plans, included in this report. Potential effects on fish habitat and significant species are not expected. There are opportunities for the enhancement of local fisheries depending upon further consideration of potential quarry water discharge temperature and quality.

There will be potential indirect effects associated with the proposed operation. These effects will relate to the potential for changes to occur in the surface and ground water regimes upon which some of the natural features and functions depend. Water investigations are ongoing. Agencies have offered recent comments on hydrological and hydrogeological technical work and activities. Work is being completed to address those comments and it is recognized that the results of the additional work may affect some aspects of this reporting, especially sections related to potential effects and mitigation.

There are many mitigation methods available to address potential effects associated with the water resources. Potential changes in the water balance (pre versus during and post extraction) will need to be carefully addressed to avoid, minimize and/or mitigate the potential indirect effects. Water quality and temperature effects are also being addressed in this work; initial observations suggest that Mountsberg Creek will be an appropriate and perhaps beneficial receiver of quarry discharge waters. This requires further consideration and validation.

The staged process of extraction and rehabilitation offers the opportunity to measure both positive and negative effects in an adaptive manner over the life of the project. An Adaptive Management Plan is being developed jointly by the Lowndes technical team to further address the predicted series of effects. That AMP will be released in draft, as it is further developed. This EIS and Level 2 Report will be reviewed and updated as earth science work is finalized.

The intent of releasing this updated report at this time is to provide current technical information and analyses to the City and agencies in order to facilitate an on-going dialogue. This report release is also intended to offer time for the City and agencies to review current data with regard to seasonal observations. Any additional thoughts/comments from the City and agencies that relate to the need to examine specific ecological features and functions can be highlighted in the near-term, prior to the onset of the 2006 ecological data collection season.

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APPENDIX A: Figures

APPENDIX B: Tables

Table 1: Field Work Program

Date of Field Work	Purpose of Field Work	Personnel
Feb 27, Mar 1, 4, 2004 Feb 11, 2005	Winter wildlife survey, deer yard assessment	Campbell Smith
Apr 14, 2004	Owl survey	Smith
Apr 14, 15, 2004 Apr 26, May 4, 2005	Salamander egg mass collection/analysis	Campbell Sandilands
Apr 14, May 12, Jun 16, 2004 Apr 29, May 24, Jun 15, 2005	Amphibian call counts	Campbell Smith
Apr 14, 2005 and all visits	Reptile surveys - hibernacula emergence - opportunistic observations during other surveys	Sandilands
May 12, 2004 Apr 26, 2005	Red-shouldered Hawk survey	Smith Wyatt
Jul 1, 2, 2004 Jun 2, 4, 21, 23, 2005	Breeding bird inventory	Kopysh Wyatt
May 12, Jul 13, 2005 and all visits 2005	Insects (Lepidoptera) - Pollard transects - opportunistic observations during other surveys	Taylor
Oct 16, 23, 2003 May 13, 14 July 19, Sept 10, 2004 June 13, 20, July 15, 18, 2005	Vegetation surveys - vegetation community survey - vascular plant survey	Zoladeski
Apr 31, June 15, 27, July 12, 26, 2005 Sept 7, Oct 7, 2005	Wetland Boundary Delination	Charlton
Nov 25, Oct 30, 2003 June 15, 17, 18, 2004 June 1, 2005	Fish Inventories - habitat assessment - Redd survey - fish community inventories	Park Clarkin Weeks Pomeroy
June, 2004	Benthic invertebrate sampling	Park Clarkin
Nov, 2004 Feb, June, Sept, 2005	Surface water sampling	Park Clarkin Harttrup
Sept, Oct, Nov, 2005	Surfacewater level and temperature monitoring	Park Clarkin Harttrup

Table 2: ELC Vegetation Types

ELC Type	Description
CONIFEROUS FOREST (FOC)	
FOC4-1 Fresh – Moist White Cedar Coniferous Forest	All the strata (tree canopy, reproduction and shrub layer) are almost exclusively composed of white cedar. Because of the density of the cedar, there are virtually no plants growing on the ground. These stands are still young, very dense and undergoing intensive self-thinning.
*FOC5-1 Fresh – Moist White Pine Coniferous Forest	A generally coniferous type dominated by white pine, with admixtures of white cedar, hemlock, green ash and sugar maple. In this, very likely, older pine plantation the trend towards a return of a deciduous community is indicated by the dominance of sugar maple in the shrub stratum. After the flush of vernal ephemerals, the ground herb cover becomes poor, with common speedwell, zigzag goldenrod and sedges.
MIXED FOREST (FOM)	
FOM Mixed Forest	This is a variably composed community, representing late-successional development on formerly agricultural lands. The tree canopy composition is variable with several species present in different proportions, e.g. white pine, white cedar, hemlock, sugar maple, trembling aspen, large-tooth aspen, black cherry, white birch, white and green ash, beech and bitternut hickory. Depending on the composition and density of the tree layer, understorey vegetation may be equally diverse.
FOM2-2 Dry–Fresh White Pine–Sugar Maple Mixed Forest	This is a middle-aged community composed of often large, open-grown white pine and the hardwood component represented by sugar maple (including very old and large specimens), trembling aspen, bitternut hickory and white birch. Sugar maple seedlings and saplings are abundant. The ground herb layer is generally poorly developed.
FOM7-2 Fresh-Moist White Cedar– Hardwood Mixed Forest	White ash and white cedar dominated the canopy in this community. A smaller proportion of trembling aspen extended above this canopy. Young white ash and white cedar formed the understory and the ground herb layer was generally poorly developed.
DECIDUOUS FOREST (FOD)	
FOD Deciduous Forest	Included here are diverse communities composed of several tree species growing in various combinations, for example trembling aspen, large-tooth aspen, white birch, sugar maple, white elm, white ash, ironwood and bitternut hickory. In the shrub layer grow black cherry and sugar maple saplings, while in the well-developed herb layer the major species are white avens, calico aster, zigzag goldenrod and wild ginger.
FOD3-1 Dry–Fresh Poplar Deciduous Forest	Large-toothed aspen dominates this mid-aged community, with sub-dominant trembling aspen, ironwood, elm and white ash. In the regeneration layer sugar maple is the main species, while in the shrub layer saplings of white ash and some choke cherry dominate. The herbaceous ground cover is well developed, with enchanter's nightshade, wild ginger, may-apple, running strawberry-bush, Jack-in-the-pulpit and several other species.
FOD5 Dry–Fresh Sugar Maple Deciduous Forest	A much disturbed community dominated by sugar maple, with variable amounts of black cherry, bur oak, basswood and aspen. Garlic mustard and periwinkle form the ground cover.

Table 2: ELC Vegetation Types

ELC Type	Description
FOD5-1 Dry–Fresh Sugar Maple Deciduous Forest	Sugar maple is the leading canopy species and the other hardwoods or softwoods (for example white ash, beech, hemlock) are present in small amounts. Maple and white ash saplings compose the well-developed shrub layer, where also occur blue beech, alternate-leaved dogwood, prickly gooseberry or, rarely, leatherwood. The fall floristic aspect is dominated by zig-zag goldenrod, enchanter's nightshade and running strawberry-bush, but the spring ephemerals are very abundant. These communities are usually mid-aged to mature.
FOD5-4 Dry–Fresh Sugar Maple – Ironwood Deciduous Forest	Sugar maple dominated stands, with admixtures of several species such as ironwood, green and white ash, beech, bur oak, white birch, black cherry and hemlock. The shrub layer is dominated by sugar maple and other hardwood saplings and seedlings, including black cherry and green ash, while true shrubs are represented by grey dogwood, prickly gooseberry and alternate-leaved dogwood. The herb layer displays distinct seasonality, with vernal ephemerals followed by late summer species—white avens, wild ginger, zig-zag goldenrod, enchanter's nightshade and running strawberry-bush. These are mid-aged to mature communities located on upland sites, usually on shallow mineral soil over bedrock.
FOD5-7 Fresh Sugar Maple–Black Cherry Deciduous Forest	Located in a small, slightly concave depression, on shallow soil over bedrock, this mid-aged community is dominated by sugar maple and black cherry, with a strong admixture of large-tooth aspen. Alternate-leaved dogwood is the main tall shrub species, followed by choke cherry, prickly gooseberry, and saplings of white ash and elm. Relatively few species form the ground cover, for example herb-Robert, running strawberry-bush, enchanter's nightshade and the introduced garden escape lily-of-the-valley.
FOD5-8 Dry–Fresh Sugar Maple–White Ash Deciduous Forest	Sugar maple and white ash are the principal tree species, followed by small amounts of other tree species. Choke cherry, red raspberry and white ash seedlings compose most of the shrub stratum. In the herb layer grow tall goldenrod, enchanter's nightshade, various sedges, herb-Robert, white avens, running strawberry-bush, zig-zag goldenrod and several other species.
FOD5-10 Dry–Fresh Sugar Maple–White Birch-Poplar Deciduous Forest	This type is composed of sugar maple, white birch, trembling aspen, with admixtures of white ash and bitternut hickory. The maple and ash dominate the sapling stratum, alongside true shrubs such as alternate-leaved dogwood, choke cherry and Alleghany blackberry. Ground herb cover is generally poorly developed, with white avens, enchanter's nightshade, Jack-in-the-pulpit and zig-zag goldenrod.
FOD8-1 Fresh–Moist Poplar Deciduous Forest	This unit is dominated by trembling aspen, with green ash present in the sub-canopy and shrub layers. Choke cherry, Virginia-creeper and poison ivy are the leading shrubs. The herb layer is well developed, with enchanter's nightshade, calico aster, white avens, red baneberry and several other species.
CULTURAL (CU)	
PLANTATION (CUP)	
CUP3-1 Red Pine Coniferous Plantation	An extensive patch of this type is found on the south side of 11th Concession. The shrub and herb understories are very poorly developed.
CUP3-2 White Pine Coniferous Plantation	Older plantations on shallow soil over bedrock, still dominated by white pine, but with several hardwoods entering the community, most importantly sugar maple, white elm and white birch. Scattered remnant hawthorn is in decline. The understorey is poorly developed to non-existent.
CUP3-6 European Larch Coniferous Plantation	A young, dense larch plantation, with some scattered presence of white pine and white ash. The herb layer is tall and dense, dominated by Canada goldenrod and numerous other old field meadow species.

Table 2: ELC Vegetation Types

ELC Type	Description
CUP3-9 Norway Spruce Coniferous Plantation	This is an open, very young (10-12 yrs) plantation. Typical old field meadow herbaceous cover still prevails, with such species as Canada goldenrod, Canada blue grass, wild carrot, glaucus king devil, and many others.
CULTURAL MEADOW (CUM)	
CUM1-1 Dry–Moist Old Field Meadow (open)	A regenerating community of invasive native and introduced plants on formerly agricultural land. The main species include Canada goldenrod, New-England aster, timothy, red-top, wild basil, ribgrass, wild carrot, tufted vetch, red clover and white sweet clover. Although some shrubs and trees may be present, they are a minor component of this community type.
CUM1-1a Dry–Moist Old Field Meadow (with invading shrubs)	A similar type as the previous in terms of the composition of the herb layer, but with a better developed shrub and young tree stratum, where the following species may occur: white pine, hawthorn, elm, ash, Tartar Ian honeysuckle, red raspberry and grey dogwood.
CULTURAL THICKET (CUT)	
*CUT1-8 Mixed Cultural Thicket	This open thicket, regenerating open old fields is composed of scattered apple trees, hawthorn, and young trees of sugar maple, black cherry, white pine, white elm, white ash and bitternut hickory. The ground cover retains old field meadow characteristics, such abundance of Canada goldenrod, fescue, ox-eye daisy, and many others.
CULTURAL SAVANNA (CUS)	
*CUS1-4 White Pine Cultural Savanna	White pine is the principal species in this open community, where in the shrub layer are several tree saplings and true shrubs, including sugar maple, green ash, white elm, prickly ash, hawthorn, grey dogwood and Tartarian honeysuckle. Leading ground cover contains hart-leaved aster, glaucus king devil, wild marjoram, Canada goldenrod and timothy.
*CUS1-5 Deciduous Mineral Cultural Savanna	An open-canopy community, composed of scattered trees, such as balsam poplar, black cherry, white elm, basswood, black walnut and white birch. The herb layer is diverse, with Canada goldenrod , orchard grass, glaucus king devil, Canada bluegrass, awnless brome and many other species typical of old fields.
CULTURAL WOODLAND (CUW)	
*CUW1-3 White Pine Cultural Woodland	White pine is the main species in this community type, forming more or less dense patches, in which other coniferous or deciduous species can occur, for example white cedar, white birch, aspen, white ash and white elm. The development of shrub and herb understoreys is variable, often as patches of old field vegetation amongst groups of trees. The low-branched open growth habit of the pine indicates that these were once open communities (likely old fields) that were invaded by the conifers.
*CUW1-4 Deciduous Mineral Cultural Woodland	This type is represented by small isolated patches amongst the crop fields. The semi-open communities may be composed of the sugar maple, trembling aspen and other hardwood species, including white birch and black cherry. The herb cover is intermediate between old field meadow and woodland species and include enchanter's nightshade, herb-Robert, white avens, scarlet strawberry, Canada goldenrod, New-England aster, garlic mustard, kidney-leaf buttercup, and many others.

Table 2: ELC Vegetation Types

ELC Type	Description
MIXED SWAMP (SWM)	
SWM1-1 White Cedar–Hardwood Mineral Mixed Swamp	A swamp forest composed of white cedar and several possible associates, including trembling aspen, red or white ash, yellow birch, white elm, balsam fir and silver maple. White cedar saplings usually dominate the shrub layer, but other canopy species are also represented. True shrubs are represented by red osier dogwood, red raspberry, Virginia creeper, prickly gooseberry, alternate-leaved dogwood and riverbank grape. The development of the herb layer is variable, with such possible leading species as spotted touch-me-not, bulblet fern, bulblet bladder fern and enchanter's nightshade. Microtopography is hummocky, with mounds and pits, caused by tree windthrows. These, usually mature forests are typically associated with bottomland situations and creek floodplains.
SWM4-1 White Cedar–Hardwood Organic Mixed Swamp	Tree canopy is discontinuous and generally short (12-15 m). Trembling aspen forms the upper layer, with white cedar growing in the lower layer. Other common species are black ash and yellow birch. The shrub layer is composed of red-osier dogwood, common elderberry and young white cedar. The herb layer is rich, with such species as smaller forget-me-not, marsh fern, marsh marigold, spotted joe-pye-weed, mint and marsh bedstraw. This unit is associated with wide creek floodplains. Some areas within this ELC type included Sphagnum mounds and plants showing bog and fen affinity such as sedges (*Carex trisperma, Carex disperma)* and round-leaved sundew.
DECIDUOUS SWAMP (SWD)	
SWD2-1 Black Ash Mineral Deciduous Swamp	Black ash dominated this community with occasional white elm and balsam poplar. Red-osier dogwood was observed in the understory forming thicket is spots. This community was relatively young and occurred along Tributary D.
SWD2-2 Green Ash Mineral Deciduous Swamp	Green ash dominated the medium-height tree canopy, along with white elm and occasional balsam poplar. In the shrub layer grow red-osier dogwood, choke cherry, narrow-leaved meadow-sweet and Virginia creeper. The herb layer is very rich and includes rough goldenrod, tall goldenrod, Canada anemone, purple loosestrife and numerous other wetland species. The community is relatively young and occurs as a narrow zone of Tributary A.
SWD3-2 Silver Maple Mineral Deciduous Swamp	An extensive swamp occurring on the floodplain of Tributary A in the north-west end of the subject lands. Dominated by silver maple, with abundances of red maple, Freeman's maple (hybrid between red and silver maples), green ash, white birch and American elm. The tree canopy reaches 25 metres in height. The shrub layer is generally poorly developed, composed of saplings of elm and white cedar, along with red osier dogwood, alder-leaved buckthorn, and red raspberry. The herb layer is continuous and rich in species, such as sensitive fern, spotted joe-pye weed, bitter nightshade, and many other forbs, sedges and grasses. Flooding is a feature in this community as high water levels were observed both during the spring survey and the fall sampling.
SWD4-2 White Elm Mineral Deciduous Swamp	A young even aged community dominated by white elm in the overstorey and poison ivy in the understorey. An ephemeral wetland as evidenced by springtime observations and water strand lines on tree trunks approximately 20 – 30 cm above the hummocky ground surface. Dry at other times of the year, Located in proximity to the pond in the northeast portion of the site that also exhibits very large fluctuation s in water levels in the spring.
*SWD4-5 Poplar Mineral Deciduous Swamp	Trembling aspen is the main canopy species, with a possible small admixture of elm or ash. The shrub layer may be composed of ash and aspen saplings, as well as round-leaved dogwood. The main herbaceous species is reed-canary grass.

Table 2: ELC Vegetation Types

ELC Type	Description
*SWD4-6 Poplar-Ash Mineral Deciduous Swamp	Trembling aspen and green ash are leading tree canopy species, followed by elm and white birch. The shrub layer is relatively well developed, with round-leaved goldenrod, Virginia creeper, nannyberry, alternate-leaved dogwood, choke cherry and common buckthorn. The herb stratum, although sparse, can contain several species, such as Jack-in-the-pulpit, calico aster, enchanter's nightshade, white avens and fringed loosestrife. The unit appears to be extensively flooded in the spring.
THICKET SWAMP (SWT)	
SWT2 Mineral Thicket Swamp	This community is located in a small depression amongst the forests in the north-central portion of the lands. The site contains almost continuous open water, 25 cm or more deep. Scattered short red maple and elm trees are present, but the community is essentially composed of red-osier dogwood and cedar saplings. In more open places there are patches of reed-canary grass. Because of the lack of clearly defined dominants and uneven physiognomy, this unit could not be defined at the ecosite level.
SWT3-2 Willow Organic Thicket Swamp	A dense community composed of Bebb's willow, with abundances of red-osier dogwood and young white cedar. The main tall shrub layer is overtopped by tall saplings of white birch and trembling aspen. The organic substrate is water-saturated and spongy with many areas of water at surface. Small's spikerush, marsh fern, reed-canary grass, bristly sedge, smaller forget-me-not and a carpet of brown mosses form the rich ground cover.
*SWT3-15 Mixed Organic Thicket Swamp	An open-canopy community dominated by young, short (10 m) white elm trees, along with other species such as white birch, red maple and trembling aspen. Red-osier dogwood, round-leaved dogwood, alder-leaved buckthorn, common elderberry and white cedar compose the medium layer. The herb layer is very rich, with dwarf raspberry, false mitrewort, marsh fern, rough goldenrod and many other species. Windthrows are common throughout the patch. Fallen, decomposing tree trunks are cover by abundant mosses.
MEADOW MARSH (MAM)	
MAM2-2 Reed-canary Grass Mineral Meadow Marsh	These dense meadows are graminoid monocultures dominated by reed-canary grass, with only small amounts of localized red-top and tall white aster or sensitive fern.
*MAM2-11a,b Mixed Mineral Meadow Marsh	Wet meadows composed of varying mixtures of graminoid and forb species. Based on the dominant plants, the unit could be divided into sub-types "a" and "b". Sub-type "a" is located along Tributary A's floodplain in the north-west corner of the subject lands. The main species are bluejoint, reed-canary grass, red-top, perfoliate thoroughwort, spotted joe-pye weed, spotted touch-me-not, sensitive fern, American stinging nettle, tall white aster and Canada thistle. Sub-type "b" is found in a narrow depression between hedgerows in the south-west corner of the subject lands, where the leading species are reed-canary grass, awnless brome, tall white aster and purple-stemmed aster.

* not listed in the ELC for Southern Ontario (Lee *et al.* 1998)

Table 3: Location of Locally Rare Plant Species

Species Name		Common Name	SRANK	GRANK	Goodban 2003	Location
Linnaea	*borealis* ssp. *longiflora*	Twinflower	S5	G5T?	R	uncommon in the swamp communities in the northeast portion of the lands
Drosera	*rotundifolia*	Round-leaved Sundew	S5	G5	R	uncommon in the Flamboro Creek wetland
Mitella	*nuda*	Naked Mitrewort	S5	G5	R	common in the swamp communities in the northeast portion of the site
Carex	*aquatilis*	Aquatic Sedge	S5	G5	R	common in the marsh in the northwest portion of the site
Carex	*trisperma* var. *trisperma*	Three-seeded Sedge	S5	G5T	R	On sphagnum mounds in SWM 4-1
Eleocharis	*smallii*	Small's Spike-rush	S5	G5?	R	abundant in the SWT in the extreme southwest corner of the site
Lilium	*philadelphicum*	Wood Lily	S5	G5	R	singly in the FOD5-1 along the northern boundary of the site
Platanthera	*hyperborea*	Tall Leafy Green Orchis	S5	G5	R	Scattered in Flamboro Creek Wetland

Table 4: Benthic Community Indices Calculated from Quantitative Data Collected in Flamborough and Mountsberg Creeks (June 2004)

Station	Enumerations			Relative Abundance of Taxonomic Groups					
	Mean # of Organisms	Mean # of Taxa	Mean # of EPT Taxa	Mean % EPT Organisms	Mean % Chironomids	Mean % Other Insects	Mean % Annelids	Mean % Molluscs	Mean % All Other Organisms
A1	549	25	1	0.2	16.8	11.6	9.0	37.0	25.5
A2	236	18	1	0.7	8.1	2.0	4.6	55.1	29.6
B1	109	15	1	2.8	4.8	4.6	2.4	59.8	25.7
C1	860	17	0	0.1	56.4	2.0	12.3	3.6	25.7
D1	169	19	4	48.8	6.6	16.5	16.6	0.3	11.2
D2	268	21	3	6.0	30.4	10.7	2.6	14.6	35.6
F1	109	14	1	0.9	56.2	2.4	12.3	12.7	15.6
F3	468	34	4	3.3	51.0	9.6	3.1	22.6	10.3
F4	531	19	0	0	10.3	1.1	27.6	29.5	31.5
M1	434	44	12	27.8	44.6	6.7	11.6	7.0	2.4
M2	987	39	12	46.3	7.6	33.6	1.7	4.5	6.3
M3	1,077	54	14	31.4	20.9	9.0	13.1	14.3	11.3

Table 5: Water Samples

Sample ID	Date	Alk 4.5 SM 2320B mg CaC0 3/L	Turb. SM 2130B NTU	TSS SM 2540B mg/L	TDS SM 2540C mg/L	Br- SM 4110B mg/L	Cl- SM 4110B mg/l	N02-N SM 4110B mg/L	N03 – N SM 4110B mg/L	S04= SM 4110B mg/L	P04-3 SM 4110B mg/L	TOC SM 5310C mg/L	DOC SM 5310C mg/L	NH3-N SM 4500H mg/L	TKN SM 4500B mg/L
A1	November 2004	171	0.6	2	622	<0.5	36.6	<0.2	<0.2	234.0	<1	13.2	13.3	0.12	0.64
	February 2005	243	0.8	<1	402	<0.5	37.0	<0.2	<0.2	53.3		9.5	10.2	<0.03	0.65
	June 2005	298	3.9	3.0	410	ND	36.6	ND	ND	ND	ND	13.2	12.8	ND	1.1
	September 2005	134	4.2	4	168	ND	40	ND	ND	19.0	ND	9.1	9.0	0.09	1.4
F4	November 2004	241	4.0	12	338	<0.5	10.1	<0.2	<0.2	36.3	<1	11.0	10	0.07	0.69
	February 2005	249	0.4	<1	310	<0.5	33.8	<0.2	<0.2	37.4		5.6	5.2	<0.03	0.18
	June 2005	304	1.4	2.0	392	ND	38.8	ND	ND	15.2	ND	13.2	6.2	0.09	0.4
	September 2005														
M2	November 2004	172	2.8	8	278	<0.5	33.4	<0.2	<0.2	28.0	<1	7.6	6.8	0.03	0.60
	February 2005	227	3.8	9	362	<0.5	43.7	<0.2	0.7	51.4		8.0	7.2	<0.03	0.67
	June 2005	307	1.6	4.0	293	ND	47.4	ND	0.1	18.2	ND	7.5	7.2	0.21	0.7
	September 2005	136	1.4	6	190	ND	39	ND	ND	15.0	ND	8.6	8.0	ND	0.9
M3	November 2004	174	0.6	2	270	<0.5	33.2	<0.2	<0.2	28.2	<1	7.8	6.6	<0.03	0.50
	February 2005	218	3.6	9	352	<0.5	44.8	<0.2	0.6	51.3		8.2	7.2	0.04	0.62
	June 2005	192	1.7	7.0	321	ND	43.0	ND	0.1	22.0	ND	9.5	8.0	0.28	0.9
	September 2005	137	1.1	ND	218	ND	39	ND	ND	7.0	ND	8.7	8.2	ND	1.2

Table 6: Potential Impacts and Mitigation

Feature/Function	Potential Impacts and Effects	Mitigation	Predicted Net Effects
Provincially Significant Wetland	Changes to groundwater balance and quality	Implementation of mitigation measures to maintain existing groundwater regime; requires mitigation subject to further investigation	TBD, expected to be limited
	Changes to surface water flows and delivery points	Surface water inputs small compared to groundwater contribution – to be confirmed through hydrological report; if necessary, surplus water could be pumped to areas of need (quality and temperature changes to be assessed)	TBD, expected to be limited
	Physical disturbance – dust, sedimentation	Implementation of minimum 30 m setback, where possible; implementation of sediment and erosion protection measures, dust control plan	No direct impacts; increase in dust and sediment is mitigable to acceptable levels
Habitat for Threatened and Endangered Species	Impacts to potential habitat of threatened species, Jefferson's salamander and redside dace	Potential habitat would be located outside the proposed footprint; mitigation measure implemented to protect wetland structure and function will protect potential habitat.	No loss of potential habitat. Subject to hydrologic/hydrogeologic work
	Loss of butternut specimens of poor health and vigour	MNR is being consulted regarding a detailed management plan for butternut	
Fish Habitat	Changes to groundwater balance and quality	Implementation of mitigation to maintain existing groundwater regime; quality subject to further investigation	TBD, expected to be limited
	Changes to surface water flows, catchments, temperature and quality	Surface water inputs small compared to groundwater contribution – to be confirmed through hydrological report; water quality as a result of surplus water discharge to Mountsberg Creek will remain unchanged. Temperatures of discharge water expected to be lower than Mountsberg Creek's summer high temperatures.	TBD, expected to be limited
	Physical disturbance – dust, sedimentation	No direct disturbance proposed; implementation of sediment and erosion protection measures, dust control plan	Increase in dust and sediment is mitigable to acceptable levels

Table 6: Potential Impacts and Mitigation

Feature/Function	Potential Impacts and Effects	Mitigation	Predicted Net Effects
Significant Woodlands	Direct loss of some woodland edge features totaling 8.7 ha of natural communities and 8.3 ha of cultural communities	Potential replanting of 34.0 ha	Net increase of woodland area Impacts to significant woodland features and functions in retained woodland communities are negligible
	Approximately 0.5 ha of forest interior habitat affected	Strategic replanting to create forest interior habitat over 1.0 ha.	No net loss in forest interior; potential net increase
	Increased sunscald, desiccation, windthrow, invasive species at new edges	Pre-stressing of new edges, planting of buffers	Forest edge effects are mitigable to acceptable levels
Significant Wildlife Habitat	Direct removal of habitat Increased disturbance from light and noise	No direct removal of habitat for locally significant species and area-sensitive species Noise berms, light shields	With some mitigation, light and noise will still be increased over existing conditions, but most species of wildlife will be able to adapt or move short distances to surrounding similar habitat
Environmentally Significant Areas	Loss of "Hydrological Function"	Implementation of mitigation measures to maintain existing groundwater regime; quality subject to further investigation	TBD, expected to be limited
	Loss of "Significant Ecological Function" (significant species, forest interior habitat and riparian links)	No direct removal of habitat for locally significant species and area-sensitive species; replanting; large-scale linkages along riparian zones will not be affected.	Significant species and riparian links are not affected. Net change in forest interior negligible.

This table will be used and revised throughout the ongoing technical process as new information is gathered and as impact analyses are refined. It will be updated to include post-closure net effects and will depend on details of the revised Rehabilitation Plan

APPENDIX C: Study Terms of Reference

Stantec Consulting Ltd.
361 Southgate Drive
Guelph ON N1G 3M5
Tel: (519) 836-6050 Fax: (519) 836-2493
stantec.com

Stantec

March 4, 2005
File: 162603782

Lowndes Holdings Corp.
c/o Bob Long
Long Environmental Consultants Inc.
43 Forest Park Rd.
Orangeville, ON L9W 1A1

Dear Gentlemen:

Reference: Proposed Dolostone Quarry, City of Hamilton
Environmental Impact Statement Terms of Reference

Stantec completed a Preliminary Level 2 Natural Environment Report, submitted as an appendix to the Planning Report for the Lowndes' Proposed Dolostone Quarry (September, 2004). Additional field data were collected during 2004. We intend now to initiate the additional studies and analyses to enable completion of an Environmental Impact Statement (EIS) for the proposed undertaking that incorporates these data, as well as comments received from the City's Environmentally Significant Areas Impact Evaluation Group (ESAIEG) and Conservation Halton, and that meets the requirements of the City's July 2004 Environmental Impact Statement (EIS) Guidelines, the Provincial Policy Statement (2005) and the Greenbelt Plan (2005). The EIS will also meet the requirements for a Level 2 Natural Environment Report for an application under the Aggregate Resources Act. Specifically, the EIS will:

- Describe the proposal
- Identify the desktop sources, research and field work methods and analyses used
- Describe the existing on-site and surrounding environment
- Identify and assess the impacts of the proposal on natural heritage features and functions
- Identify positive effects of the proposal (enhancement, restoration)
- Evaluate feasible mitigation measures and their effectiveness
- Recommend mitigation measures, site plan changes, adaptive management, progressive rehabilitation and monitoring plans as necessary.

Reference: Proposed Dolostone Quarry, City of Hamilton
Environmental Impact Statement Terms of Reference

The Preliminary Level 2 Natural Environment Report was prepared to address the Proposed Dolostone Quarry Site Plan (Long Environmental, September 2004). This Site Plan included extraction, other quarry-related development and progressive and final rehabilitation partially within the Environmentally Sensitive Areas (ESAs) and Provincially Significant Wetland (PSW) on site. Recommendations will be made for revising the September 2004 Site Plan to exclude quarrying from inside the PSW and to ensure extraction only occurs within the ESAs where adverse effects will not be caused or can be mitigated.

Two documents are attached. One is our recommended annotated Table of Contents of the proposed EIS, which describes the proposed development and lists in detail the information sources referenced, the timing and nature of completed and proposed field work, and the approach to assessing the impacts of the proposed quarry including site planning, adaptive management and progressive rehabilitation recommendations. The second is a summary of all the field work planned or conducted to date, which we believe fully satisfies the requirements of the Guidelines. Together with this letter, these documents represent our Terms of Reference for the EIS.

Sincerely,

STANTEC CONSULTING LTD.

Valerie Wyatt, M.Sc.
Senior Project Manager
Tel: (519) 836-6050
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Attachments: Annotated Table of Contents
Field Work Summary

c. Sherry Yundt, S. E. Yundt Ltd.

Annotated Table of Contents

1 INTRODUCTION

1.1 DESCRIPTION OF THE PROPOSAL

Lowndes Holdings Corp. has acquired 154 ha located in Part Lot 1 and Lots 2 and 3, Concession 11, geographic Township of East Flamborough, in the City of Hamilton. The site contains a significant Amabel dolostone deposit up to 40 m in depth, and has been designated as a mineral aggregate area. Extraction of this resource is planned to produce crushed rock. The proposed quarry will be developed in four phases, which will be progressively rehabilitated. Extraction will be below the water table and will require dewatering.

The initial quarry site plan (Long Environmental, September 2004) involved the excavation of 96 ha (62%) of the site. A revised site plan will be prepared in conjunction with the EIS and associated environmental studies being conducted by the Client's consulting team. A detailed description and map will be included in the EIS.

1.2 ENVIRONMENTAL POLICY CONTEXT

1.2.1 Province of Ontario
- *Provincial Policy Statement, 2005*
- *Aggregate Resources Act*
- *Greenbelt Plan and Greenbelt Act, 2005*

1.2.2 Regional Municipality of Hamilton-Wentworth

1.2.3 Former Township of Flamborough

1.3 STUDY PURPOSE AND CONTENTS

An EIS is a study that assesses the potential impact of a development proposal on the natural environment. Such a study allows the applicant to create a development plan that avoids, minimizes and/or mitigates against negative environmental effects and which assists planners in determining whether the proposal is in compliance with municipal and provincial policy. The EIS also serves as a source of important information to the landowner (City of Hamilton, 2004). This EIS has been prepared to meet the requirements of the City of Hamilton and the Provincial Policy Statement, consistent with the Greenbelt Plan (2005). Additionally this EIS is extended to comprise a Level 2 Natural Environment Report for an application under the Aggregate Resources Act.

This EIS will:

- Describe the proposal
- Identify the desktop sources, research and field work methods and analyses used
- Describe the existing on-site and surrounding environment
- Identify and assess the impacts of the proposal on natural heritage features and functions
- Identify positive effects of the proposal (enhancement, restoration)
- Evaluate feasible mitigation measures and their effectiveness
- Recommend mitigation measures, site plan changes, adaptive management, progressive rehabilitation and monitoring plans as necessary.

2 APPROACH

2.1 BACKGROUND RESOURCES

A variety of background resources were consulted to characterize the site and assess the significance of features, including:

- Natural Heritage Information Centre (NHIC) database (accessed January, May and November 2004)
- Bronte Creek Watershed Study (Conservation Halton, 2002)
- Nature Counts Project: Hamilton Natural Areas Inventory, Vol. I and II (J. Dwyer (ed.), 2003)
- Hamilton-Wentworth Region Environmentally Sensitive Areas Study (Ecologistics, 1976)
- Ecological Survey of the Niagara Escarpment Biosphere Reserve (Riley et al., 1996)
- Ministry of Natural Resources (Provincially Significant Wetlands, deer wintering areas, Areas of Natural and Scientific Interest)

Additionally, detailed site-specific studies of soils, geology, hydrology and hydrogeology were reviewed and incorporated:

- Agricultural Report (Stovel and Associates, 2004)
- Surficial Soils and Microdrainage (Stovel and Associates, in preparation)
- Preliminary Hydrogeological Assessment (Gartner Lee Ltd., 2004)
- Level 2 Hydrogeological Assessment (Gartner Lee Ltd., in preparation)
- Geological Investigation (JEGEL, 2004)

2.2 VEGETATION AND VASCULAR PLANTS

The site was subject to detailed field investigation. Dates and purposes of field visits are summarized in Table 1 (appended).

Vegetation work was conducted on the following dates:

- October 16 and 23, 2003
- May 13 and 14, 2004
- July 19, 2004
- September 10, 2004

Additional coverage is planned for early June 2005. Vegetation communities were delineated and described using the Ecological Land Classification system (Lee et al., 1998). Provincially and regionally (City of Hamilton) significant/rare species will be identified using Oldham (1999) and Goodban (2003), respectively and their locations will be mapped.

Wetlands will be delineated and characterized using the Ontario Wetland Evaluation System: Southern Manual 3rd Edition (OMNR 1993 with updates). Boundaries of the Provincially Significant Wetland on site will be delineated based on soils, microdrainage and vegetation and will be confirmed in the field with agency staff in 2005.

2.3 WILDLIFE

2.3.1 Winter Wildlife Surveys

Winter wildlife surveys were conducted on February 27, March 1 and 4, 2004 and February 11, 2005. 2004 surveys consisted of transects through the northern third of the site, and 2005 surveys studied deer use of the southeastern portion of the site. Surveys were primarily focused on deer use of the areas identified by the MNR as locally significant deer wintering areas. Opportunistic observations of other wildlife signs were also made during these surveys.

2.3.2 Amphibians

A salamander survey was completed for this site on April 14 and 15, 2004. The survey consisted of a wandering transect method to inspect all vernal pools for the presence of amphibian egg masses, with special attention to potential Jefferson salamander complex egg masses. This methodology was approved by the MNR and has been used in cooperation with the MNR on numerous other sites in southern Ontario.

Identification of this species is difficult due to hybridization and cannot be accurately completed in a field situation. In order to identify this species, the eggs of suspected Jefferson salamanders are collected and taken to a laboratory. A Scientific Collector's Permit is required for the collection of a Threatened species. The specimens are then grown to maturity and a genetic test is completed on a segment of the tail. Through this test, an accurate identification of the species can be accomplished. The mature specimens are then taken back to their breeding ponds and released.

Three frog call surveys were completed for this site on April 14, May 12 and June 16, 2004. Five locations were visited on each evening survey.

Both salamander and frog call surveys will be repeated in spring, 2005. Additional frog call stations will be added in 2005.

2.3.3 Breeding Birds

A Red-shouldered Hawk survey was completed for this site on May 12, 2004. This survey consisted of a wandering transect method throughout the forested portions of this site. A tape-recorded call, developed by Bird Studies Canada for the purpose of surveying for Red-shouldered Hawks, was played at intervals along this transect. Trees were surveyed for the presence of stick nests that might support breeding woodland raptors.

Breeding bird surveys were conducted on July 1 and 2, 2004. The July 1 survey was conducted between 06:00-10:00, and the initial weather was overcast, with a very light breeze (Beaufort scale 1), and a temperature of approximately 17°C, with a clearing and warming trend through the morning. The weather during the July 2 survey (06:10-10:30) was calm and clear, with a temperature of approximately 16°C. There was good bird song activity on both days.

The Red-shouldered Hawk survey will be repeated between April 17-May 7, 2005. The breeding bird survey will be expanded in 2005 to include two visits covering early (May 24-June 17) and late (June 13-July 10) breeding species.

2.3.4 Other Wildlife

An owl survey was conducted on April 14, 2004. Field checking for snake hibernacula is planned for April 2005 on a day suitable for snake emergence. Opportunistic observations of odonates and butterflies will be recorded during other 2005 surveys.

2.4 AQUATIC RESOURCES

2.4.1 Surface Water Monitoring

A surface water monitoring program was established for this site in the fall of 2003 in association with Gartner Lee Limited. This program included measurements of monthly flow and water level (April, 2004-ongoing) and temperature (monthly - March, April, May, 2004; continuous mid-July 2004-ongoing) (Gartner Lee Ltd.) in the watercourses surrounding the site. Water levels and flows were monitored at all of the locations during the pump tests in April and November 2004, and as part of the fisheries program. Samples of surface water collected in November 2004 were analyzed for baseline levels of dissolved oxygen, conductivity, pH, alkalinity, total suspended solids, total dissolved solids, nitrogen, major ions by ICP-MS and anions (chloride, phosphate, bromide, sulphate, nitrate, nitrite) were established. Surface water quality analysis will be continued quarterly in 2005.

Temperature dataloggers were strategically placed at five locations within the vicinity of the subject lands to determine the thermal regime of surface water features that have the potential to be cool/cold water.

2.4.2 Fish Habitat Assessment

A review of available background information on Flamboro and Mountsberg Creeks within the vicinity of the subject lands was completed. Information sources included fish “dot” (survey point inventory) data obtained from the Ministry of Natural Resources, the Bronte Creek Watershed Study (BCWS) (Conservation Halton, 2002) and a search of the Natural Heritage Information Centre (NHIC) database to identify any significant species.

Field investigations included redd surveys, fisheries community inventories, aquatic habitat assessments and benthic invertebrate sampling for the surface water features located on and adjacent to the subject lands, with particular emphasis on the tributary in the northwest corner of the subject lands. The redd surveys were performed on November 25, 2003. Habitat assessments were performed on October 30, 2003 and on June 15, 17 and 18 of 2004. Fisheries community inventories were completed on June 15, 17 and 18 of 2004. A site visit to off-site intermittent tributaries was performed in January 2004 to assess year round flow conditions. An additional habitat assessment and community inventory is planned during higher spring flows (April 2005) to address the comments of ESAIEG and Conservation Halton.

Fisheries community inventories were performed at fifteen stations on tributaries of Mountsberg and Flamboro Creeks. The inventories were performed with a Smith-Root Model 12 electro-fisher used to target all habitat types with a single pass to determine the species present and relative abundance. Gill nets and minnow traps were also used in the pond located on the property. Fish habitat notes were recorded at each of the fifteen stations. Photographic documentation of each station will be continued in 2005.

Habitat assessments included observations on the following stream attributes:

- In-stream Cover
- Percent Cover
- Bank Stability
- Substrate Type
- Stream Dimensions and Morphology

- Riparian Vegetation
- Canopy Cover
- Adjacent Land Use
- In-situ Water Quality (dissolved oxygen, pH and conductivity)

2.4.3 Benthic Invertebrates

Benthic conditions were surveyed in early June 2004. Samples were collected in triplicate using a Surber sampler where coarse substrates were present, and an Ekman dredge in depositional areas with fine sediments. Where possible, Surber samples were the preferred method as coarser substrates generally support a more diverse community of benthic organisms. All samples were sieved in the field using a 500 µm mesh and placed in 1litre wide mouth plastic jars. The samples were preserved in the field using 10% buffered formalin and delivered to a qualified taxonomist for sorting and identification (Zaranko Environmental Assessment Services).

3 REGIONAL CONTEXT – OVERVIEW OF NATURAL FEATURES

3.1 LANDSCAPE SETTING

3.1.1 Geology, Surficial Geology and Soils

This section will summarize the physiographic region characteristics identified by Chapman and Putnam (1984), and the regional descriptions of soils, surficial geology and bedrock geology in the Natural Areas Inventory (Dwyer, 2003), JEGEL (2004) (who compiled information from numerous Ontario Geological Survey and Ontario Department of Mines documents) and Presant et al. (1965).

3.1.2 Hydrology and Hydrogeology

This section will summarize regional surface and groundwater characteristics based on the work of Gartner Lee Ltd., including watercourse flow and temperature regimes, aquifer descriptions, water table elevations, areas of recharge or discharge, groundwater flow direction and quality, etc. A discussion of watershed and subwatersheds will draw information from the Bronte Creek Watershed Study.

3.1.3 Climate

Gartner Lee Ltd. will include meteorological data and a water budget in their reporting. It will be summarized in the EIS.

3.1.4 Vegetation

The site is located in Site District 6E-1 (Jalava et al., 1997). This section will include a description of the site district's characteristics in terms of their relation to vegetation.

The subject lands are located in the Niagara section of the Deciduous Forest Region (Rowe, 1972). This section is dominated by sugar maple and American beech, mixed with basswood, red maple, red oak, white oak and bur oak. The bulk of Canada's black walnuts, sycamores, swamp white oaks and shagbark hickories are found in this region as well. Other species include the butternut and bitternut hickories, rock elm, silver maple and blue beech. Coniferous species are generally limited

to scattered white pine, eastern hemlock, eastern red cedar and, more rarely, black spruce, tamarack and eastern white cedar.

3.2 DESIGNATED FEATURES

An inventory of regional features will be conducted for a 3 km-radius area surrounding the site, which will permit the identification and mapping of local natural features that create the environmental setting for the site, such as significant woodlots and wetlands supporting wildlife or fish populations. This scale encompasses adjacent subwatersheds and ensures that potentially related features and functions are considered. Designated natural features in this zone include Environmentally Sensitive Areas, Provincially Significant Wetlands, Areas of Natural and Scientific Interest (ANSIs) and deer wintering areas identified by the MNR. The following sections will describe the designated features listed, with particular attention to the features and functions for which the areas were designated.

3.2.1 Provincially Significant Wetlands

A Provincially Significant Wetland, the Mountsberg East Wetland Complex, occupies the headwaters of tributaries to Mountsberg Creek, and Flamboro Creek, at the north and east portions of the property, respectively. Approximately 2 km southwest of the subject lands is the locally significant Freelton Esker Wetland Complex and the locally significant Kilbride Swamp lays to the southeast of the subject lands. The latter is listed as a regionally significant Life Science ANSI.

3.2.2 Environmentally Sensitive Areas

Portions of two Environmentally Sensitive Areas (ESAs) fall on the site, the Mountsberg East Wetlands ESA and the Carlisle North Forests ESA. Specific criteria forming the basis for ESA designation have been identified (Heagy, 1993; Dwyer, 2003).

The Mountsberg East Wetlands ESA has been designated because it provides:

Significant Ecological Function

- riparian area serves as a link between other natural areas in Flamborough
- the area provides habitat for significant species
- the area contains interior forest habitat (at least 200 m from forest edge)

Significant Hydrological Function

- the area helps to recharge groundwater supplies, maintain surface water quality and regulate stream flow in the upper Bronte Creek system

The Carlisle North Forests ESA has been designated because it provides:

Significant Ecological Function

- the area contains significant species
- the area contains interior forest habitat (100-200 m from the forest edge
- the riparian area serves as a link between natural areas in Flamborough

Significant Hydrological Function

- the natural vegetation of the area helps to maintain water quality in the coldwater streams

Halton Region's Guelph Junction Woods ESA lies approximately 1.5 km east of the subject lands.

3.2.3 Natural Heritage System and Linkages

This section will highlight regional linkages between the designated features and other features identified in existing documents such as the Bronte Creek Watershed Study (Conservation Halton, 2002), the Greenbelt Plan (2005) and the components of the Official Plan's Natural Heritage System.

4 EXISTING CONDITIONS

This section will summarize the results of the background review and detailed field inventory.

4.1 SOILS AND SURFICIAL GEOLOGY

This section will summarize the detailed characterization of the site's bedrock and surficial geology provided by John Emery Geotechnical Engineering Ltd. (JEGEL) (2004) and the site specific soils information provided by Stovel and Associates (2004 and in prep.). The surficial soil report will be included as an appendix to the EIS.

4.2 HYDROLOGY AND HYDROGEOLOGY

This section will summarize the detailed characterization of the site hydrology and hydrogeology provided by Gartner Lee Ltd. (in prep.). This will include, but not be limited to, a description of groundwater elevations, flow, quality and aquifer characteristics; surface water drainage, flows and seasonal variation; and connections between ground and surface water. Surface microdrainage will be summarized from Stovel and Associates (in prep.). The Level 2 Hydrogeological Assessment (Gartner Lee Ltd., in prep.) will be included as an appendix or companion report to the EIS.

4.3 VEGETATION

4.3.1 Vegetation Communities

Vegetation communities, identified using the Ecological Land Classification system (Lee et al., 1998), will be mapped. Following a general description of the historical land use as it related to vegetation, a table will present a description of each vegetation community. Higher quality (characterized by more mature, less disturbed or particularly diverse vegetation) and sensitive vegetation features will be identified.

Table 2. ELC Vegetation Types

ELC Type	Description

Wetlands, delineated and characterized using the Ontario Wetland Evaluation System: Southern Manual 3rd Edition (OMNR 1993 with updates), will be mapped.

4.3.2 Vascular Plants

The revised species list includes 325 species observed to date on site and will be included as an appendix to the report. The list will be discussed with reference to significance (Oldham, 1993 and Goodban, 2003), conservatism (Floristic Quality Assessment) and sensitivity of species and habitats.

4.4 WILDLIFE

The revised species list will be included as an appendix to the report. The list will be discussed with reference to significance and sensitivity of species, communities and habitats. A map will be included showing the locations of transects, stations and species occurrences, where appropriate.

4.4.1 Mammals

4.4.2 Amphibians and Reptiles

4.4.3 Birds

4.4.4 Other Wildlife

4.5 AQUATIC RESOURCES

This section will include a summary of the habitat assessment and community inventories. The detailed habitat notes will be included as an appendix to the report, and will include a table summarizing the findings within each reach. Fixed-point photographic documentation of each station will be presented.

Fish inventory results, benthic community indices and surface water quality information will be presented in three tables. Examples of the information to be presented are provided below. The results of the water temperature measurements and Bronte Creek Watershed study (Conservation Halton, 2002) will also be reported.

Table 3. Fisheries Inventory Results: Number of Each Species Caught Within Each Reach

Species	Reach														
	A1	A2	B1	C1	D1	D2	F1	F2	F3	F4	M1	M2	M3	Pond	Totals

Table 4. Benthic Community Indices Calculated from Quantitative Data Collected in Flamborough and Mountsberg Creeks (June 2004)

Station	Enumerations			Relative Abundance of Taxonomic Groups					
	Mean # of Organisms	Mean # of Taxa	Mean # of EPT Taxa	Mean % EPT Organisms	Mean % Chironomids	Mean % Other Insects	Mean % Annelids	Mean % Molluscs	Mean % All Other Organisms
A1									

Table 5. Baseline Surface Water Quality Information

	Station			
	A1	**M3**	**M2**	**F4**
Alkalinity (mg CaCO3/L)				
Turbidity (NTU)				
Total Dissolved Solids (mg/L)				
Total Suspended Solids (mg/L)				
Br- (mg/L)				
Cl- (mg/L)				
SO4 (mg/L)				
$PO4^{-3}$ (mg/L)				
NO2-N (mg/L)				
NO3-N (mg/L)				
TKN				
NH3-N (mg/L)				
TOC (mg/L)				
Dissolved Oxygen (mg/L				

4.5.1 Mountsberg Creek

The discussion for each watercourse will summarize the overall water quality (based on both water quality testing and benthic community indices), and fish habitat characteristics, identifying any barriers to fish passage. Fish habitat type or potential will be assessed. Seasonal changes in temperature or flow will be described.

4.5.2 Flamboro Creek

The discussion for each watercourse will summarize the overall water quality (based on both water quality testing and benthic community indices), and fish habitat characteristics, identifying any barriers to fish passage. Fish habitat type or potential will be assessed. Seasonal changes in temperature or flow will be described.

5 ANALYSIS

This section analyzes the existing conditions with respect to the policies of the Province and the City, with reference the Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement (OMNR, 1999), the Greenbelt Plan (2005) and other materials described in the sections below.

Features that meet the criteria will be mapped. To date, endangered and threatened species, ANSIs and significant valleylands have not been identified on the subject lands.

5.1 SIGNIFICANT WETLANDS

Portions of the Provincially Significant Lower Mountsberg Creek Wetland Complex occur on site. This section of the report will describe and map the revisions to the boundary made through review of the wetland scoring and evaluation record, soils and microdrainage reports (Stovel and Associates, 2004 and Stovel and Associates, in prep.), and field investigation. Any connections between the wetland and watercourses or groundwater, established by Gartner Lee Ltd. (in prep.), will be discussed.

5.2 SIGNIFICANT PORTIONS OF THE HABITAT OF THREATENED AND ENDANGERED SPECIES

A search of the NHIC database indicates that there are several records of one Threatened species, redside dace, in the vicinity of the site through the 1970's. The most recent records from 1995 are in the lower reaches of Mountsberg Creek at or downstream from Concession 10. Available data from the Bronte Creek Watershed Study indicates a decline of the species in Mountsberg Creek. The effects of Mountsberg Reservoir and the introduction of northern pike and other non-indigenous species into the watershed could have contributed to the demise of redside dace in Mountsberg Creek (Conservation Halton, 2002). Field studies will be repeated in spring, 2005.

A genetic analysis of one salamander egg mass collected from the site was not sufficient to determine the species; the non-viable eggs may have been from a Jefferson/blue-spotted salamander polyploid. Jefferson salamanders are known to occur in similar wetland habitat in neighbouring regions. The Jefferson salamander is a Threatened species, and further work is required to determine the presence or absence of this species. Field studies will be repeated in spring, 2005.

5.3 AREAS OF NATURAL AND SCIENTIFIC INTEREST

There are no ANSIs present within the subject lands or adjacent to them (i.e. within 120 metres of the lands).

5.4 FISH HABITAT

Fish habitat is defined as the spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes (OMNR, 1999). Fish habitat is available on and adjacent to the subject lands. This section of the report will summarize the results of section 4.5 and provide an aquatic habitat classification map.

5.5 SIGNIFICANT WOODLANDS

Guidelines for determining the significance of woodlands are presented in the Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement (OMNR, 1999) and the policies of the Greenbelt Plan (2005). Criteria suggested by the manual for designating significant woodlands include woodland size, shape, proximity to other woodlands or natural features, linkages, species diversity, uncommon characteristics, and economic and social values.

Additionally, the City of Hamilton (2005a) has released a technical discussion paper regarding the identification of significant woodlands. It is suggested that woodlands that meet two or more of the following criteria should be considered significant in the City of Hamilton: size (variable criterion according to forest cover in the planning unit); the presence of interior forest located more than 100 m from an edge; location within 50 m of a significant natural area (wetlands 0.5 ha or greater in size,

ESAs, PSWs and Life Science ANSIs); location within 30 m of streams, headwater areas, wetlands or lakes; presence of trees that are 100 years old or more; and the presence of threatened, endangered, special concern, provincially or locally rare plant or wildlife species.

The woodlands on site will be discussed with reference to these criteria.

5.6 SIGNIFICANT VALLEYLANDS

No significant valley lands have been identified on or within 120 m of the subject lands. Any watercourses located within or adjacent to the study area are small tributaries without significant valley features associated with them. The more substantial local valley feature associated with Mountsberg Creek is to the west of the site, but falls outside of the 120 m area of influence, except for a small portion in the very northwest portion of the subject lands.

5.7 SIGNIFICANT WILDLIFE HABITAT

Significant wildlife habitat is one of the more complicated natural heritage features to identify and evaluate. In the Provincial Policy Statement (2005), the term wildlife refers to all wild, native, living organisms including insects, amphibians, reptiles, birds, mammals and vegetation. The Natural Heritage Reference Manual (OMNR, 1999) includes criteria and guidelines for designating significant wildlife habitat. There are two other documents, the Significant Wildlife Habitat Technical Guide and the Significant Wildlife Habitat Decision Support System, that can be used to help decide what areas and features should be considered significant wildlife habitat (OMNR, 2000). There are four general types of significant wildlife habitat: seasonal concentration areas, migration corridors, rare or specialized habitat and habitat for species of conservation concern.

Seasonal Concentration Areas

Seasonal concentration areas are those sites where large numbers of a species gather together at one time of the year, or where several species congregate. The following is a partial list of numerous potential examples: deer yards, amphibian breeding ponds, snake and bat hibernacula, waterfowl staging and moulting areas, raptor roosts, bird nesting colonies, shorebird staging areas, and passerine migration concentrations. Only the best examples of these concentration areas are usually designated as significant wildlife habitat. Areas that support a species at risk, or if a large proportion of the population may be lost if the habitat is destroyed, are examples of seasonal concentration areas which should be designated as significant.

A locally significant deer wintering area has been identified by the OMNR in approximately the northern third of the property and along the PSW on Flamborough Creek.

Migration Corridors

Migration corridors are areas that are traditionally used by wildlife to move from one habitat to another. This is usually in response to different seasonal habitat requirements. Some examples are trails used by deer to move to wintering areas, and areas used by amphibians between breeding and summering habitat.

Rare or Specialized Habitat

Rare, or specialized habitats are two separate components. Rare habitats are those with vegetation communities that are considered rare in the province. “S-Ranks” are rarity rankings applied to species at the “state”, or in Canada at the provincial level, and are part of a system developed under

the auspices of the Nature Conservancy (Arlington, VA). Generally, community types with S-Ranks of S1 to S3 (extremely rare to rare-uncommon in Ontario), as defined by the Natural Heritage Information Centre (NHIC), could qualify. It is assumed that these habitats are at risk and that they are also likely to support additional wildlife species that are considered significant.

Specialized habitats are microhabitats that are critical to some wildlife species. Potential examples include salt licks for ungulates and groundwater seeps for Wild Turkeys.

Habitat for Species of Conservation Concern

Rare species are considered at five levels: globally rare, nationally rare (with designations by the Committee on the Status of Endangered Wildlife in Canada, or COSEWIC), provincially rare (with designations by the Committee on the Status of Species at Risk in Ontario, or COSSARO), regionally rare (at the Site Region level); and locally rare (in the municipality or Site District). This is also the order of priority that should be attached to the importance of maintaining species. Some species have been identified as being susceptible to certain practices, and their presence may result in an area being designated significant wildlife habitat. Examples include species vulnerable to forest fragmentation and species such as woodland raptors that may be vulnerable to forest management or human disturbance. The final group of species of conservation concern includes species that have a high proportion of their global population in Ontario. Although they may be common in Ontario, they are found in low numbers in other jurisdictions. Under the PPS, vascular plants are considered to be wildlife.

5.8 ENVIRONMENTALLY SIGNIFICANT AREAS

Two ESAs, designated by the City, occur on site. This section will summarize the significant features and functions for which they were designated.

6 POTENTIAL IMPACTS, MITIGATION AND REHABILITATION

6.1 DESCRIPTION OF THE PROPOSED QUARRY

The quarry site plan is currently under review. Revisions are being considered in response to early work on this EIS. The EIS will provide a summary of important environmental features, functions and linkages that will need to be respected within the context of proposed quarrying. The limits for quarry extraction and associated services and facilities, will be assessed through a detailed review of degree of significance and sensitivity. Constraint mapping (layering of various constraints) will assist with these analyses.

This section will include a map of the proposed extraction limit and will describe the accessory features, such as on-site roads and berms, that will be associated with the quarry. The extraction plan will be described in terms of proposed staging and progressive rehabilitation concept.

Extraction is proposed below the water table and a description of the dewatering process, discharge locations and volumes, expected drawdown and surface water balance, as well as measures to mitigate the hydrogeological effects (Gartner Lee Limited) will be provided. This work will provide a detailed assessment of how the quarry might affect the important features, functions and linkages during and post-extraction (with separate analyses addressing individual stages of proposed quarrying, through progressive rehabilitation).

The following sections will identify specific ecological effects of quarry operation, both with hydrological and hydrogeological mitigation measures in place and in the case of these measures failing, with recommendations for an Adaptive Management Plan (AMP). Net effects of the proposed quarry following closure and rehabilitation will be discussed in sections 6.8 and 6.9.

6.2 PROVINCIALLY SIGNIFICANT WETLAND

6.2.1 Potential Impacts

This section will discuss potential direct and indirect effects associated with the quarry establishment, operation and rehabilitation. Hydrological and hydrogeological effects will be summarized from Gartner Lee Ltd. (in prep.) and will be used to assess the nature and degree of effects on the wetland vegetation, soils and wildlife. There are a number of impacts that could cause effects:

1) A change in contributing surface waters' volume, quality (e.g. surface catchment area removed by extraction),
2) Altered ground water table associated with drawdown and/or with mounding associated with extraction and progressive rehabilitation scenarios,
3) Erosion and sedimentation, and,
4) Increased dust, noise, vibration and disturbance.

6.2.2 Mitigation Options

Options for mitigating hydrological and hydrogeological effects will be summarized from Gartner Lee Ltd. (in prep.) and will be used to compare the baseline biological conditions, the conditions under extraction scenarios with mitigation, and conditions in the event that the mitigation measures fail. Additional mitigation measures to prevent negative effects from disturbance will be proposed as input to the AMP and progressive rehabilitation plans.

6.3 AQUATIC HABITAT

6.3.1 Potential Impacts

This section will discuss potential direct and indirect effects associated with the quarry establishment, operation and post-extraction. There are several main impacts that could cause effects associated with the aquatic resources:

1) A change in contributing surface waters (e.g. surface catchment area removed by extraction, altered pumping regime from quarry dewatering),
2) A change in surface water quality (e.g. from quarry dewatering),
3) Erosion and sedimentation, and
4) Altered ground water table associated with drawdown and/or with mounding associated with extraction and post-extraction scenarios.

6.3.2 Mitigation Options

Options for mitigating hydrological and hydrogeological effects will be summarized from Gartner Lee Ltd. (in prep.) and will be used to compare the baseline biological conditions, the conditions under

extraction scenarios with mitigation, and conditions in the event that the mitigation measures fail, to be incorporated into the AMP.

Measures to mitigate the effects from altered water chemistry from dewatering, if applicable, will be recommended. The feasibility of improving aquatic habitat, particularly for the redside dace as described in the Draft Recovery Strategy for Redside Dace in Ontario (2005), will be considered.

6.4 SIGNIFICANT WOODLANDS

6.4.1 Potential Impacts

This section will discuss potential direct and indirect effects associated with the quarry establishment, operation and progressive rehabilitation. When the quarry site plan is finalized, in consultation with the Client's study team, it will be possible to determine if any woodland will be removed, and if so, where and what type. Potential effects include:

1) Direct loss of wooded areas (to be quantified by vegetation community), including an evaluation of the types, significance and number of plant and wildlife species affected,
2) Drying, sunscald, windthrow and other exposure effects at new edges created by removal of buffering vegetation, and
3) Indirect disturbance due to dust, noise and vibration
4) Change in surface water quality and quantity and related soil drainage

6.4.2 Mitigation Options

Measures to mitigate any effects will be recommended as input into the AMP.

6.5 (POTENTIALLY) SIGNIFICANT WILDLIFE HABITAT

A locally significant deer wintering area has been identified on site by the OMNR. The presence of other specific types of significant wildlife habitat has not been determined on the site and will take into account substantial additional field work in 2005.

Potential impacts to the deer wintering include the direct loss of habitat, increased disturbance through noise, dust and vibration, increased difficulty in crossing Milburough Line as a result of increased truck traffic.

6.6 ENVIRONMENTALLY SENSITIVE AREAS

This section of the EIS will examine the potential effects on the two designated ESAs, relevant to the proposed quarry. Each criterion for which the two ESAs have been identified will be reviewed. Potential direct, indirect and cumulative effects on each criterion and on the overall designation of the lands as ESA will be addressed.

For example, the Mountsberg East Wetlands ESA has been designated as achieving two criteria; Significant Ecological Function (i.e. linking riparian area, habitat for significant species and interior forest habitat (at least 200 m from forest edge). The ESA also satisfies the Significant Hydrological Function criterion (i.e. groundwater recharge, supplies, maintains surface water in the upper Bronte Creek system). Potential effects on these criteria and sub-criteria will be addressed.

The Carlisle North Forests ESA, has been designated because it also satisfies two criteria, Significant Ecological Function (i.e. significant species, interior forest habitat, and riparian links) and Significant Hydrological Function (i.e. maintains water quality in the coldwater streams). Potential effects on these criteria and characteristics will be thoroughly examined.

6.7 OTHER NATURAL HERITAGE FEATURES

Features that might be included in this category include agricultural fields, hedgerows and cultural communities that have not been identified as part of a significant natural feature, as well as common species of wildlife and plants. This section will describe the extent, degree and nature of impacts and, if appropriate, measures to mitigate impacts where possible.

6.8 REHABILITATION PLAN

The current concept for rehabilitation of the quarry is to create revegetated perimeter buffers, permanent, naturally landscaped berms, and a water feature with a diversity of aquatic and wetland habitats. There will be areas of exposed cliff (i.e. specialized habitat) and areas of shallow wetland and deep water systems.

These amenities will relate to and enhance the retained and enhanced terrestrial systems that will surround the water feature. Opportunities will be created for both education and interpretation.

Other characteristics of the rehabilitated natural systems will be described in this section along with an indication of timing for development according to the various stages of extraction and progressive rehabilitation. This section will also address the rehabilitation requirements as defined in the Greenbelt Plan (2005), including limitations on the extent of disturbed areas.

6.9 SUMMARY OF NET EFFECTS

This section will present conclusions regarding potential direct, indirect and cumulative effects associated with the proposed quarrying life cycle.

7 SUMMARY AND CONCLUSIONS

7.1 STATEMENT OF NET EFFECTS

A detailed summary of the functions associated with each natural heritage feature on the property, the potential impacts and effects on those features and functions, proposed mitigation and adaptive management measures and the predicted net effects will be provided in a table (an example is provided below) and followed by a summary statement of net effects.

Table 6. Potential Impacts and Mitigation

Feature	Function	Potential Impacts and Effects	Mitigation	Predicted Net Effects

7.2 RECOMMENDED SITE PLAN REFINEMENTS

This section will discuss the September 2004 Site Plan and will review the reasons for revisions to that plan. Changes to the extraction limits, quarry-related development (such as access roads or berms), adaptive management and progressive rehabilitation that are recommended as a result of the impact assessment will be discussed.

7.3 RECOMMENDED MONITORING PLAN

The recommended monitoring plan will be based on the natural heritage elements that required mitigation measures to protect them, or that have the potential to be affected if the mitigation measures fail.

7.4 CONCLUSIONS

This section will provide conclusions regarding:

- Compliance with relevant planning legislation, polices and guidelines
- Modifications to the Site Plan to avoid, minimize, and/or mitigate potential effects on important environmental features, functions and linkages
- A summary of proposed mitigation
- Supplementary Site Plan drawing(s) to prescribe specific environmental management techniques
- Net effects (direct, indirect, cumulative) associated with the undertaking
- A summary of proposed monitoring.

Overall conclusions regarding the proposed quarry will be summarized and presented.

8 LITERATURE CITED

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Appendix A: Stovel and Associates Surficial Soil and Microdrainage report (in prep)

Appendix B: Level 2 Hydrogeological Assessment (Gartner Lee Ltd., in prep.) or summary

Appendix C: List of Vascular Plants

Appendix D: List of Wildlife

Appendix E: Detailed Aquatic Investigation Methodology and Findings

Appendix F: Study Team *Curricula Vitae*

Table 1. Ecological Field Work Program

Date of Field Work	Purpose of Field Work	Personnel
Oct 16, 23, 2003 May 13, 14, July 19, Sept 10, 2004 *June 2005*[1]	Botanical inventory and Ecological Land Classification	C. Zoladeski
Feb 27, March 1, 4, 2004 Feb 11, 2005	Winter wildlife survey	L. Campbell G. Weeks
Apr 14, 2004	Owl survey	N. Smith R. Park
Apr 14, 15, 2004 *Mar 28-Apr 15, 2005*	Salamander egg mass collection/analysis	A. Goodban L. Campbell R. Park
Apr 14, May 12, June 16, 2004 *Apr, May, June 2005*	Amphibian call counts	N. Smith R. Park
Apr 2005 *and all visits*	Reptile surveys - hibernacula emergence - opportunistic observations during other surveys	C. Clarkin
May 12, 2004 *Apr 17-May 7, 2005*	Red-shouldered Hawk survey	V. Wyatt N. Smith
July 1, 2, 2004 *May 24-Jun 17 and Jun 10-Jul 10, 2005* *(two visits)*	Breeding bird inventory	V. Wyatt
Nov 2004 Feb*, May, Aug 2005*	Surface water quality analysis	R. Park
Oct 30, Nov 25, 2003 Jan, Jun 15, 17, 18, 2004 *Apr 2005*	Aquatic habitat assessment and in-situ surface water sampling (dissolved oxygen, pH, conductivity)	S. Geddes R. Park C. Clarkin
Jun 15, 17, 18, 2004 *Apr 2005*	Electrofishing inventory	R. Park C. Clarkin
Jun 2004	Benthic invertebrate sampling	R. Park C. Clarkin
Jun 2005	Wetland boundary refinement	D. Charlton A. Goodban
All visits 2005	Insects (Odonada, Lepidoptera)	A. Sandilands

[1] Dates of future work are italicized

APPENDIX D: List of Vascular Plants

List of the vascular plants recorded from the proposed Flamborough Quarry; August 2005

LATIN NAME		COMMON NAME	COEFFICIENT OF CONSERVATISM	WETNESS INDEX	WEEDINESS INDEX	PROVINCIAL STATUS	OMNR STATUS	COSEWIC STATUS	GLOBAL STATUS	LOCAL STATUS HALT	LOCAL STATUS HAM-WENT	LOCAL STATUS HAMILTON
	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
PTERIDOPHYTES		**FERNS & ALLIES**										
Dennstaedtiaceae		**Bracken Fern Family**										
Pteridium	*aquilinum* var. *latiusculum*	Eastern Bracken-fern	2	3		S5			G5T	X	X	X
Dryopteridaceae		**Wood Fern Family**										
Athyrium	*filix-femina* var. *angustum*	Northern Lady Fern	4	0		S5			G5T5	X	X	X
Cystopteris	*bulbifera*	Bulblet Bladder Fern	5	-2		S5			G5	X	X	X
Dryopteris	*carthusiana*	Spinulose Wood Fern	5	-2		S5			G5	X	X	X
Dryopteris	*cristata*	Crested Wood Fern	7	-5		S5			G5	X	X	X
Dryopteris	*marginalis*	Marginal Wood Fern	5	3		S5			G5	X	X	X
Matteuccia	*struthiopteris* var. *pensylvanica*	Ostrich Fern	5	-3		S5			G5	X	X	X
Onoclea	*sensibilis*	Sensitive Fern	4	-3		S5			G5	X	X	X
Polystichum	*acrostichoides*	Christmas Fern	5	5		S5			G5	X	X	X
Equisetaceae		**Horsetail Family**										
Equisetum	*arvense*	Field Horsetail	0	0		S5			G5	X	X	X
Equisetum	*hyemale* ssp. *affine*	Scouring-rush	2	-2		S5			G5T5	X	X	X
Equisetum	*pratense*	Meadow Horsetail	8	-3		S5			G5	R2	R3	U
Osmundaceae		**Royal Fern Family**										
Osmunda	*cinnamomea*	Cinnamon Fern	7	-3		S5			G5	X	X	X
Pteridaceae		**Maidenhair Fern Family**										
Adiantum	*pedatum*	Northern Maidenhair Fern	7	1		S5			G5	X	X	X
Thelypteridaceae		**Marsh Fern Family**										
Thelypteris	*palustris* var. *pubescens*	Marsh Fern	5	-4		S5			G5T?	X	X	X
GYMNOSPERMS		**CONIFERS**										
Cupressaceae		**Cedar Family**										
Thuja	*occidentalis*	Eastern White Cedar	4	-3		S5			G5	X	X	X
Pinaceae		**Pine Family**										

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Abies	*balsamea*	Balsam Fir	5	-3		S5			G5	U	U7	X
Larix	*decidua*	European Larch		5	-1	SE2			G?		I	I
Larix	*laricina*	Tamarack	7	-3		S5			G5	U	X	X
Pinus	*resinosa*	Red Pine	8	3		S5			G5	R1	I/N	I/N
Pinus	*strobus*	Eastern White Pine	4	3		S5			G5	X	X	X
Pinus	*sylvestris*	Scotch Pine		5	-3	SE5			G?	X	I	I
Tsuga	*canadensis*	Eastern Hemlock	7	3		S5			G5	X	X	X
DICOTYLEDONS		**DICOTS**										
Aceraceae		**Maple Family**										
Acer	*rubrum*	Red Maple	4	0		S5			G5	X	X	X
Acer	*saccharinum*	Silver Maple	5	-3		S5			G5	X	X	X
Acer	*saccharum* ssp. *saccharum*	Sugar Maple	4	3		S5			G5T?	X	X	X
Acer	*saccharum* ssp. *nigrum*	Black Maple	7	3		S4?			G5Q	X	X	X
Acer	*spicatum*	Mountain Maple	6	3		S5			G5	X	X	X
Acer X	*freemanii*	Freeman's Maple								X		X
Amaranthaceae		**Amaranth Family**										
Amaranthus	*albus*	White Tumbleweed		3	-1	SE5			G5	X	I	I
Amaranthus	*retroflexus*	Green Amaranth		2	-1	SE5			G?	X	I	I
Anacardiaceae		**Sumac or Cashew Family**										
Rhus	*radicans* ssp. *negundo*	Poison-ivy	5	-1		S5			G5T	X	X	X
Rhus	*rydbergii*	Western Poison-ivy	0	0		S5			G5T	X	X	X
Rhus	*typhina*	Staghorn Sumac	1	5		S5			G5	X	X	X
Apiaceae		**Carrot or Parsley Family**										
Cicuta	*bulbifera*	Bulb-bearing Water-hemlock	5	-5		S5			G5	U	X	X
Cicuta	*maculata*	Spotted Water-hemlock	6	-5		S5			G5	X	X	X
Daucus	*carota*	Wild Carrot		5	-2	SE5			G?	X	I	I
Hydrocotyle	*americana*	American Marsh-pennywort	7	-5		S5			G5	U	X	X
Osmorhiza	*claytonii*	Woolly Sweet-cicely	5	4		S5			G5	X	X	X
Sium	*suave*	Hemlock Water-parsnip	4	-5		S5			G5	X	X	X

List of the vascular plants recorded from the proposed Flamborough Quarry; August 2005

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Apocynaceae		**Dogbane Family**										
Vinca	*minor*	Periwinkle		5	-2	SE5			G?	X	I	I
Aquifoliaceae		**Holly Family**										
Ilex	*verticillata*	Winterberry	5	-4		S5			G5	X	X	X
Araliaceae		**Ginseng Family**										
Aralia	*nudicaulis*	Wild Sarsaparilla	4	3		S5			G5	X	X	X
Aralia	*racemosa* ssp. *racemosa*	Spikenard	7	5		S5			G5T?	X	X	X
Aristolochiaceae		**Duchman's-pipe Family**										
Asarum	*canadense*	Wild Ginger	6	5		S5			G5	X	X	X
Asclepiadaceae		**Milkweed Family**										
Asclepias	*incarnata* ssp. *incarnata*	Swamp Milkweed	6	-5		S5			G5T5	X	X	X
Asclepias	*syriaca*	Common Milkweed	0	5		S5			G5	X	X	X
Asteraceae		**Composite or Aster Family**										
Achillea	*millefolium* ssp. *millefolium*	Common Yarrow		3	-1	SE?			G5T?	X	I	I
Arctium	*lappa*	Great Burdock				SE5			G?	X	I	I
Arctium	*minus* ssp. *minus*	Common Burdock		5	-2	SE5			G?T?	X	I	I
Artemisia	*biennis*	Biennial Wormwood		-2	-1	SE5			G5	X	I	I
Aster	*cordifolius*	Heart-leaved Aster	5	5		S5			G5	X	X	X
Aster	*ericoides* ssp. *ericoides*	White Heath Aster				S5			G5T?	X	X	X
Aster	*lanceolatus* ssp. *lanceolatus*	Tall White Aster	3	-3		S5			G5T?	X	X	X
Aster	*lateriflorus* var. *lateriflorus*	Calico Aster	3	-2		S5			G5T5	X	X	X
Aster	*macrophyllus*	Large-leaved Aster	5	5		S5			G5	X	X	X
Aster	*novae-angliae*	New England Aster	2	-3		S5			G5	X	X	X
Aster	*pilosus* var. *pilosus*	Hairy Aster	4	2		S5			G5T?	U	X	X
Aster	*puniceus* var. *puniceus*	Purple-stemmed Aster				S5			G5T?	X	X	X
Aster	*urophyllus*	Arrow-leaved Aster	6	5		S4			G4	R5	X	X
Bidens	*cernua*	Stick-tight	2	-5		S5			G5	X	X	X
Bidens	*frondosa*	Devil's Beggar-ticks	3	-3		S5			G5	X	X	X

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Bidens	*vulgata*	Tall Beggar-ticks	5	-3		S5			G5	U	X	X
Carduus	*acanthoides*	Plumeless Thistle		5	-1	SE5			G?	X	I	I
Carduus	*nutans* ssp. *nutans*	Musk Thistle		5	-1	SE?			G?T?	X	I	X
Centaurea	*nigra*	Black Knapweed				SE?			G?	X	I	I
Chrysanthemum	*leucanthemum*	Ox-eye Daisy		5	-1	SE5			G?	X	I	I
Cirsium	*arvense*	Canada Thistle		3	-1	SE5			G?	X	I	I
Cirsium	*vulgare*	Bull Thistle		4	-1	SE5			G5	X	I	I
Conyza	*canadensis*	Horseweed	0	1		S5			G5	X	X	X
Erigeron	*strigosus*	Daisy Fleabane	0	1		S5			G5	X	X	X
Eupatorium	*perfoliatum*	Perfoliate Thoroughwort	2	-4		S5			G5	X	X	X
Eupatorium	*rugosum*	White Snakeroot	5	3		S5			G5	X	X	X
Eupatorium	*maculatum* ssp. *maculatum*	Spotted Joe-pye-weed	3	-5		S5			G5T5	X	X	X
Euthamia	*graminifolia*	Flat-topped Bushy Goldenrod	2	-2		S5			G5	X	X	X
Hieracium	*caespitosum* ssp. *caespitosum*	Field Hawkweed		5	-2	SE5				X	I	I
Hieracium	*pilosella*	Mouse-ear Hawkweed		5	-1	SE5			G?	X	I	I
Hieracium	*piloselloides*	Glaucous King Devil		5	-2	SE5			G?	X	I	I
Inula	*helenium*	Elecampane		5	-2	SE5			G?	X	I	I
Lactuca	*biennis*	Biennial Lettuce	6	0		S5			G5	R3	U6	U
Lactuca	*serriola*	Prickly Lettuce		0	-1	SE5			G?	X	I	I
Matricaria	*matricarioides*	Pineapple-weed				SE5			G5	X	I	I
Matricaria	*perforata*	Scentless Chamomile		5	-1	SE?			G?	X		I
Prenanthes	*altissima*	Tall White Rattlesnake-root	5	3		S5			G5?	X	X	X
Solidago	*altissima* var. *altissima*	Tall Goldenrod	1	3		S5				X	X	X
Solidago	*caesia*	Blue-stem Goldenrod	5	3		S5			G5	X	X	X
Solidago	*canadensis*	Canada Goldenrod	1	3		S5			G5	X	X	X
Solidago	*flexicaulis*	Zig-zag Goldenrod	6	3		S5			G5	X	X	X
Solidago	*nemoralis* ssp. *nemoralis*	Gray Goldenrod	2	5		S5			G5T?	X	X	X
Solidago	*patula*	Rough-leaved Goldenrod	8	-5		S5			G5	U	X	X
Solidago	*rugosa* ssp. *rugosa*	Rough Goldenrod	4	-1		S5			G5T?	X	X	X
Sonchus	*asper* ssp. *asper*	Spiny-leaved Sow-thistle		0	-1	SE5			G?T?	X	I	I
Taraxacum	*officinale*	Common Dandelion		3	-2	SE5			G5	X	I	I
Tragopogon	*dubius*	Doubtful Goat's-beard		5	-1	SE5			G?	X	I	I
Tragopogon	*pratensis* ssp. *pratensis*	Meadow Goat's-beard		5	-1	SE5			G?T?	X	I	I
Tussilago	*farfara*	Coltsfoot		3	-2	SE5			G?	X	I	I

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Balsaminaceae		**Touch-me-not Family**										
Impatiens	*capensis*	Spotted Touch-me-not	4	-3		S5			G5	X	X	X
Berberidaceae		**Barberry Family**										
Berberis	*thunbergii*	Japanese Barberry		4	-3	SE5			G?	X	I	I
Caulophyllum	*thalictroides*	Blue Cohosh	6	5		S5			G	X	X	X
Podophyllum	*peltatum*	May-apple	5	3		S5			G5	X	X	X
Betulaceae		**Birch Family**										
Alnus	*incana* spp. *rugosa*	Speckled Alder	6	-5		S5			G5T5	U	X	X
Betula	*alleghaniensis*	Yellow Birch	6	0		S5			G5	X	X	X
Betula	*papyrifera*	White Birch		2		S5			G5	X	X	X
Carpinus	*caroliniana* ssp. *virginiana*	Blue Beech	6	0		S5			G5T	X	X	R
Ostrya	*virginiana*	Hop Hornbeam	4	4		S5			G5	X	X	X
Boraginaceae		**Borage Family**										
Echium	*vulgare*	Blueweed		5	-2	SE5			G?	X	I	I
Myosotis	*laxa*	Smaller Forget-me-not	6	-5		S5			G5	X	X	X
Brassicaceae		**Mustard Family**										
Alliaria	*petiolata*	Garlic Mustard		0	-3	SE5			G5	X	I	I
Arabis	*glabra*	Tower Mustard	4	5		S5			G5	R3	R3	R
Barbarea	*vulgaris*	Yellow Rocket		0	-1	SE5			G?	X	I	I
Capsella	*bursa-pastoris*	Shepherd's Purse		1	-1	SE5			G?	X	I	I
Cardamine	*concatenata*	Cut-leaved Toothwort	6	3		S5			G5	X	X	X
Cardamine	*diphylla*	Two-leaved Toothwort	7	5		S5			G5	X	X	X
Erucastrum	*gallicum*	Dog Mustard		5	-1	SE5			G5	X	I	I
Erysimum	*cheiranthoides* ssp. *cheiranthoides*	Wormseed Mustard		3	-1	SE5				X	I	I
Lepidium	*densiflorum*	Common Pepper-grass		0	-2	SE5			G5	X	I	I
Sisymbrium	*officinale*	Hedge Mustard		5	-1	SE5			G?	X	I	I
Campanulaceae		**Bellflower Family**										
Lobelia	*inflata*	Indian Tobacco	3	4		S5			G5	x	X	X

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Caprifoliaceae		**Honeysuckle Family**										
Linnaea	*borealis* ssp. *longiflora*	Twinflower	7	0		S5			G5T?	U	R2	R
Lonicera	*tatarica*	Tartarian Honeysuckle		3	-3	SE5			G?	x	I	I
Sambucus	*canadensis*	Common Elderberry	5	-2		S5			G5	x	X	X
Sambucus	*racemosa* ssp. *pubens*	Red-berried Elderberry	5	2		S5			G5T4T5	x	X	X
Triosteum	*aurantiacum*	Wild Coffee	7	5		S5			G5	x	X	X
Viburnum	*acerifolium*	Maple-leaved Viburnum	6	5		S5			G5	x	X	X
Viburnum	*lentago*	Nannyberry	4	-1		S5			G5	x	X	X
Viburnum	*trilobum*	High Bush Cranberry	5	-3		S5			G5T5	x	X	X
Caryophyllaceae		**Pink Family**										
Arenaria	*serpyllifolia*	Thyme-leaved Sandwort		0	-2	SE5			G?	x	I	I
Cerastium	*fontanum*	Larger Mouse-ear Chickweed		3	-1	SE5			G?	x	I	I
Dianthus	*armeria*	Deptford Pink		5	-1	SE5			G?	x	I	I
Silene	*latifolia*	Bladder Campion				SE5			G?	x	I	I
Silene	*vulgaris*	Catchfly		5	-1	SE5			G?	x	I	I
Stellaria	*graminea*	Grass-leaved Stitchwort		5	-2	SE5			G?	x	I	I
Stellaria	*media*	Common Chickweed		3	-1	SE5			G?	x	I	I
Celastraceae		**Staff-tree Family**										
Euonymus	*obovata*	Running Strawberry-bush	6	5		S5			G5	x	X	X
Chenopodiaceae		**Goosefoot Family**										
Chenopodium	*album* var. *album*	Lamb's Quarters		1	-1	SE5			G5T5	x	I	I
Convolvulaceae		**Morning-glory Family**										
Convolvulus	*arvensis*	Field Bindweed		5	-1	SE5			G?	x	I	I
Cornaceae		**Dogwood Family**										
Cornus	*alternifolia*	Alternate-leaved Dogwood	6	5		S5			G5	x	X	X
Cornus	*amomum* ssp. *obliqua*	Silky Dogwood	5	-4		S5			G5T?	U	X	X
Cornus	*foemina* ssp. *racemosa*	Red Panicled Dogwood	2	-2		S5			G5?	x	X	X
Cornus	*rugosa*	Round-leaved Dogwood	6	5		S5			G5	x	X	X

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Cornus	*stolonifera*	Red-osier Dogwood	2	-3		S5			G5	x	X	X
Cucurbitaceae		**Gourd Family**										
Echinocystis	*lobata*	Prickly Cucumber	3	-2		S5			G5	x	X	X
Dipsacaceae		**Teasel Family**										
Dipsacus	*fullonum* ssp. *sylvestris*	Wild Teasel		5	-1	SE5			G?T?	x	I	I
Elaeagnaceae		**Oleaster Family**										
Elaeagnus	*umbellata*	Russian Olive		3	-3	SE3			G?	x	I	I
Euphorbiaceae		**Spurge Family**										
Acalypha	*virginica* var. *rhomboidea*	Three-seeded Mercury	0	3		S5			G5T5	x	X	X
Fabaceae		**Pea Family**										
Lotus	*corniculatus*	Bird's-foot Trefoil		1	-2	SE5			G?	x	I	I
Medicago	*lupulina*	Black Medick		1	-1	SE5			G?	x	I	I
Medicago	*sativa* ssp. *sativa*	Alfalfa		5	-1	SE5			G?T?	x	I	I
Melilotus	*alba*	White Sweet-clover		3	-3	SE5			G?	x	I	I
Melilotus	*officinalis*	Yellow Sweet-clover		3	-1	SE5			G?	x	I	I
Trifolium	*pratense*	Red Clover		2	-2	SE5			G?	x	I	I
Vicia	*cracca*	Tufted Vetch		5	-1	SE5			G?	x	I	I
Vicia	*tetrasperma*	Slender Vetch		5	-1	SE5			G?	x	I	I
Fagaceae		**Beech Family**										
Fagus	*grandifolia*	American Beech	6	3		S5			G5	x	X	X
Quercus	*alba*	White Oak	6	3		S5			G5	x	X	X
Quercus	*macrocarpa*	Bur Oak	5	1		S5			G5	x	X	X
Fumariaceae		**Fumitory Family**										
Dicentra	*canadensis*	Squirrel-corn	7	5		S5			G5	U	X	X
Gentianaceae		**Gentian Family**										
Gentiana	*andrewsii*	Closed Gentian	6	-3		S4			G4	R1	X	X

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Geraniaceae		**Geranium Family**										
Geranium	*robertianum*	Herb-robert		5	-2	SE5			G5	x	I	I
Grossulariaceae		**Currant Family**										
Ribes	*americanum*	Wild Black Currant	4	-3		S5			G5	x	X	X
Ribes	*cynosbati*	Prickly Gooseberry	4	5		S5			G5	x	X	X
Ribes	*triste*	Wild Red Currant	6	-5		S5			G5	x	X	X
Guttiferae		**St. John's-wort Family**										
Hypericum	*perforatum*	Common St. John's-wort		5	-3	SE5			G?	x	I	I
Hydrophyllaceae		**Water-leaf Family**										
Hydrophyllum	*virginianum*	Virginia Water-leaf	6	-2		S5			G5	x	X	X
Juglandaceae		**Walnut Family**										
Carya	*cordiformis*	Bitternut hickory	6	0		S5			G5	x	X	X
Juglans	*cinerea*	Butternut	6	2		S3?	END	END	G3G4	x	X	X
Juglans	*nigra*	Black Walnut	5	3		S4			G5	x	X	X
Lamiaceae		**Mint Family**										
Clinopodium	*vulgare*	Wild Basil	4	5		S5			G?	x	X	X
Glechoma	*hederacea*	Creeping Charlie		5	-2	SE5			G?	x	I	I
Leonurus	*cardiaca* ssp. *cardiaca*	Common Motherwort		5	-2	SE5			G?T?	x	I	I
Lycopus	*americanus*	Cut-leaved Water-horehound	4	-5		S5			G5	x	X	X
Lycopus	*uniflorus*	Northern Water-horehound	5	-5		S5			G5	x	X	X
Mentha	*arvensis* ssp. *borealis*	American Wild Mint	3	-3		S5				x	X	X
Origanum	*vulgare*	Wild Marjarom		5	-2	SE5			G?		I	I
Prunella	*vulgaris* ssp. *lanceolata*	Heal-all	5	5		S5			G5T?	x	X	X
Lauraceae		**Laurel Family**										
Lindera	*benzoin*	Spicebush	6	-2		S5			G5	x	X	X
Lythraceae		**Loosestrife Family**										

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Lythrum	*salicaria*	Purple Loosestrife		-5	-3	SE5			G5	x	I	I
Malvaceae		**Mallow Family**										
Malva	*neglecta*	Cheeses		5	-1	SE5			G?	x	I	I
Menispermaceae		**Moonseed Family**										
Menispermum	*canadense*	Moonseed	7	0		S4			G5	x	X	X
Oleaceae		**Olive Family**										
Fraxinus	*americana*	White Ash	4	3		S5			G5	x	X	X
Fraxinus	*nigra*	Black Ash	7	-4		S5			G5	x	X	X
Fraxinus	*pennsylvanica*	Red Ash	3	-3		S5			G5	x	X	X
Syringa	*vulgaris*	Common Lilac		5	-2	SE5			G?	x	I	I
Onagraceae		**Evening-primrose Family**										
Circaea	*alpina*	Smaller Enchanter's Nightshade	6	-3		S5			G5	x	X	X
Circaea	*lutetiana* ssp. *canadensis*	Yellowish Enchanter's Nightshade	3	3		S5			G5T5	x	X	X
Epilobium	*hirsutum*	Great Hairy Willow-herb		-4	-2	SE5			G?	x	I	I
Ludwigia	*palustris*	Marsh Purslane	5	-5		S5			G5	U	X	X
Oenothera	*biennis*	Common Evening-primrose	0	3		S5			G5	R1	X	X
Oenothera	*parviflora*	Small-flowered Evening-primrose	1	3		S5?			G?	x	X	X
Oxalidaceae		**Wood Sorrel Family**										
Oxalis	*stricta*	Upright Yellow Wood-sorrel	0	3		S5			G5	x	X	X
Papaveraceae		**Poppy Family**										
Sanguinaria	*canadensis*	Bloodroot	5	4		S5			G5	x	X	X
Phrymaceae		**Lopseed Family**										
Phryma	*leptostachya*	Lopseed	6	5		S4S5			G5	x	X	X
Plantaginaceae		**Plantain Family**										
Plantago	*lanceolata*	Ribgrass		0	-1	SE5			G5	x	I	I
Plantago	*rugelii*	Rugel's Plantain	1	0		S5			G5	x	X	X

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Polemoniaceae		**Phlox Family**										
Phlox	*divaricata*	Wild Blue Phlox	7	3		S4			G5	x	X	X
Polygonaceae		**Smartweed Family**										
Polygonum	*amphibium*	Water Smartweed	5	-5		S5			G5	U	X	X
Polygonum	*convolvulus*	Black Bindweed		1	-1	SE5			G?	x	I	I
Polygonum	*lapathifolium*	Pale Smartweed	2	-4		S5			G5	U	X	X
Polygonum	*persicaria*	Lady's-thumb		-3	-1	SE5			G?	x	I	I
Rumex	*crispus*	Curly-leaf Dock		-1	-2	SE5			G?	x	I	I
Primulaceae		**Primrose Family**										
Lysimachia	*ciliata*	Fringed Loosestrife	4	-3		S5			G5	x	X	X
Lysimachia	*nummularia*	Moneywort		-4	-3	SE5			G?	x	X	I
Lysimachia	*thyrsiflora*	Tufted Loosestrife	7	-5		S5			G5	x	X	X
Ranunculaceae		**Buttercup Family**										
Actaea	*pachypoda*	White Baneberry	6	5		S5			G5	x	X	X
Anemone	*canadensis*	Canada Anemone	3	-3		S5			G5	x	X	X
Anemone	*acutiloba*	Sharp-lobed Hepatica	6	5		S5			G5	x		X
Anemone	*cylindrica*	Thimbleweed	7	5		S4			G5	U	U8	U
Anemone	*virginiana* var. *virginiana*	Thimbleweed	4	5		S5			G5T	x	X	X
Aquilegia	*canadensis*	Wild Columbine	5	1		S5			G5	x	X	X
Caltha	*palustris*	Marsh-marigold	5	-5		S5			G5	U	X	X
Clematis	*virginiana*	Virgin's-bower	3	0		S5			G5	x	X	X
Ranunculus	*abortivus*	Kidney-leaf Buttercup	2	-2		S5			G5	x	X	X
Ranunculus	*acris*	Tall Buttercup			-2	SE5			G5	x	I	I
Ranunculus	*recurvatus* var. *recurvatus*	Hooked Buttercup	4	-3		S5			G5	x	X	X
Thalictrum	*dioicum*	Early Meadow-rue	5	2		S5			G5	x	X	X
Thalictrum	*pubescens*	Tall Meadow-rue	5	-2		S5			G5	x	X	X
Rhamnaceae		**Buckthorn Family**										
Rhamnus	*alnifolia*	Alder-leaved Buckthorn	7	-5		S5			G5	x	X	X
Rhamnus	*cathartica*	Common Buckthorn		3	-3	SE5			G?	x	I	I

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Rosaceae		**Rose Family**										
Agrimonia	*gryposepala*	Tall Hairy Agrimony	2	2		S5			G5	x	X	X
Crataegus	*species*	Hawthorn species									X	
Fragaria	*vesca* ssp. *americana*	Woodland Strawberry	4	4		S5			G5T?	x	X	X
Fragaria	*virginiana* ssp. *virginiana*	Scarlet Strawberry	2	1		SU			G5T?	x	X	X
Geum	*aleppicum*	Yellow Avens	2	-1		S5			G5	x	X	X
Geum	*canadense*	White Avens	3	0		S5			G5	x	X	X
Potentilla	*argentea*	Silvery Cinquefoil		3	-2	SE5			G?	x	I	I
Potentilla	*norvegica* ssp. *norvegica*	Cinquefoil				SU			G5T?	x	I	I
Potentilla	*recta*	Rough-fruited Cinquefoil		5	-2	SE5			G?	x	I	I
Prunus	*americana*	American Plum	6	5		S4			G5		U8	U
Prunus	*pensylvanica*	Pin Cherry	3	4		S5			G5	U	X	X
Prunus	*serotina*	Black Cherry	3	3		S5			G5	x	X	X
Prunus	*virginiana* ssp. *virginiana*	Choke Cherry	2	1		S5			G5T?	x	X	X
Rubus	*allegheniensis*	Alleghany Blackberry	2	2		S5			G5	x	X	X
Rubus	*idaeus* ssp. *melanolasius*	Wild Red Raspberry	0	-2		S5			G5T	x	X	X
Rubus	*occidentalis*	Thimble-berry	2	5		S5			G5	x	X	X
Rubus	*pubescens*	Dwarf Raspberry	4	-4		S5			G5	x	X	X
Spiraea	*alba*	Narrow-leaved Meadow-sweet	3	-4		S5			G5	x	X	X
Waldsteinia	*fragarioides*	Barren Strawberry	5	5		S5			G5	U	X	X
Rubiaceae		**Madder Family**										
Galium	*aparine*	Cleavers	4	3		S5			G5	U	X	X
Galium	*palustre*	Marsh Bedstraw	5	-5		S5			G5	x	X	X
Galium	*triflorum*	Sweet-scented Bedstraw	4	2		S5			G5	x	X	X
Rutaceae		**Rue Family**										
Zanthoxylum	*americanum*	American Prickly-ash	3	5		S5			G5	x	X	X
Salicaceae		**Willow Family**										
Populus	*alba*	Silver Poplar		5	-3	SE5			G5	x	I	I
Populus	*balsamifera* ssp. *balsamifera*	Balsam Poplar	4	-3		S5			G5T?	x	X	X
Populus	*deltoides* ssp. *monilifera*	Cottonwood				S5			G5T?	U		

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Populus	*grandidentata*	Large-tooth Aspen	5	3		S5			G5	x	X	X
Populus	*tremuloides*	Trembling Aspen		0		S5			G5	x	X	X
Salix	*species*	Willow species										
Salix	*bebbiana*	Long-beaked Willow	4	-4		S5			G5	x	X	X
Salix	*eriocephala*	Missouri Willow	4	-3		S5			G5	x	X	X
Salix	*petiolaris*	Slender Willow	3	-4		S5			G4	x	X	X
Salix	*purpurea*	Basket Willow		-3	-1	SE4			G5	x	I	I
Saxifragaceae		**Saxifrage Family**										
Mitella	*diphylla*	Two-leaved Bishop's Cap	5	2		S5			G5	x	X	X
Mitella	*nuda*	Naked Mitrewort	6	-3		S5			G5	x	R5	R
Penthorum	*sedoides*	Ditch Stonecrop	4	-5		S5			G5	U	X	X
Tiarella	*cordifolia*	False Mitrewort	6	1		S5			G5	x	X	X
Scrophulariaceae		**Figwort Family**										
Chelone	*glabra*	Turtlehead	7	-5		S5			G5	U	X	X
Linaria	*vulgaris*	Butter-and-eggs		5	-1	SE5			G?	x	I	I
Lindernia	*dubia* var. *dubia*	Doubtful False Pimpernel	7	-5		S4			G5T?	R1	U10	X
Mimulus	*ringens*	Square-stemmed Monkey-flower	6	-5		S5			G5	U	X	X
Penstemon	*digitalis*	Foxglove Beard-tongue	6	1		S4S5			G5	U	U10	X
Verbascum	*thapsus*	Common Mullein		5	-2	SE5			G?	x	I	I
Veronica	*anagallis-aquatica*	Water Speedwell		-5	-1	SE5			G5	x	I	I
Veronica	*officinalis*	Common Speedwell		5	-2	SE5			G5	x	I	I
Veronica	*serpyllifolia* ssp. *serpyllifolia*	Thyme-leaved Speedwell				SE5			G?T?	x	I	I
Solanaceae		**Nightshade Family**										
Physalis	*heterophylla*	Clammy Ground-cherry	3	5		S4			G5	R2	X	X
Solanum	*dulcamara*	Bitter Nightshade		0	-2	SE5			G?	x	I	I
Thymelaeaceae		**Mezereum Family**										
Dirca	*palustris*	Leatherwood	7	0		S4?			G4	x	U8	U
Tiliaceae		**Linden Family**										
Tilia	*americana*	American Basswood	4	3		S5			G5	x	X	X

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Ulmaceae		**Elm Family**										
Ulmus	*americana*	White Elm	3	-2		S5			G5?	x	X	X
Urticaceae		**Nettle Family**										
Boehmeria	*cylindrica*	False Nettle	4	-5		S5			G5	x	X	X
Laportea	*canadensis*	Wood Nettle	6	-3		S5			G5	x	X	X
Urtica	*dioica* ssp. *gracilis*	American Stinging Nettle	2	-1		S5			G5T?	x	X	X
Verbenaceae		**Vervain Family**										
Verbena	*hastata*	Blue Vervain	4	-4		S5			G5	x	X	X
Verbena	*urticifolia*	White Vervain	4	-1		S5			G5	x	X	X
Violaceae		**Violet Family**										
Viola	*arvensis*	Wild Violet				SE4			G?	x	I	I
Viola	*canadensis*	Canada Violet				S5			G5	x	X	X
Viola	*pubescens*	Downy Yellow Violet				S5			G5	x	X	X
Viola	*sororia*	Woolly Blue Violet				S5			G5	x	X	X
Vitaceae		**Grape Family**										
Parthenocissus	*inserta*	Inserted Virginia-creeper	3	3		S5			G5	x	X	X
Vitis	*riparia*	Riverbank Grape	0	-2		S5			G5	x	X	X
MONOCOTYLEDONS		**MONOCOTS**										
Alismataceae		**Water-plantain Family**										
Alisma	*plantago-aquatica*	Common Water-plantain	3	-5		S5			G5	x	X	X
Sagittaria	*latifolia*	Broad-leaved Arrowhead	4	-5		S5			G5	x	X	X
Araceae		**Arum Family**										
Arisaema	*triphyllum* ssp. *triphyllum*	Small Jack-in-the-pulpit	5	-2		S5			G5T5	x	X	X
Cyperaceae		**Sedge Family**										
Carex	*aquatilis*	Aquatic Sedge	7	-5		S5			G5	R1	R2	R
Carex	*bebbii*	Bebb's Sedge	3	-5		S5			G5	U	X	X

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Carex	*blanda*	Woodland Sedge	3	0		S5			G5?	X	X	X
Carex	*comosa*	Bristly Sedge	5	-5		S5			G5	X	U7	X
Carex	*crinita*	Fringed Sedge	6	-4		S5			G5	U	X	X
Carex	*deweyana*	Dewey's Sedge	6	4		S5			G5	X	X	X
Carex	*disperma*	Soft-leaved Sedge	8	-5		S5			G5	X	R4	U
Carex	*flava*	Yellow Sedge	5	-5		S5			G5	X	U8	X
Carex	*gracillima*	Graceful Sedge	4	3		S5			G5	X	X	X
Carex	*granularis*	Meadow Sedge	3	-4		S5			G5	X	X	X
Carex	*hystericina*	Porcupine Sedge	5	-5		S5			G5	X	X	X
Carex	*intumescens*	Bladder Sedge	6	-4		S5			G5	X	X	X
Carex	*lupulina*	Hop Sedge	6	-5		S5			G5	X	X	X
Carex	*normalis*	Larger Straw Sedge	6	-3		S4			G5	R2	U9	U
Carex	*pedunculata*	Long-stalked Sedge	5	5		S5			G5	X	X	X
Carex	*pensylvanica*	Pennsylvania Sedge	5	5		S5			G5	X	X	X
Carex	*plantaginea*	Plantain-leaved Sedge	7	5		S5			G5	X	U6	X
Carex	*radiata*	Radiate Sedge	4	5		S5			G4	X	X	X
Carex	*retrorsa*	Retrorse Sedge	5	-5		S5			G5	X	X	X
Carex	*rosea*	Stellate Sedge	5	5		S5			G5	X	X	X
Carex	*spicata*	Spiked Sedge		5	-1	SE5			G?	X	I	I
Carex	*stipata*	Awl-fruited Sedge	3	-5		S5			G5	X	X	X
Carex	*stricta*	Tussock Sedge	4	-5		S5			G5	X	U8	X
Carex	*tenera*	Straw Sedge	4	-1		S5			G5T	X	X	X
Carex	*trisperma* var. *trisperma*	Three-seeded Sedge				S5			G5T	R3	R3	R
Carex	*vulpinoidea*	Fox Sedge	3	-5		S5			G5	X	X	X
Eleocharis	*acicularis*	Needle Spike-rush	5	-5		S5			G5	R1	U6	U
Eleocharis	*smallii*	Small's Spike-rush	6	-5		S5			G5?	U	R4	R
Scirpus	*atrovirens*	Dark-green Bulrush	3	-5		S5			G5?	X	X	X
Scirpus	*cyperinus*	Wool-grass	4	-5		S5			G5	X	X	X
Scirpus	*pendulus*	Lined Bulrush	3	-5		S5			G5	U	U7	X
Hydrocharitaceae		**Frog's-bit Family**										
Elodea	*canadensis*	Canada Waterweed	4	-5		S5			G5	R1	U9	X
Iridaceae		**Iris Family**										

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Iris	*versicolor*	Multi-coloured Blue-flag	5	-5		S5			G5	U	X	X
Juncaceae		**Rush Family**										
Juncus	*bufonius*	Toad Rush	1	-4		S5			G5	x	U9	X
Juncus	*dudleyi*	Dudley's Rush	1	0		S5			G5	x	X	X
Juncus	*tenuis*	Path Rush	0	0		S5			G5	x	X	X
Lemnaceae		**Duckweed Family**										
Lemna	*minor*	Lesser Duckweed	2	-5		S5			G5	x	X	X
Liliaceae		**Lily Family**										
Allium	*tricoccum*	Wild Leek	7	2		S5			G5	x	X	X
Asparagus	*officinalis*	Garden Asparagus		3	-1	SE5			G5?	x	I	I
Convallaria	*majalis*	Lily-of-the-valley		5	-2	SE5			G5	x	I	I
Erythronium	*americanum* ssp. *americanum*	Yellow Dog's-tooth Violet	5	5		S5			G5T5	x	X	X
Lilium	*philadelphicum*	Wood Lily	8	1		S5			G5	R1	R1	R
Maianthemum	*canadense*	Wild Lily-of-the-valley	5	0		S5			G5	x	X	X
Maianthemum	*racemosum* ssp. *racemosum*	False Solomon's Seal	4	3		S5			G5T	x	X	X
Maianthemum	*stellatum*	Star-flowered Solomon's Seal	6	1		S5			G5	x	X	X
Polygonatum	*pubescens*	Hairy Solomon's Seal	5	5		S5			G5	x	X	X
Trillium	*erectum*	Purple Trillium	6	1		S5			G5	x	X	X
Trillium	*grandiflorum*	White Trillium	5	5		S5			G5	x	X	X
Uvularia	*grandiflora*	Large-flowered Bellwort	6	5		S5			G5	x	X	X
Orchidaceae		**Orchid Family**										
Epipactis	*helleborine*	Common Helleborine		5	-2	SE5			G?	x	I	I
Liparis	*loeselii*	Fen Twayblade	5	-4		S4S5			G5	U	X	X
Platanthera	*hyperborea*	Tall Leafy Green Orchis	5			S5			G5	x	R3	R
Poaceae		**Grass Family**										
Agrostis	*gigantea*	Red-top		0	-2	SE5			G4G5	x	I	I
Agrostis	*stolonifera*	Redtop		-3		S5			G5	x	X	X
Bromus	*inermis* ssp. *inermis*	Awnless Brome		5	-3	SE5			G4G5T?	x	I	I
Calamagrostis	*canadensis*	Blue-joint Grass	4	-5		S5			G5	x	X	X

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
Cinna	*arundinacea*	Wood Reed Grass	7	-3		S4			G5	U	X	X
Dactylis	*glomerata*	Orchard Grass		3	-1	SE5			G?	X	I	I
Digitaria	*ischaemum*	Small Crabgrass		3	-1	SE5			G?	X	I	I
Digitaria	*sanguinalis*	Large Crabgrass		3	-1	SE5			G5	X	I	I
Echinochloa	*crusgalli*	Common Barnyard Grass		-3	-1	SE5			G?	X	I	I
Elymus	*hystrix*	Bottle-brush Grass	5	5		S5			G5	X	X	X
Elymus	*repens*	Quack Grass		3	-3	SE5			G?	X	I	I
Elymus	*virginicus* var. *virginicus*	Virginia Wild Rye	5	-2		S5			G5T?	X	X	X
Eragrostis	*cilianensis*	Stink Grass		3	-1	SE5			G?	X	I	I
Festuca	*pratensis*	Meadow Fescue		4	-1	SE5			G5	X	I	I
Glyceria	*grandis*	Tall Manna Grass	5	-5		S4S5			G5	XU	U6	X
Glyceria	*septentrionalis*	Floating Manna Grass	8	-5		S4			G5	XU	X	X
Glyceria	*striata*	Fowl Meadow Grass	3	-5		S5			G5	X	X	X
Muhlenbergia	*mexicana* var. *mexicana*	Mexican Satin Grass	1	-3		S5			G5T?	X	X	X
Oryzopsis	*asperifolia*	White-grained Mountain-rice	6	5		S5			G5	X	U9	X
Panicum	*capillare*	Witch Grass	0	0		S5			G5	X	X	X
Phalaris	*arundinacea*	Reed Canary Grass	0	-4		S5			G5	X	X	X
Phleum	*pratense*	Timothy		3	-1	SE5			G?	X	I	I
Phragmites	*australis*	Common Reed	0	-4		S5			G5	X	X	X
Poa	*alsodes*	Grove Meadow Grass	7	-2		S4			G4?	R5	U6	U
Poa	*compressa*	Canada Blue Grass	0	2		S5			G?	X	X	X
Poa	*palustris*	Fowl Meadow Grass	5	-4		S5			G5	X	X	X
Poa	*pratensis* ssp. *pratensis*	Kentucky Bluegrass	0	1		S5			G5T	X	I	I
Schizachne	*purpurascens* ssp. *purpurascens*	False Melic Grass	6	2		S5			G5T?	X	U6	X
Setaria	*pumila*	Yellow Foxtail		0	-1	SE5			G?	X	I	I
Setaria	*viridis*	Green Foxtail			-1	SE5			G?	X	I	I
Potamogetonaceae		**Pondweed Family**										
Potamogeton	*natans*	Common Floating Pondweed	5	-5		S5			G5	R2	R5	U
Smilacaceae		**Catbrier Family**										
Smilax	*herbacea*	Herbaceous Carrion Flower	5	0		S4			G5	X	X	X
Sparganiaceae		**Bur-reed Family**										

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Sparganium	*emersum* ssp. *emersum*	Green-fruited Bur-reed	5	-5		S5				X	U10	X
Sparganium	*eurycarpum*	Broad-fruited Bur-reed	3	-5		S5			G5	R4	X	X
Typhaceae		**Cattail Family**										
Typha	*angustifolia*	Narrow-leaved Cattail	3	-5		S5			G5	X	X	X
Typha	*latifolia*	Broad-leaved Cattail	3	-5		S5			G5	X	X	X
FLORISTIC SUMMARY & ASSESSMENT												
Species Diversity												
Total Species:		**368**										
Native Species:		**268**	73%									
Exotic Species		**100**	27%									
Regionally Significant Species		enter manually										
S1-S3 Species		1	0%									
S4 Species		20	8%									
S5 Species		245	92%									
Co-efficient of Conservatism and Floristic Quality Index												
Co-efficient of Conservatism (CC) (average)		**4.4**										
CC 0 to 3	*lowest sensitivity*	75	29%									
CC 4 to 6	*moderate sensitivity*	150	58%									
CC 7 to 8	*high sensitivity*	32	12%									
CC 9 to 10	*highest sensitivity*	0	0%									
Floristic Quality Index (FQI)		**70**										
Presence of Weedy & Invasive Species												
mean weediness		**-1.6**										
weediness = -1	*low potential invasiveness*	51	54%									
weediness = -2	*moderate potential invasiveness*	30	32%									
weediness = -3	*high potential invasiveness*	13	14%									
Presence of Wetland Species												
average wetness value		**0.4**										

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	LOCAL STATUS SOURCE LAST UPDATE/ INITIALS									VARGA 2000 July 2002/KH	GOODBAN 1995	GOODBAN 2003
upland		84	24%									
facultative upland		79	23%									
facultative		57	16%									
facultative wetland		74	21%									
obligate wetland		57	16%									

APPENDIX E: List of Wildlife

Wildlife Recorded from Lowndes Holdings Corp., Proposed Dolostone Quarry - July 2004

COMMON NAME	***SCIENTIFIC NAME***	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	SITE REGION	LOCAL	AREA	**COMMENTS**
Least Skipper	*Ancyloxypha numitor*	S5	G5						
European Skipper	*Thymelicus lineola*	SE	G5						
Crossline Skipper	*Polites origenes*	S4	G5						
Hobomok Skipper	*Poanes hobomok*	S5	G5						
Dun Skipper	*Euphyes vestris*	S5	G5						
Giant Swallowtail	*Papilio cresphontes*	S2	G5						
Eastern Tiger Swallowtail	*Papilio glaucus*	S4S5	G5						
Cabbage White	*Pieris rapae*	SE	G5						
Clouded Sulphur	*Colias philodice*	S5	G5						
Orange Sulphur	*Colias eurytheme*	S5	G5						
Coral Hairstreak	*Harkenclenus titus*	S4	G5						
Banded Hairstreak	*Satyrium calanus*	S4	G5						
Hickory Hairstreak	*Satyrium caryaevorum*	S3S4	G4						
Spring Azure	*Celastrina ladon*	S5	G5						
Great Spangled Fritillary	*Speyeria cybele*	S5	G5						
Pearl Crescent	*Phyciodes tharos*	S4	G5						
Question Mark	*Polygonia interrogationis*	S5	G5						
Mourning Cloak	*Nymphalis antiopa*	S5	G5						
Painted Lady	*Vanessa cardui*	SZB	G5						
Red-spotted Purple	*Limenitis arthemis astyanax*	S5	G5T5						
Little Wood-Satyr	*Megisto cymela*	S5	G5						
Common Ringlet	*Coenonympha tullia*	S5	G5						
Common Wood-Nymph	*Cercyonis pegala*	S5	G5						
Monarch	*Danaus plexippus*	S4	G4	NIAC	SC				
AMPHIBIANS									
Tremblay's/Silvery Salamander	*Ambystoma* hybrid								non-viable eggs collected
Spotted Salamander	*Ambystoma maculatum*	S4	G5						egg masses observed
American Toad	*Bufo americanus*	S5	G5						
Tetraploid Gray Treefrog	*Hyla versicolor*	S5	G5						
Western Chorus Frog	*Pseudacris triseriata*	S4	G5		NAR				
Spring Peeper	*Pseudacris crucifer*	S5	G5						
Northern Green Frog	*Rana clamitans*	S5	G5						
Pickerel Frog	*Rana palustris*	S4	G5	NIAC	NAR		x		

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	SITE REGION	LOCAL	AREA	COMMENTS
Wood Frog	*Rana sylvatica*	S5	G5						
Northern Leopard Frog	*Rana pipiens*	S5	G5	NIAC	NAR				
REPTILES									
Snapping Turtle	*Chelydra serpentina*	S5	G5						
Eastern Gartersnake	*Thamnophis sirtalis*	S5	G5						
BIRDS									
Canada Goose	*Branta canadensis*	S5	G5						
Wood Duck	*Aix sponsa*	S5	G5				x		
Mallard	*Anas platyrhynchos*	S5	G5						
Ruffed Grouse	*Bonasa umbellus*	S5	G5					25	
Wild Turkey	*Meleagris gallopava*	S4	G5						
Turkey Vulture	*Cathartes aura*	S4	G5				x		
Broad-winged Hawk	*Buteo platypterus*	S5	G5				x	100	
American Kestrel	*Falco sparverius*	S5	G5						
Killdeer	*Charadrius vociferus*	S5	G5						
American Woodcock	*Scolopax minor*	S5	G5						
Herring Gull	*Larus argentatus*	S5	G5						overhead - non-breeding
Rock Pigeon	*Columba livia*	SE	G5						flying over
Mourning Dove	*Zenaida macroura*	S5	G5						
Black-billed Cuckoo	*Coccyzus erythropthalmus*	S4	G5						
Eastern Screech-Owl	*Megascops asio*	S5	G5		NAR		x		
Whip-poor-will	*Caprimulgus vociferus*	S4	G5				x	100	
Ruby-throated Hummingbird	*Archilochus colubris*	S5	G5						
Belted Kingfisher	*Ceryle alcyon*	S5	G5				x		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	S5	G5				x	30	
Downy Woodpecker	*Picoides pubescens*	S5	G5						
Hairy Woodpecker	*Picoides villosus*	S5	G5					10	
Northern Flicker	*Colaptes auratus*	S5	G5						
Pileated Woodpecker	*Dryocopus pileatus*	S4S5	G5				x	30-50	
Eastern Wood-Pewee	*Contopus virens*	S5	G5						
Alder Flycatcher	*Empidonax alnorum*	S5	G5						
Willow Flycatcher	*Empidonax traillii*	S5	G5						
Great Crested Flycatcher	*Myiarchus crinitus*	S5	G5						

Wildlife Recorded from Lowndes Holdings Corp., Proposed Dolostone Quarry - July 2004

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	SITE REGION	LOCAL	AREA	COMMENTS
Eastern Kingbird	*Tyrannus tyrannus*	S5	G5						
Red-eyed Vireo	*Vireo olivaceus*	S5	G5						
Blue Jay	*Cyanocitta cristata*	S5	G5						
American Crow	*Corvus brachyrhynchos*	S5	G5						
Horned Lark	*Eremophila alpestris*	S5	G5						
Tree Swallow	*Tachycineta bicolor*	S5	G5						
Black-capped Chickadee	*Poecile atricapilla*	S5	G5						
Red-breasted Nuthatch	*Sitta canadensis*	S5	G5					10	
White-breasted Nuthatch	*Sitta carolinensis*	S5	G5					10	
House Wren	*Troglodytes aedon*	S5	G5						
Veery	*Catharus fuscescens*	S4	G5					10	
Wood Thrush	*Hylocichla mustelina*	S5	G5					4	
American Robin	*Turdus migratorius*	S5	G5						
Gray Catbird	*Dumetella carolinensis*	S5	G5						
European Starling	*Sturnus vulgaris*	SE	G5						
Cedar Waxwing	*Bombycilla cedrorum*	S5	G5						
Blue-winged Warbler	*Vermivora pinus*	S4	G5						
Nashville Warbler	*Vermivora ruficapilla*	S5	G5						
Yellow Warbler	*Dendroica petechia*	S5	G5						
Chestnut-sided Warbler	*Dendroica pensylvanica*	S5	G5				x		
Magnolia Warbler	*Dendroica magnolia*	S5	G5			7		30	migrant (May 12, 2004)
Black-throated Green Warbler	*Dendroica virens*	S5	G5					30	migrant (May 12, 2004)
Black-and-white Warbler	*Mniotilta varia*	S5	G5					100	migrant (May 12, 2004)
Ovenbird	*Seiurus aurocapilla*	S5	G5					20	
Northern Waterthrush	*Seiurus noveboracensis*	S5	G5					20	
Mourning Warbler	*Oporornis philadelphia*	S5	G5				x	30	
Common Yellowthroat	*Geothlypis trichas*	S5	G5						
Scarlet Tanager	*Piranga olivacea*	S5	G5				x	30	
Eastern Towhee	*Pipilo erythrophthalmus*	S4	G5				x		
Chipping Sparrow	*Spizella passerina*	S5	G5						
Field Sparrow	*Spizella pusilla*	S5	G5						
Vesper Sparrow	*Pooecetes gramineus*	S4	G5						
Savannah Sparrow	*Passerculus sandwichensis*	S5	G5						
Song Sparrow	*Melospiza melodia*	S5	G5						
Swamp Sparrow	*Melospiza georgiana*	S5	G5						

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	SITE REGION	LOCAL	AREA	COMMENTS
Northern Cardinal	*Cardinalis cardinalis*	S5	G5						
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	S5	G5						
Indigo Bunting	*Passerina cyanea*	S5	G5						
Bobolink	*Dolichonyx oryzivorus*	S4	G5						flying over Milborough Line - non-
Red-winged Blackbird	*Agelaius phoeniceus*	S5	G5						
Rusty Blackbird	*Euphagus carolinus*	S5	G5			6			migrant (April 19, 2005)
Common Grackle	*Quiscalus quiscula*	S5	G5						
Brown-headed Cowbird	*Molothrus ater*	S5	G5						
Baltimore Oriole	*Icterus galbula*	S5	G5						
House Finch	*Carpodacus mexicanus*	SE	G5						
Pine Siskin	*Carduelis pinus*	S5	G5			7			wintering - non-breeding
American Goldfinch	*Carduelis tristis*	S5	G5						
MAMMALS									
Northern Short-tailed Shrew	*Blarina brevicauda*	S5	G5						
Little Brown Bat	*Myotis lucifugus*	S5	G5						
Eastern Cottontail	*Sylvilagus floridanus*	S5	G5						
Eastern Chipmunk	*Tamias striatus*	S5	G5						
Grey Squirrel	*Sciurus carolinensis*	S5	G5						
Red Squirrel	*Tamiasciurus hudsonicus*	S5	G5						
White-footed Mouse	*Peromyscus leucopus*	S5	G5						
Meadow Vole	*Microtus pennsylvanicus*	S5	G5						
Porcupine	*Erethizon dorsatum*	S5	G5			7			
Coyote	*Canis latrans*	S5	G5						
Red Fox	*Vulpes vulpes*	S5	G5						
Raccoon	*Procyon lotor*	S5	G5						
Ermine	*Mustela erminea*	S5	G5						
Mink	*Mustela vison*	S5	G5						
Striped Skunk	*Mephitis mephitis*	S5	G5						
White-tailed Deer	*Odocoileus virginianus*	S5	G5						
SUMMARY									
Total Butterflies:	*24*								

Wildlife Recorded from Lowndes Holdings Corp., Proposed Dolostone Quarry - July 2004

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	SITE REGION	LOCAL	AREA	COMMENTS
Total Amphibians:	*10*								
Total Reptiles:	*2*								
Total Birds:	*74*								
Total Breeding Birds:	*66*								
Total Mammals:	*16*								
SIGNIFICANT SPECIES									
Global:	*0*								
National:	*0*								
Provincial:	*0*								
Regional:	*0*								
Local:	*13*								
Explanation of Status and Acronymns									
COSSARO: Committee on the Status of Species at Risk in Ontario									
COSEWIC: Committee on the Status of Endangered Species in Canada									
REGION: Rare in a Site Region									
S1: Extremely rare in Ontario; usually fewer than 5 occurrences									
S1S2: Extremely rare to very rare in Ontario									
S2: Very rare in Ontario; usually be	5-20 occurrences								
S2S3: Very rare to uncommon in Ontario									
S3: Rare to uncommon in Ontario; usually between 20-100 occurrences									
S3S4: Rare to common in Ontario									
S4: Common in Ontario: apparently secure, usually more than 100 occurrences									

APPENDIX F: Fish Habitat Descriptions

DETAILED RESULTS

The following results section summarizes the fish habitat observation made at each station individually during the June 2004 field program; any identifiable differences at the stations between observation dates is addressed in the discussion. A full list of fish species identified within the study area during the 2004 field survey and background sources as well as species designations can be found in Table D1

Station: F1

Watershed: Flamboro Creek

This station was located in Flamboro Creek upstream of the 10th Concession crossing and extended 30m upstream of the road. Observed stream flow at station F1 was 100% flat, no pools, riffles or runs were found; average stream width was estimated to be 2m. Cover was provided by large / small organic debris and aquatic / wetland vegetation which was found in abundance, throughout the wetted area. Bank stability was approximately 80% depositional and 20% vulnerable. The dominant substrate at this station was detritus with a thin layer of muck overlaying firm sediments. Adjacent land use was vegetated and consisted of cattails, aquatic grasses, dogwoods and mixed cedar forest. Canopy cover was estimated to be 50% closed and 50% partly open.

Downstream of the 10th concession no defined channel or flow could be found. Surface water was diffused through a sparsely treed fallow portion of a farm pasture. Aquatic / wetland plant species were observed in this area indicating that the soils remain moist, This area was likely not cleared for farming, like the adjacent pasture due to its wet nature.

No fish were captured at this location. Flows in this reach are likely intermittent and the potential for fish habitat is low, especially south of the 10th Concession. Benthic invertebrate sampling will help to determine the potential contribution this reach has to downstream habitats.

As discussed below fish were found further upstream in Flamboro Creek, and upstream reaches appear to be permanent. Perhaps the existence of an on-line pond between the 10th and 11th Concessions has interrupted the contribution of downstream flows during periods of low flow.

Station: F2

Watershed: Flamboro Creek

Station F2 was located in Flamboro Creek 300m downstream of F3 (11th Concession).

The station was 60m in length with an average wetted width of 1.2m. Large organic debris, deep pools, undercut banks; boulders, cobble and aquatic vegetation provided moderate in-stream cover, to a total percent estimated at 50. Stream flow habitats observed at the station were 70% runs, 20% pools, and 10% riffles. Substrate was comprised of cobble and boulder, with abundant detritus and silt along the margins. The meandering nature of the stream has created an even distribution of eroding and depositional banks with a small portion of the stream banks protected from erosion by significant vegetation. The surrounding cedar forest provided

excellent canopy cover to the stream with 80% of it being closed and the remaining 20% partly open.

Despite the excellent habitat characteristics present in this reach only a small number of brook stickleback and blacknose dace were captured. Anecdotal evidence identified potential barrier in the form of a falls that is located downstream of this reach, which may explain the low densities and diversity of fish captured. Additional anecdotal evidence indicates the presence of brook trout in an on-line pond located between the 10th and 11th Concession but downstream of the potential barrier. A site visit to observe these areas of interest was not possible due to lack of access to the private lands on which they are found.

Station: F3

Watershed: Flamboro Creek

Station F3 was located in Flamboro Creek downstream of the 11th Concession crossing and extended 20m downstream of the road. The stream at this location meanders through a lowland cedar forest with a riffle, pool, run morphology in the following proportions; 60% runs, 20% flats, 10% pools and 10% riffles. Estimated average stream width was 1.2m and the maximum depth was 0.4m. In-stream cover was abundant and provided by large organic debris, root masses and undercut banks; total in-stream cover was approximately 70%. Additionally small isolated patches of watercress were observed at this station. Bank stability was found to be 40% vulnerable, 40% depositional and 20% eroding. Substrate was predominately detritus, small organic debris and muck with isolated areas of gravel and sand. The cedar swamp surrounding the station provides significant shade to the majority of this reach.

Similar to Station F2, blacknose dace and brook stickleback were captured within this reach. However, much higher numbers of blacknose dace were obtained. The majority of blacknose dace were captured in a swift flowing riffle with gravel substrates located immediately downstream of the culvert under the road. This is likely due to their preference for gravel substrates and high stream flows during spawning which takes place during May and June (Scott, Crossman, 1973).

Station: F4

Watershed: Flamboro Creek

Flamboro Creek Station F4 was a stream/cedar swamp that extended 50m upstream of the road crossing at the 11th Concession. A small section of the station, approximately 20m, had a slow flowing moderately defined stream with an average width of 5m. The majority of the station was observed to be a broad cedar swamp with abundant pools approximately 100m in width. Undercut banks, deep pools, Large/small organic debris and aquatic vegetation provided significant in-stream cover. The substrate at the station was composed entirely of detritus. The banks of the station were almost entirely depositional with small isolated areas of erosion in the sections with some flow. The trees found throughout the station provided partial shading throughout the day.

Although the station is potently a coldwater habitat, the low dissolved oxygen value and the low numbers of fish captured compared to the high numbers caught immediately downstream suggest limited direct fish habitat.

Station: B1

Watershed: Mountsberg Creek

Station B1 consisted of two small channels originating from a wooded swamp upstream of the confluence with Mountsberg creek adjacent to Lawson Park. The station was approximately 40m long of which 37m where upstream of the 11th Concession. Upstream of the 11th Concession the station consisted of two short slow flowing stream channels, approximately 20m, flowing from a cedar/grass wetland. The cedar/grass wetland had no observable channels or flow. The channels were narrow and were completely covered by surrounding wetland vegetation. Substrate in the stream was estimated to be 60% detritus, 20% muck, 10% gravel and 10%sand. Stream banks throughout the station were observed to be 100% depositional. Dogwood shrubs, cedar tress and the riparian wetland vegetation provided complete abundant stream shading throughout the day. Watercress was observed to be abundant in the western channel. Downstream of the 11th Concession the two channels spill through separate culverts across a manicured lawn and down a steep 0.5m bank to Mountsberg Creek. Both culverts are perched a short distance, roughly 0.10m, in combination to with the steep bank and low flow this provides a barrier to fish movement upstream. Approximately 80 m north of the station a small spring was observed providing groundwater input to the station.

The stream at station B1 provided limited direct fish habitat due to the perched culverts and low flow entering Mountsberg Creek. During additional site visits the culverts under the 11th Concession were found to be dry. It is possible for fish to migrate upstream during flood events within Mountsberg Creek, though the intermittent nature of the streams would significantly limit their ability to sustain a resident population of fish. Although Station B1 provides limited direct fish habitat it does provide cold-water input to Mountsberg Creek during periods of flow.

Station: B2

Watershed: Mountsberg Creek

Station B2 was a dry streambed running through cattle pastureland. Substrate in the streambed was dry hard packed silt/dirt with some gravel and sparse cobbles. The shallow slopping banks were vegetated with grasses and stable though portions of the station have been eroded by the cattle that graze throughout the area. Isolated tall ash and maple trees provide limited shading to a portion of the dry streambed at this station. The streambed had terrestrial vegetation growing in it along much of its length indicating it is dry for most of the year. Downstream the stream enters a wood area where the channel disappears as it travels down the valley slope into the grass wetland mentioned above.

Given the factors mentioned above this section of tributary B provides little in the way of direct fish habitat for much of the year. The lack of a channel and the valley slope downstream of the station suggest the stream forms a sheet flow into the wetland, which would be a potential barrier to fish moving into the area. The lack of cover, current land use and intermittent nature of the stream, combine to provide very little direct habitat for seasonal use by fish. This station

would however provide some indirect fish habitat by providing water to Mountsberg Creek during periods of sporadic flow though the water quality may be impacted by current land use.

Station: B3

Watershed: Mountsberg Creek

Station B3 is located upstream of station B2 on the northwestern end of the cattle farm. No channels or running water were identified during the June 2004 field program. There was no observable culvert to allow for the movement of water under the lane way that separates station B3 and B2. The station was observed to be a band of wetted soil and organic matter running through a corridor of mature deciduous forest. Sparse shallow pools of standing water were found at a few locations along the stations length. Station B3 contains extremely limited direct fish habitat and would only provide water to fisheries habitat downstream during storm events. It should be noted that the southern end of the station appeared to be used heavily as pastureland that may impact downstream water quality during periods of flow.

Station: C1

Watershed: Mountsberg Creek

Station C1 was a ponded/wetland area located upstream of the 11th Concession crossing of tributary C. The length of stream surveyed was 120m long and had an average wetted width of 5m and a maximum depth of 0.5m. In-stream cover at this station was abundantly provided by large/small organic debris and emergent and terrestrial vegetation. Substrate composition at this station was approximately 70% detritus and 30% silt. Stream banks throughout the station were observed to be entirely depositional. Riparian vegetation was found to be grasses, dogwoods, wild grape and scattered willow trees. Land used beyond the riparian zone was natural vegetation and old-field to the north, with natural vegetation and a horse farm to the south. The Willow trees and dogwood shrubs at the station provided a moderate amount of canopy cover. During the field study of this station water levels were high due to a predawn rain event, lower water levels and dry periods were observed at the station on all previous and subsequent visits.

The portions of tributary C located downstream of the 11th Concession were not surveyed due lack of access. As a result it was not possible to observe its confluence with tributary D and Mountsberg Creek to identify possible barriers to fish movement. Although no potential barriers to fish movement into the station were identified, the lack of fish and intermittent nature of the stream suggests that station C1 provides seasonally limited low quality direct and indirect fish habitat with seasonal contribution of water to downstream habitats.

Station: D1

Watershed: Mountsberg Creek

Station D1 was a stream located downstream of the 11th Concession crossing of tributary D. The section of stream surveyed was 20m long and had a mean wetted width of 0.5m. The station was only 20m in length as further investigation downstream was not possible due to lack of access to private land. In-stream cover was estimated to be 20%, the cover was provided by a deep pool, boulders, cobbles, and small organic debris. The observed substrate at the station was an equal mixture of cobble, gravel, sand, muck, silt, and boulder. Stream flow at the station during the survey period was small a riffle pool run complex. The maximum observed pool

depth at station D1 was 0.20m. The riparian vegetation of the stream was terrestrial herbaceous plants and deciduous trees. Bank stability at this station was 80% protected by road material, 10% vulnerable and 10% eroding. Canopy cover of the stream was limited. Adjacent land use beyond the riparian zone was deciduous forest, a horse exercise track and the 11th Concession road. The deepest pool found at this station was created by the perched culvert under the 11th Concession, the culvert was perched approximately 0.30m. The culvert under the road crossing drains from a dense phragmities wetland

Station D1 was found to support fish habitat as Brook stickleback were identified during the inventory. The perched culvert found at the road crossing is a significant barrier to fish movement upstream of the station.

Station: D2

Watershed: Mountsberg Creek

Station D2 was a slow flowing stream located downstream of the pond at the south end of the property. The section of stream surveyed was 50m long and had an average wetted width of 0.75m and a maximum depth of 0.15m. In-stream cover was estimated to be 30% and was provided by large/small organic debris and terrestrial vegetation. The Stream substrate at this station was mostly detritus with a mixture of muck and sand. Stream banks throughout the station were observed to be 100% depositional. The riparian vegetation of the stream was mixed deciduous forest and herbaceous under-story plants. The surrounding deciduous forest provided excellent canopy cover for the stream. Land use beyond the forest was agricultural fields and the 11th Concession road.

On previous visits station D2 was found to contain no surface water suggesting that it is of an intermittent nature. Intermittent nature and presence of a barrier downstream at station D1 the direct use of this habitat by fish. This station does provide water to the fish habitat found at station D1.

Station: D3 Pond

Watershed: Mountsberg Creek

The Pond is located in the southwestern portion of the property upstream of station D2. The Pond was approximately 20m long and 10m wide with an estimated average depth of 2m. Heavily vegetated piles of debris surround the pond on three sides, which strongly suggest this is a manmade pond. A small inflow was identified in the southeast end and a small outflow was identified in the southwest end of the pond. Both the inflow and the outflow were densely vegetated with aquatic grasses and lacked defined channels. In-stream cover was submergent and emergent aquatic macrophytes as well as industrial debris such as drums and building material. Substrate at the station was mostly silt and clay with smaller amounts of sand and grave. The staghorn sumacs surrounding the pond provided little to no shading to its surface. All of the banks were stable due to the vegetative growth surrounding the pond with the exception of the northeast corner that showed signs of moderate erosion. Adjacent land use was observed to be a mixed deciduous forest and an agricultural field. The colour of the pond and the sediment composition suggest that the pond has received significant inputs of silt runoff from

the near by field. No evidence of groundwater upwelling within the pond was identified during any of the site visits.

The pond was found to contain a population of Brook stickleback, which appeared to be unhealthy as a many where slow moving and gulping at the surface, additionally several were found dead and floating. During periods of high water pond outflow though small would allow the movement of fish downstream into station D2 and into the phragmities wetland and eventually into station D1. Upstream of the pond was a wetland form of grasses, touch-me-not and marsh marigold. The movement of fish into this area would only occur during high water as very little surface water was observed during all site visits. During a November 30th, 2004 visit the pond's water level had dropped significantly, an estimated 1.2m. No fish were observed during the period of low water. The low water levels in the pond may allow it to freeze completely or become anoxic during the winter, which would have a negative impact on any existing fish population.

Station: A1

Watershed: Mountsberg Creek

Station A1 was located in tributary A from its confluence with Mountsberg Creek and extended 230m upstream. The slow flowing stream had an average wetted width of approximately 2.5m with and average depth 0.25m. In-stream cover was found in abundance and was provided by undercut banks, large/small organic debris, submergent/emergent vegetation and sparse cobble. Stream substrate was primarily detritus with some silt and sparse cobble. Wetland hummocky sedges, and sparse willow trees formed the riparian community for the first 40m of stream from its confluence with Mountsberg Creek. Sedges, sensitive fens and mixed deciduous lowland forest composed the riparian community for the remainder of the station. Stream banks throughout the station were observed to be 100% eroding with undercut banks and exposed soils under the hummocky sedges. Adjacent land use was wetland and mixed deciduous lowland forest.

Station: A2

Watershed: Mountsberg Creek

Station A2 was located upstream of station A1 and extended from the open tall grass marsh and continued to the property line. For the first 50m of the station the stream infiltrated through the grassy marsh with no significant pools or channels. Upstream of the marsh a short slow flowing moderately defined channel approximately 50m long was observed, it had an average wetted width of 2m and an average depth of 0.30m. Undercut banks, large/small organic debris, cobble and aquatic vegetation provided abundant In-stream cover. Stream substrate was primarily detritus with small quantities of silt. The riparian community was composed of wetland grasses, marsh marigold, bracken fern, dogwoods, and white cedar. The stream banks of the station were found to be 80% depositional, 15% vulnerable and 5% eroding. Adjacent land use to the station was cedar/deciduous swamp. Upstream of the short channeled section the stream became very convoluted and dispersed through the dense hummocky cedar swamp that formed the remainder of the station. Numerous iron deposits were observed throughout the station suggesting numerous areas of ground water input in the station.

Both stations located in tributary A were found to support limited fish populations with low species diversities.

Station: M1

Watershed: Mountsberg Creek

Station M1 was located in Mountsberg Creek at the 10th Concession crossing the station extended 20m upstream and 20m downstream of the bridge. The average wetted width of the stream was 8m with an average depth of 0.6m and a maximum observed depth of 1.2m. Cobbles, boulders, large organic debris and submergent macrophytes provided a moderate amount of in-stream cover. Stream substrate was mainly cobble, gravel, and sand with limited quantities of boulder and silt. The stream flow habitat at this station was a fast flowing run. Typha, willow shrubs, water iris, various wetland grasses and one large maple formed the riparian community of the stream. Bank stability was estimated to be 50% vulnerable and 50% depositional. The rare tree and overhanging tall grasses provided extremely limited canopy cover. Surrounding land use was observed to be agricultural pasture and old-field thicket upstream of the 10th Concession with residential lawn and natural field downstream of the crossing.

Station: M2

Watershed: Mountsberg Creek

Station M2 was located downstream of the 11th Concession crossing adjacent to the Lawson Park campground, approximately 150m of stream was surveyed. The average wetted width of the stream was 7m with an average depth of 0.30m and a maximum pool depth of 1.0m. Deep pools, large organic debris, cobbles, boulders and submergent macrophytes provided abundant in-stream cover. Stream substrate was composed of a mixture of cobble, sand, gravel with smaller amounts of silt and boulder. Stream flow at this station was a series of riffle pool run sequences; composed mainly of riffles and runs with fewer pools. Riparian vegetation was observed to be manicured lawn, dogwood, meadow rue, current and large trees with limited undergrowth. Bank stability at this station was 100% vulnerable due to its slope and lack of vegetative cover. Canopy cover was limited for much of the stream with the exception of the Lawson Park Bridge and the forested area located in the downstream section of the station. Surrounding land use was mixed deciduous forest, manicured lawn, and recreational parkland.

Station: M3

Watershed: Mountsberg Creek

Station M3 was a section of Mountsberg Creek that started at the Stone Brook Estates road crossing and extended 100m upstream. The first 30m were a fast flowing braided section with the remainder of the station consisting of a fast flowing shallow stream. The stream had an estimated wetted width of 20m in the braided regions and 5m in the non-braided regions; average depth of the stream was approximately 0.30m with a maximum pool depth of 0.6m. In-stream cover was abundant and varied; boulders, cobbles, large/small organic debris, and emergent/submergent aquatic macrophytes formed the observable cover types. The observed substrate consisted of primarily gravel and sand with small sections of cobbles and silt isolated boulders were also observed. Stream flow at the station was an elongated sequence of riffles runs and pools with the majority being runs with small amounts of riffles and isolated pools. The

riparian vegetation of the stream consisted of sedges, rushes, typha, dogwood and willow trees. The bank stability at the station was estimated as 35% depositional, 35% vulnerable and 30% protected. Canopy cover was 50% partly open, 35% open and 15% closed. The surround land use identified as old-field and deciduous forest.

Every station in Mountsberg Creek (M1, M2, M3) was found to support substantial and diverse fish communities.

Station: M4

Watershed: Mountsberg Creek

Station M4 was a section of Mountsberg Creek approximately 50m long, located in a sedge and typha wetland in the Northwest corner of the subject lands. Throughout this station the creek was narrower and deeper then other observed sections of its watercourse. The average stream width and depth at this station was observed to be 2m and 0.5m respectively, a maximum pool depth of 1.3m was also noted. Undercut banks, large organic debris, submergent vegetation and sparse cobble provided a moderate amount of in-stream cover. The prevalence of undercut banks indicates many locations of bank erosion and generally poor bank stability in the area. The majority of stream substrate was composed of detritus with some silt and isolated cobbles. Stream flow throughout the entire station was a moderately flowing flat. Riparian vegetation was identified to be hummocky sedges and typha with stands of dogwoods and scattered ash trees. Very little canopy cover was provided to the Mountsberg Creek by the low-lying sedges, which dominated the near stream area of this station. Fisheries inventory and Benthic invertebrate sampling was not performed at this station.

Station: M5

Watershed: Mountsberg Creek

Station M5 is a short section of Mountsberg Creek located an estimated 30m upstream of the sedge and typha wetland mentioned above. The station was approximately 30m in length with an average width and depth of 4m and 0.3m respectively. The maximum observed pool depth at the station was 0.6m. In-stream cover was abundant and was provided by: large/small organic debris, cobble, submergent macrophytes, and one deep pool. Bank stability of this section of Mountsberg Creek was estimated to be 50% vulnerable, 30% depositional and 20% eroding. Stream substrate at this station was composed of gravel, sand, and cobble with detritus and silt fond in some slow flowing near shore areas. The majority of flow through this section of stream was run, with a short stretch of riffle and a couple pools in the sheltered near shore areas. Riparian vegetation within 2m of the stream was identified to be dogwoods, willows and grasses. Beyond 2m the riparian community was a cedar forest to the west and a mixed coniferous forest to the east. The riparian communities provided a canopy cover estimated to be 70% open, 25% partly open and 5% closed. The abundance of grasses area in close proximity to the stream at this station would provide excellent northern pike (*Esox lucius*) spawning grounds during periods of flooding. Fisheries inventory and Benthic invertebrate sampling was not performed at this station.

Fish Recorded from Lowndes Holdings Corp. Proposed Quarry Property and Adjacent Watercourses

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	COMMENTS	A1	A2	B1	C1	D1	D2	F1	F2	F3	F4	M1	M2	M3	BCWS M4[a]	BCWS M5[a]	BCWS M6[a]	HRCA 1998 F[b]	HRCA 1998 G[b]	HRCA 1999 11th conn.[c]	HRCA 2000 10th conn.[d]
TROUT FAMILY	**SALMONIDAE**																									
Brown Trout	*Salmo trutta*	SE	G5																	☒					☒	
MUDMINNOW FAMILY	**UMBRIDAE**																				☒					
Central Mudminnow	*Umbra limi*	S5	G5				☒											☒	☒				☒			
PIKE FAMILY	**ESCOCIDAE**																									
Northern Pike	*Esox lucius*	S5	G5															☒								
MINNOW FAMILY	**CYPRINIDAE**																									
Northern Redbelly Dace	*Phoxinus eos*	S5	G5															☒		☒		☒				
Brassy Minnow	*Hybognathus hankinsoni*	S5	G5															☒								
Hornyhead Chub	*Nocomis biguttatus*	S4	G5		NAR														☒							
Common Shiner	*Notropis cornutus*	S5	G5		NAR													☒	☒	☒	☒	☒				
Blacknose Shiner	*Notropis heterolepis*	S5	G5														☒			☒						
Rosyface Shiner	*Notropis rubellus*	S4	G5	NIAC	THR															☒						
Sand Shiner	*Notropis stramineus*	S4	G5																							
Bluntnose Minnow	*Pimephales notatus*	S5	G5		NAR												☒	☒	☒		☒	☒				
Fathead Minnow	*Pimephales promelas*	S5	G5															☒		☒		☒	☒			
Blacknose Dace	*Rhinichthys atratulus*	S5	G5											☒	☒	☒			☒	☒	☒	☒		☒		
Longnose Dace	*Rhinichthys cataractae*	S5	G5															☒	☒	☒						
Creek Chub	*Semotilus atromaculatus*	S5	G5															☒	☒	☒	☒	☒				
Pearl Dace	*Margariscus margarita*	S5	G5				☒	☒										☒	☒							
Shiner sp.?						collected												☒								
SUCKER FAMILY	**CATOSTOMIDAE**																									
White Sucker	*Catostomus commersoni*	S5	G5				☒										☒	☒	☒	☒	☒	☒		☒		
Northern Hog Sucker	*Hypentelium nigricans*	S4	G5														☒	☒	☒	☒	☒			☒		
STICKLEBACK FAMILY	**GASTEROSTEIDAE**																									
Brook Stickleback	*Culaea inconstans*	S5	G5								☒			☒	☒											
SUNFISH FAMILY	**CENTRARCHIDAE**																									
Rock Bass	*Ambloplites rupestris*	S5	G5														☒		☒		☒					
Green Sunfish	*Lepomis cyanellus*	S4	G5		NAR																					☒
Pumpkinseed	*Lepomis gibbosus*	S5	G5																☒		☒	☒	☒	☒		
Largemouth Bass	*Micropterus salmoides*	S5	G5																			☒				
Black Crappie	*Pomoxis nigromaculatus*	S4	G5																							
PERCH FAMILY	**PERCIDAE**																									
Johnny Darter	*Etheostoma nigrum*	S5	G5														☒	☒	☒	☒	☒	☒				
SUMMARY																										
Total Species:	***26***						3	1			1			2	2	1	6	14	13	12	10	10	3	4	1	1
SIGNIFICANT SPECIES																										
Global:	*0*																									
National:	*0*																									
Provincial:	*0*																									
Regional:																										

Fish Recorded from Lowndes Holdings Corp. Proposed Quarry Property and Adjacent Watercourses

COMMON NAME	*SCIENTIFIC NAME*	ONTARIO STATUS	GLOBAL STATUS	COSSARO	COSEWIC	COMMENTS	A1	A2	B1	C1	D1	D2	F1	F2	F3	F4	M1	M2	M3	BCWS M4[a]	BCWS M5[a]	BCWS M6[a]	HRCA 1998 F[b]	HRCA 1998 G[b]	HRCA 1999 11th conn.[c]	HRCA 2000 10th conn.[d]
Explanation of Status and Acronymns																										
COSSARO: Committee on the Status of Species at Risk in Ontario																										
COSEWIC: Committee on the Status of Endangered Species in Canada																										
S1: Extremely rare in Ontario; usually fewer than 5 occurrences																										
S1S2: Extremely rare to very rare in Ontario																										
S2: Very rare in Ontario; usually be	5-20 occurrences																									
S2S3: Very rare to uncommon in Ontario																										
S3: Rare to uncommon in Ontario; usually between 20-100 occurrences																										
S4: Common in Ontario: apparently secure, usually more than 100 occurrences																										
S5: Very common in Ontario, demonstrably secure																										
SU: Status uncertain																										
SXC: Extirpated in Ontario, culturally stocked																										
SZ: Not of practical conservation concern as there are no clearly definable occurrences																										
?: Not yet ranked; or, following a ranking, rank inexact or uncertain																										
G2: Very rare globally; usually between 5-10 occurrences in the overall range																										
G3: Rare to uncommon globally; usually between 20-100 occurrences																										
G4: Common globally; usually more than 100 occurrences in the overall range																										
G5: Very common globally; demonstrably secure																										
THR: Threatened																										
VUL: Vulnerable																										
SC: Special Concern																										
NAR: Not At Risk																										
NIAC: Not In Any Category of risk																										
IND: Indeterminant; insufficient data to assign a category of risk																										
[a] Bronte Creek Watershed Study Appendix 2 Aquatic Habitat Inventory and Assessment (Conservation Halton 2002)																										
[b] Flamboro Creek Instream Flow Study (Halton Region Conservation Authority, December 1998)																										
[c] Bronte Creek Fish Community Studies letter ((Halton Region Conservation Authority, January 1999)																										
[d] Bronte Creek Fisheries Community Studies letter (Conservation Halton, April 2000)																										

APPENDIX G: Surface Water Quality Sampling Results

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	A1			A2			B1			C1		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
HYDROIDS												
P. Coelenterata												
Hydra	-	-	-	-	-	-	-	1	-	-	-	-
ROUNDWORMS												
P. Nemata	20	40	80	12	8	14	-	-	-	505	76	76
FLATWORMS												
P. Platyhelminthes												
Cl. Turbellaria												
indeterminate	4	8	8	-	-	-	-	-	1	-	-	-
O. Tricladida	-	-	-	-	-	-	1	3	-	-	-	-
UNSEGMENTED WORMS												
P. Nemertea												
Prostoma	-	-	-	-	-	-	-	-	-	-	-	-
ANNELIDS												
P. Annelida												
WORMS												
Cl. Oligochaeta												
F. Enchytraeidae	-	-	-	-	-	-	-	-	-	201	40	4
F. Naididae												
Dero digitata	-	-	-	-	-	-	-	-	-	-	-	-
Dero	-	8	-	-	-	-	-	-	-	-	-	-
Nais bretscheri	-	-	-	-	-	-	-	-	-	-	-	-
Nais communis	-	-	-	-	-	-	-	-	-	59	12	8
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-
F. Tubificidae												
Aulodrilus pigueti	2	8	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	28	48	8	-	-	-	1	1	7	-	-	-
Tasserkidrilus harmani	-	-	-	-	-	-	-	-	-	-	-	-
Tasserkidrilus superiorensis	-	-	-	-	-	-	-	-	-	24	4	4
immatures with hair chaetae	4	8	-	6	2	8	-	-	-	12	4	4
immatures without hair chaetae	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae												
Lumbriculus variegatus	-	-	-	4	4	10	-	-	-	-	-	4
F. Lumbricidae												
Eiseniella tetraedra	-	-	-	-	-	-	-	-	-	-	-	-
F. Sparganophilidae												
Sparganophilus	-	-	-	-	-	-	-	-	-	-	-	-
LEECHES												
Cl. Hirudinea												
F. Erpobdellidae												
Erpobdella punctata	-	-	-	-	-	-	-	-	-	-	-	-
Mooreobdella fervida	-	-	-	-	-	-	-	-	-	-	-	-
Mooreobdella	-	-	-	-	-	-	-	-	-	-	-	-
F. Glossiphoniidae												
Actinobdella	2	-	-	-	-	-	-	-	-	-	-	-
Glossiphonia complanata	6	9	16	-	-	-	-	-	-	-	-	-
Helobdella stagnalis	-	-	-	-	-	-	-	-	-	-	-	-
Placobdella ornata	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS												
P. Arthropoda												
MITES												
Cl. Arachnida												
O. Acarina	-	8	8	-	-	2	-	1	2	-	-	-
HARPACTICOIDS												
O. Harpacticoida	-	16	8	1	-	-	-	1	-	8	-	4
SEED SHRIMPS												
Cl. Ostracoda	2	48	8	6	2	-	3	16	13	32	30	12
WATER SCUDS												
O. Amphipoda												
F. Crangonyctidae												
Crangonyx	4	-	-	2	8	12	2	26	18	-	-	-
F. Hyalellidae												
Hyalella	4	-	-	-	-	-	-	-	-	-	-	-
AQUATIC SOW BUGS												
O. Isopoda												

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	A1			A2			B1			C1		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
F. Asellidae												
Caecidotea	24	64	72	21	54	66	-	1	1	-	-	-
CRAYFISH												
O. Decapoda												
F. Cambaridae												
Orconectes propinquus	-	-	-	-	-	-	-	-	-	-	-	-
SPRINGTAILS												
Cl. Entognatha												
O. Collembola	-	8	-	2	2	-	1	-	-	16	4	8
INSECTS												
Cl. Insecta												
BEETLES												
O. Coleoptera												
F. Curculionidae	-	-	-	-	-	2	-	-	-	-	-	-
F. Dytiscidae												
Agabus	-	-	-	-	2	-	-	-	-	-	-	-
Heterosternuta	-	-	-	-	-	-	-	-	-	-	-	-
Neoporus carolinus	-	-	-	-	-	-	-	-	-	-	-	-
Neoporus	2	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae												
Dubiraphia minima	-	-	-	-	-	-	-	-	-	-	-	-
Dubiraphia vittata	4	-	-	-	-	-	-	-	-	-	-	-
Dubiraphia larvae	**84**	16	8	-	-	-	-	-	-	-	-	-
Macronychus glabratus	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus fastiditus	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus trivittatus	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus larvae	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis crenata	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis larvae	-	-	-	-	-	-	-	-	-	-	-	-
F. Haliplidae												
Haliplus	-	-	-	-	-	-	-	-	-	8	4	-
Peltodytes	-	-	-	-	-	-	-	-	-	-	-	-
F. Hydrophilidae												
Anacaena	-	-	-	-	-	-	-	-	-	-	-	-
Berosus	-	-	-	-	-	-	-	-	-	1	-	-
Hydrobius	-	-	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-	24
F. Psephenidae												
Ectopria	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-
F. Staphylinidae	-	8	-	-	2	-	-	-	-	-	-	-
MAYFLIES												
O. Ephemeroptera												
F. Baetidae												
Baetis ?brunneicolor	-	-	-	-	-	-	-	-	-	-	-	-
Baetis flavistriga	-	-	-	-	-	-	-	-	-	-	-	-
Callibaetis	-	-	-	-	-	-	-	-	-	-	-	-
F. Caenidae												
Caenis	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae												
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephemerellidae												
Serratella	-	-	-	-	-	-	-	-	-	-	-	-
F. Heptageniidae												
Stenacron	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema mediopunctatum	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema vicarium	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptohyphidae												
Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae												
Paraleptophlebia	2	-	-	-	-	-	1	-	-	-	-	-
F. Siphlonuridae												
Siphlonurus	-	-	-	2	-	-	-	-	-	-	-	-
O. Megaloptera												
FISHFLIES & DOBSONFLIES												
F. Corydalidae												
Nigronia	-	-	-	-	-	-	-	-	-	-	-	-
ALDERFLIES												
F. Sialidae												
Sialis	-	-	-	-	-	-	-	-	-	-	-	-
O. Odonata												
DRAGONFLIES												

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	A1			A2			B1			C1		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
F. Aeshnidae												
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-
F. Corduliidae												
Somatochlora	-	-	-	-	-	-	-	-	-	-	-	-
F. Libellulidae												
Ladona julia	-	1	-	-	-	-	-	-	-	-	-	-
Sympetrum	-	-	-	-	-	-	-	-	-	-	-	-
STONEFLIES												
O. Plecoptera												
F. Leuctridae												
Leuctra	-	-	-	-	-	-	-	-	-	-	-	-
F. Nemouridae												
Amphinemura	-	-	-	-	-	-	2	2	-	-	-	-
F. Perlidae												
Acroneuria	-	-	-	-	-	-	-	-	-	-	-	-
Perlesta	-	-	-	-	-	-	-	-	-	-	-	-
BUGS												
O. Hemiptera												
F. Corixidae												
Palmacorixa nana	-	-	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES												
O. Trichoptera												
F. Brachycentridae												
Micrasema	-	-	-	-	-	-	-	-	-	-	-	-
F. Helicopsychidae												
Helicopsyche	-	-	-	-	-	-	-	-	-	-	-	-
F. Hydropsychidae												
Cheumatopsyche	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche betteni	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche bronta	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche morosa	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche sparna	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche	-	-	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-	-	-
F. Hydroptilidae												
Hydroptila	-	-	-	-	-	-	-	-	-	-	-	-
Ochrotrichia	-	-	-	-	-	-	-	-	-	-	-	-
F. Lepidostomatidae												
Lepidostoma	-	-	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae												
Ironoquia	-	-	-	-	-	-	-	-	-	-	-	-
Limnephilus	1	-	-	-	-	2	-	-	-	-	-	-
Platycentropus	-	-	-	-	1	-	-	-	-	-	-	-
Pycnopsyche	-	-	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-	2	-
F. Phryganeidae												
immature	-	-	-	-	-	-	-	1	-	-	-	-
F. Polycentropodidae												
Nyctiophylax	-	-	-	-	-	-	-	-	-	-	-	-
Polycentropus	-	-	-	-	-	-	-	-	-	-	-	-
F. Uenoidae												
Neophylax	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES												
O. Diptera												
pupae	-	-	-	-	-	2	-	-	-	-	4	-
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-
BITING-MIDGE												
F. Ceratopogonidae												
Alluaudomyia	-	-	-	4	-	-	-	-	-	-	-	-
Bezzia	8	16	8	-	-	-	-	-	-	-	-	-
Mallochohelea	-	-	-	-	-	-	-	-	2	-	-	-
Probezzia	-	-	-	-	-	2	1	1	-	-	-	-
Serromyia	-	16	8	-	-	-	-	-	2	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-	-	-
MIDGES												
F. Chironomidae												
chironomid pupae	**2**	-	**40**	-	**2**	-	-	-	-	-	**4**	-
S.F. Chironominae												
Chironomus	-	-	-	-	-	-	-	-	1	475	222	474
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus	-	-	-	-	2	6	-	-	-	-	-	-
Micropsectra	-	-	-	12	-	2	-	3	1	-	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	A1			A2			B1			C1		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
Microtendipes	-	8	-	-	-	-	-	-	-	-	-	-
Parachironomus	-	-	-	-	-	-	-	-	-	-	-	4
Paratanytarsus	-	-	-	-	-	-	-	-	-	8	-	-
Paratendipes	-	-	-	-	-	12	-	1	1	-	-	-
Phaenopsectra	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum flavum	-	-	-	-	-	-	1	-	-	-	-	-
Polypedilum halterale	40	48	72	-	-	-	-	-	-	-	-	-
Polypedilum illinoense group	-	-	-	-	-	-	-	-	-	-	4	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum ?trigonus	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum	2	-	-	-	-	-	-	-	-	-	-	-
Rheotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus	-	-	-	-	-	-	-	-	-	40	20	20
S.F. Diamesinae												
Diamesa	-	-	-	-	-	-	-	-	-	-	-	-
Pagastia	-	-	-	-	-	-	-	-	-	-	-	-
Potthastia	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Orthocladiinae												
Abiskomyia	-	-	-	-	-	-	-	-	-	-	-	-
Brillia	-	-	-	-	-	-	-	-	-	-	-	-
Chaetocladius	-	-	-	-	-	-	-	-	-	-	-	-
Corynoneura	-	-	-	-	-	-	-	-	-	-	-	4
Cricotopus	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus (Isocladius)	-	-	-	-	-	-	-	-	-	8	-	-
Cricotopus trifascia	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/Orthocladius	-	-	-	-	-	-	-	-	-	-	-	-
Eukiefferiella	-	-	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	-	-	-	-	-	-	1	1	4	-	-	-
Parametriocnemus	2	-	-	-	2	-	1	-	-	-	-	-
Rheocricotopus	-	-	-	-	-	-	-	-	-	-	-	-
Thienemanniella	-	-	-	-	-	-	-	-	-	-	-	-
Tvetenia	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Tanypodinae												
Ablabesmyia	-	-	-	-	-	-	-	-	-	-	-	8
Clinotanypus	18	8	8	-	-	-	-	-	-	-	-	-
Conchapelopia	-	-	-	-	-	-	-	-	-	-	-	-
Helopelopia	-	-	-	-	-	-	-	-	-	-	-	-
Larsia	8	-	16	-	-	-	-	-	-	-	-	-
Natarsia	-	-	-	4	-	-	-	-	-	-	-	-
Procladius	-	-	-	-	-	-	-	-	-	16	8	8
Thienemanniella complex	-	8	-	4	4	2	-	-	-	-	-	-
Trissopelopia	-	-	-	-	-	2	-	-	-	-	-	-
Zavrelimyia	-	-	-	-	2	2	-	-	-	-	-	-
F. Dolichopodidae	-	-	-	-	-	-	-	-	-	-	-	-
F. Empididae												
Chelifera	-	-	-	-	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephydridae	-	-	-	-	-	-	-	-	-	-	-	-
F. Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae												
Odontomyia	-	-	-	-	-	-	-	-	-	-	-	-
F. Tabanidae												
Chrysops	-	-	-	-	-	-	1	-	2	-	-	-
F. Tipulidae												
Antocha	-	-	-	-	-	-	-	-	-	-	-	-
Dicranota	-	-	-	-	-	-	-	-	-	-	-	-
Limnophila	-	-	-	-	-	-	-	-	-	-	-	-
Limonia	-	-	-	-	-	-	-	-	1	-	-	-
Pedicia	-	-	-	-	-	-	-	-	-	-	-	-
Pilaria	-	-	-	-	-	-	1	-	4	-	-	-
Pseudolimnophila	-	-	-	-	-	-	-	-	-	-	-	-
Tipula	-	-	-	-	-	-	-	-	-	-	-	-
MOLLUSCS												
P. Mollusca												
SNAILS												
Cl. Gastropoda												
indeterminate	-	8	-	-	-	-	-	-	-	-	-	-
F. Ancylidae												
Ferrissia	-	-	-	-	-	-	-	-	-	-	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	A1			A2			B1			C1		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
F. Hydrobiidae												
Amnicola	-	-	-	-	-	-	-	-	-	-	-	-
F. Lymnaeidae												
Fossaria	-	-	-	-	-	-	-	-	-	-	-	-
Stagnicola elodes	-	-	-	-	-	-	-	-	-	-	-	-
indeterminate	-	-	-	-	-	-	-	-	-	-	20	-
F. Physidae												
Physella	4	-	-	111	8	12	-	-	1	-	-	-
F. Planorbidae												
Armiger crista	34	-	8	-	-	-	-	-	-	-	-	-
Gyraulus	21	48	16	14	14	12	-	-	-	16	15	4
Helisoma anceps	2	-	-	-	-	-	-	-	-	-	-	-
Planorbella pilsbryi	-	8	-	-	-	-	-	-	-	-	-	-
Planorbella trivolvis	-	-	-	-	-	-	-	-	-	-	-	-
Planorbula armigera	2	-	1	-	-	15	-	-	-	-	-	-
F. Valvatidae												
Valvata lewisi	14	16	8	8	8	12	-	-	-	-	-	-
CLAMS												
Cl. Bivalvia												
F. Sphaeriidae												
Pisidium	120	88	200	-	82	90	35	60	95	-	8	-
Sphaerium rhomboideum	3	1	2	-	-	-	-	-	-	-	-	-
Sphaerium striatinum	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Organisms	473	571	603	213	209	287	52	119	156	1429	481	670
Mean Number of Organisms ¨		549			236			109			860	
Total Number of Taxa ¨	29	27	20	16	18	21	14	15	17	16	17	17
Mean Number of Taxa ¨		25			18			15			17	

¨ Mean numbers calculated from quantitative samples only
¨ Bold entries excluded from taxa count

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	D1			D2			F1			F3
Replicate	1	2	3	1	2	3	1	2	3	1
HYDROIDS										
P. Coelenterata										
Hydra	-	1	-	-	-	-	-	-	-	-
ROUNDWORMS										
P. Nemata	2	3	2	2	-	5	8	15	11	34
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
indeterminate	-	-	-	-	1	-	-	-	-	-
O. Tricladida	2	4	-	2	2	-	-	-	-	-
UNSEGMENTED WORMS										
P. Nemertea										
Prostoma	-	-	-	-	-	-	-	-	-	-
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	6	2	118	16	3	2	-	-	3	-
F. Naididae										
Dero digitata	-	-	-	-	-	-	-	-	-	-
Dero	-	-	-	-	-	-	1	-	-	-
Nais bretscheri	-	-	-	-	-	-	-	-	-	-
Nais communis	-	-	-	-	-	-	1	2	-	-
Nais variabilis	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-
F. Tubificidae										
Aulodrilus pigueti	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-
Tasserkidrilus harmani	-	-	-	-	-	-	10	10	11	-
Tasserkidrilus superiorensis	-	-	-	2	-	-	-	-	-	-
immatures with hair chaetae	-	-	-	-	-	-	-	1	1	-
immatures without hair chaetae	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae										
Lumbriculus variegatus	-	-	-	-	-	-	-	-	-	-
F. Lumbricidae										
Eiseniella tetraedra	-	-	-	-	-	-	-	-	-	-
F. Sparganophilidae										
Sparganophilus	-	-	2	2	1	-	-	-	-	-
LEECHES										
Cl. Hirudinea										
F. Erpobdellidae										
Erpobdella punctata	-	-	-	-	-	-	-	-	-	-
Mooreobdella fervida	-	-	-	-	-	-	-	-	-	-
Mooreobdella	-	-	-	-	-	-	-	-	-	-
F. Glossiphoniidae										
Actinobdella	-	-	-	-	-	-	-	-	-	-
Glossiphonia complanata	-	-	-	-	-	-	-	-	-	-
Helobdella stagnalis	-	-	-	-	-	-	-	-	-	-
Placobdella ornata	-	-	-	-	-	-	-	-	-	-
ARTHROPODS										
P. Arthropoda										
MITES										
Cl. Arachnida										
O. Acarina	-	3	-	2	2	1	-	-	1	2
HARPACTICOIDS										
O. Harpacticoida	-	-	1	34	-	-	-	-	-	30
SEED SHRIMPS										
Cl. Ostracoda	4	7	6	106	76	13	-	-	1	8
WATER SCUDS										
O. Amphipoda										
F. Crangonyctidae										
Crangonyx	2	5	4	28	33	2	-	-	-	2
F. Hyalellidae										
Hyalella	-	-	-	-	-	-	-	-	-	-
AQUATIC SOW BUGS										
O. Isopoda										

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	D1			D2			F1			F3
Replicate	1	2	3	1	2	3	1	2	3	1
F. Asellidae										
Caecidotea	-	-	-	-	-	-	12	-	3	2
CRAYFISH										
O. Decapoda										
F. Cambaridae										
Orconectes propinquus	-	-	-	-	-	-	-	-	-	-
SPRINGTAILS										
Cl. Entognatha										
O. Collembola	-	-	-	-	-	-	-	-	-	-
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Curculionidae	-	-	-	-	1	-	-	-	-	-
F. Dytiscidae										
Agabus	-	-	-	2	-	1	-	-	-	-
Heterosternuta	-	-	1	-	-	-	-	-	-	-
Neoporus carolinus	-	-	-	-	-	-	-	-	-	2
Neoporus	-	1	-	-	-	-	-	-	-	-
F. Elmidae										
Dubiraphia minima	-	-	-	-	-	-	-	-	-	-
Dubiraphia vittata	-	-	-	-	-	-	-	-	-	-
Dubiraphia larvae	-	-	-	-	-	-	-	-	-	-
Macronychus glabratus	-	-	-	-	-	-	-	-	-	-
Optioservus fastiditus	-	-	-	-	-	-	-	-	-	-
Optioservus trivittatus	-	-	-	-	-	-	-	-	-	-
Optioservus larvae	-	-	-	-	-	-	-	-	-	2
Stenelmis crenata	-	-	-	-	-	-	-	-	-	-
Stenelmis larvae	-	-	-	-	-	-	-	-	-	-
F. Haliplidae										
Haliplus	-	-	-	-	-	-	-	1	1	-
Peltodytes	-	-	-	-	-	-	-	-	-	-
F. Hydrophilidae										
Anacaena	1	-	-	-	-	-	1	1	-	-
Berosus	-	-	-	-	-	-	-	-	-	-
Hydrobius	1	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-
F. Psephenidae										
Ectopria	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
F. Staphylinidae	-	-	-	-	-	-	-	-	-	2
MAYFLIES										
O. Ephemeroptera										
F. Baetidae										
Baetis ?brunneicolor	-	-	-	-	-	-	-	-	-	5
Baetis flavistriga	-	-	-	-	-	-	-	-	-	-
Callibaetis	-	-	-	-	-	-	-	-	-	-
F. Caenidae										
Caenis	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae										
Hexagenia	-	-	-	-	-	-	-	-	-	-
F. Ephemerellidae										
Serratella	-	-	-	-	-	-	-	-	-	-
F. Heptageniidae										
Stenacron	-	-	-	-	-	-	-	-	-	-
Stenonema mediopunctatum	-	-	-	-	-	-	-	-	-	-
Stenonema vicarium	-	-	-	-	-	-	-	-	-	-
F. Leptohyphidae										
Tricorythodes	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae										
Paraleptophlebia	36	70	43	2	7	18	-	-	-	-
F. Siphlonuridae										
Siphlonurus	1	-	1	1	-	-	-	-	-	-
O. Megaloptera										
FISHFLIES & DOBSONFLIES										
F. Corydalidae										
Nigronia	-	-	-	-	-	-	-	-	-	-
ALDERFLIES										
F. Sialidae										
Sialis	-	-	-	-	-	-	-	-	-	-
O. Odonata										
DRAGONFLIES										

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	D1			D2			F1			F3
Replicate	1	2	3	1	2	3	1	2	3	1
F. Aeshnidae										
indeterminate	-	-	-	-	-	-	-	-	-	-
F. Corduliidae										
Somatochlora	-	-	-	-	-	-	-	-	-	-
F. Libellulidae										
Ladona julia	-	-	-	-	-	-	-	-	-	-
Sympetrum	-	-	-	-	-	-	2	-	-	-
STONEFLIES										
O. Plecoptera										
F. Leuctridae										
Leuctra	-	-	-	-	-	-	-	-	-	6
F. Nemouridae										
Amphinemura	-	-	-	-	-	-	-	-	-	-
F. Perlidae										
Acroneuria	-	-	-	-	-	-	-	-	-	-
Perlesta	-	-	-	-	-	-	-	-	-	-
BUGS										
O. Hemiptera										
F. Corixidae										
Palmacorixa nana	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-
CADDISFLIES										
O. Trichoptera										
F. Brachycentridae										
Micrasema	-	-	-	-	-	-	-	-	-	-
F. Helicopsychidae										
Helicopsyche	-	-	-	-	-	-	-	-	-	-
F. Hydropsychidae										
Cheumatopsyche	-	-	-	-	-	-	-	-	-	4
Hydropsyche betteni	-	-	-	-	-	-	-	-	-	-
Hydropsyche bronta	-	-	-	-	-	-	-	-	-	-
Hydropsyche morosa	-	-	-	-	-	-	-	-	-	-
Hydropsyche sparna	-	-	-	-	-	-	-	-	-	-
Parapsyche	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-
F. Hydroptilidae										
Hydroptila	-	-	-	-	-	-	-	-	-	-
Ochrotrichia	-	-	-	-	-	-	-	-	-	-
F. Lepidostomatidae										
Lepidostoma	-	-	-	2	-	-	-	-	-	-
F. Limnephilidae										
Ironoquia	-	1	-	1	1	-	-	-	-	-
Limnephilus	19	12	2	2	2	-	2	-	-	-
Platycentropus	-	-	-	-	-	-	-	1	-	-
Pycnopsyche	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-
F. Phryganeidae										
immature	-	-	-	-	-	-	-	-	-	-
F. Polycentropodidae										
Nyctiophylax	-	-	-	-	-	-	-	-	-	-
Polycentropus	1	-	2	-	-	-	-	-	-	-
F. Uenoidae										
Neophylax	-	-	-	-	-	-	-	-	-	-
TRUE FLIES										
O. Diptera										
pupae	-	1	-	-	-	-	-	-	-	-
indeterminate	-	-	-	2	1	-	-	-	-	-
BITING-MIDGE										
F. Ceratopogonidae										
Alluaudomyia	-	-	-	-	-	-	-	-	-	-
Bezzia	-	-	-	-	3	-	-	-	-	6
Mallochohelea	-	-	-	-	-	-	-	-	-	-
Probezzia	-	-	-	-	-	-	-	-	-	4
Serromyia	5	11	80	82	9	5	-	-	-	2
pupae	-	-	-	-	-	-	1	-	-	-
MIDGES										
F. Chironomidae										
chironomid pupae	-	**1**	-	**4**	**1**	**5**	-	**3**	**2**	**10**
S.F. Chironominae										
Chironomus	-	-	1	-	-	-	67	46	61	-
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-
Cryptochironomus	-	-	-	-	-	-	-	-	-	-
Micropsectra	1	3	5	32	4	50	-	-	-	78

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	D1			D2			F1			F3
Replicate	1	2	3	1	2	3	1	2	3	1
Microtendipes	-	-	-	-	-	-	-	-	-	4
Parachironomus	-	-	-	-	-	-	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	-	1	-	-
Paratendipes	-	-	-	-	-	-	-	-	-	-
Phaenopsectra	-	-	-	-	-	-	1	1	1	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum flavum	-	-	-	-	-	-	-	-	-	-
Polypedilum halterale	-	-	-	-	-	-	-	-	-	-
Polypedilum illinoense group	-	-	-	-	-	-	-	-	-	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	10
Polypedilum ?trigonus	-	-	-	2	-	-	-	-	-	2
Polypedilum	-	-	-	-	-	-	-	-	-	-
Rheotanytarsus	-	-	-	-	-	-	-	-	-	4
Stempellinella	-	-	-	-	-	-	-	-	-	-
Tanytarsus	-	-	-	10	3	50	-	-	-	-
S.F. Diamesinae										
Diamesa	-	-	-	-	-	-	-	-	-	-
Pagastia	-	-	-	-	-	-	-	-	-	-
Potthastia	-	-	-	-	-	-	-	-	-	-
S.F. Orthocladiinae										
Abiskomyia	-	1	1	-	-	-	-	-	-	-
Brillia	-	-	-	-	-	-	-	-	-	-
Chaetocladius	1	-	-	8	1	-	-	-	-	-
Corynoneura	-	-	-	2	-	-	-	-	-	-
Cricotopus	-	-	-	-	-	-	-	-	-	-
Cricotopus (Isocladius)	-	-	-	-	-	-	-	-	-	-
Cricotopus trifascia	-	-	-	-	-	-	-	-	-	-
Cricotopus/Orthocladius	-	-	-	-	-	-	-	-	-	-
Eukiefferiella	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	-	-	-	4	-	-	-	-	-	-
Parametriocnemus	1	3	16	12	3	-	-	-	-	88
Rheocricotopus	-	-	-	-	-	-	-	-	-	-
Thienemanniella	-	-	-	2	-	-	-	-	-	-
Tvetenia	-	-	-	-	-	-	-	-	-	2
S.F. Tanypodinae										
Ablabesmyia	-	-	-	-	-	-	-	-	-	-
Clinotanypus	-	-	-	-	-	-	-	-	-	-
Conchapelopia	-	-	-	-	-	-	-	-	-	26
Helopelopia	-	-	-	-	-	-	-	-	-	-
Larsia	-	-	-	-	-	-	-	-	-	-
Natarsia	-	-	-	-	-	-	-	-	-	-
Procladius	-	-	-	-	-	-	-	-	-	-
Thienemannimyia complex	-	-	-	-	1	-	-	-	-	20
Trissopelopia	-	-	-	-	-	-	-	-	-	-
Zavrelimyia	1	1	1	-	-	-	-	-	-	-
F. Dolichopodidae	1	1	3	-	-	-	-	-	-	-
F. Empididae										
Chelifera	-	-	-	-	1	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	-
F. Ephydridae	-	-	-	-	-	-	-	1	-	-
F. Simuliidae	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae										
Odontomyia	-	-	-	-	-	-	-	-	-	-
F. Tabanidae										
Chrysops	-	-	-	-	-	-	-	-	-	4
F. Tipulidae										
Antocha	-	-	-	-	-	-	-	-	-	-
Dicranota	-	-	-	-	-	-	-	-	-	2
Limnophila	-	-	-	-	-	-	-	-	-	-
Limonia	-	-	-	2	-	-	-	-	-	-
Pedicia	-	-	1	-	-	-	-	-	-	-
Pilaria	-	-	1	2	1	-	-	-	-	-
Pseudolimnophila	-	-	-	-	-	-	-	-	-	-
Tipula	-	-	-	-	-	-	-	-	-	-
MOLLUSCS										
P. Mollusca										
SNAILS										
Cl. Gastropoda										
indeterminate	-	-	-	-	-	-	-	-	-	-
F. Ancylidae										
Ferrissia	-	-	-	-	-	-	-	-	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	D1			D2			F1			F3
Replicate	1	2	3	1	2	3	1	2	3	1
F. Hydrobiidae										
Amnicola	-	-	-	-	-	-	-	-	-	-
F. Lymnaeidae										
Fossaria	-	-	-	-	-	-	-	13	-	-
Stagnicola elodes	-	-	-	-	-	-	7	-	1	2
indeterminate	-	-	-	2	-	-	-	-	1	-
F. Physidae										
Physella	-	-	-	-	-	2	-	-	-	13
F. Planorbidae										
Armiger crista	-	-	-	-	-	-	-	-	-	-
Gyraulus	-	-	-	-	-	-	1	6	1	10
Helisoma anceps	-	1	-	-	-	-	-	-	-	-
Planorbella pilsbryi	-	-	-	-	-	-	-	-	-	-
Planorbella trivolvis	-	-	-	-	-	-	-	-	-	-
Planorbula armigera	-	-	-	-	-	-	-	-	-	-
F. Valvatidae										
Valvata lewisi	-	-	-	-	-	-	-	-	-	-
CLAMS										
Cl. Bivalvia										
F. Sphaeriidae										
Pisidium	-	-	-	64	57	1	1	12	-	100
Sphaerium rhomboideum	-	-	-	-	-	-	-	-	-	-
Sphaerium striatinum	-	-	-	-	-	-	-	-	-	-
Total Number of Organisms	85	132	291	434	214	155	115	114	99	486
Mean Number of Organisms ¨		169			268			109		
Total Number of Taxa ¨	17	19	20	29	22	12	14	14	13	30
Mean Number of Taxa ¨		19			21			14		

¨ Mean numbers calculated from quantit

¨ Bold entries excluded from taxa count

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station			F4			M1			M2		
Replicate	2	3	1	2	3	1	2	3	1	2	3
HYDROIDS											
P. Coelenterata											
Hydra	-	-	-	-	4	-	-	-	-	-	-
ROUNDWORMS											
P. Nemata	14	13	34	168	248	5	2	3	9	23	6
FLATWORMS											
P. Platyhelminthes											
Cl. Turbellaria											
indeterminate	-	-	4	-	4	-	-	-	-	-	-
O. Tricladida	3	1	-	-	-	-	-	-	5	12	19
UNSEGMENTED WORMS											
P. Nemertea											
Prostoma	-	-	-	-	-	-	-	-	8	64	33
ANNELIDS											
P. Annelida											
WORMS											
Cl. Oligochaeta											
F. Enchytraeidae	-	-	4	10	13	-	-	-	3	4	-
F. Naididae											
Dero digitata	-	-	11	-	-	-	-	-	-	-	-
Dero	-	-	-	-	-	-	-	-	-	-	-
Nais bretscheri	-	-	-	-	-	-	4	12	4	24	-
Nais communis	-	-	4	10	-	-	-	-	-	-	-
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	2	52	50	58	-	-	-	-	-	-
F. Tubificidae											
Aulodrilus pigueti	-	-	11	69	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	7	20	13	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	4	1	4	9	1	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-
Tasserkidrilus harmani	-	-	-	-	-	-	-	-	-	-	-
Tasserkidrilus superiorensis	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	-	-	4	69	18	2	2	12	-	-	-
immatures without hair chaetae	-	-	-	20	4	22	42	43	-	-	-
F. Lumbriculidae											
Lumbriculus variegatus	2	6	-	-	-	-	-	-	-	-	-
F. Lumbricidae											
Eiseniella tetraedra	-	-	-	-	-	-	-	-	-	1	7
F. Sparganophilidae											
Sparganophilus	-	-	-	-	-	-	-	-	3	4	-
LEECHES											
Cl. Hirudinea											
F. Erpobdellidae											
Erpobdella punctata	1	5	-	-	-	-	-	-	-	-	-
Mooreobdella fervida	-	-	-	-	-	-	-	-	-	-	-
Mooreobdella	4	17	2	-	-	-	-	-	-	-	-
F. Glossiphoniidae											
Actinobdella	-	-	-	-	-	-	-	-	-	-	-
Glossiphonia complanata	-	-	-	-	-	-	-	-	-	-	-
Helobdella stagnalis	-	-	2	-	-	-	-	-	-	-	-
Placobdella ornata	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS											
P. Arthropoda											
MITES											
Cl. Arachnida											
O. Acarina	-	3	-	-	-	-	12	-	4	-	5
HARPACTICOIDS											
O. Harpacticoida	-	-	-	-	4	-	-	-	-	-	-
SEED SHRIMPS											
Cl. Ostracoda	2	6	4	-	-	-	-	-	-	4	-
WATER SCUDS											
O. Amphipoda											
F. Crangonyctidae											
Crangonyx	5	3	-	-	-	-	2	-	-	-	-
F. Hyalellidae											
Hyalella	-	-	-	-	-	-	-	-	-	-	-
AQUATIC SOW BUGS											
O. Isopoda											

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station			F4			M1			M2		
Replicate	2	3	1	2	3	1	2	3	1	2	3
F. Asellidae											
Caecidotea	6	5	16	-	16	-	-	-	-	-	2
CRAYFISH											
O. Decapoda											
F. Cambaridae											
Orconectes propinquus	-	-	-	-	-	1	1	-	1	1	-
SPRINGTAILS											
Cl. Entognatha											
O. Collembola	1	3	-	-	-	-	-	-	-	-	-
INSECTS											
Cl. Insecta											
BEETLES											
O. Coleoptera											
F. Curculionidae	1	-	-	-	-	-	-	-	-	-	-
F. Dytiscidae											
Agabus	1	1	-	-	-	-	-	2	-	-	-
Heterosternuta	-	-	-	-	-	-	-	-	-	-	-
Neoporus carolinus	-	-	-	-	-	-	-	-	-	-	-
Neoporus	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae											
Dubiraphia minima	-	-	-	-	-	-	-	-	1	-	-
Dubiraphia vittata	-	-	-	-	-	-	-	-	-	-	-
Dubiraphia larvae	-	6	-	-	-	-	-	-	**7**	5	4
Macronychus glabratus	-	-	-	-	-	4	-	3	1	-	-
Optioservus fastiditus	-	4	-	-	-	-	-	-	2	4	4
Optioservus trivittatus	-	-	-	-	-	-	-	-	2	-	8
Optioservus larvae	6	**6**	-	-	-	3	1	4	**54**	**177**	**96**
Stenelmis crenata	-	5	-	-	-	-	-	-	8	4	12
Stenelmis larvae	2	**23**	-	-	-	3	2	8	**107**	**303**	**162**
F. Haliplidae											
Haliplus	-	-	-	-	-	-	-	-	-	-	-
Peltodytes	-	-	-	-	-	-	-	-	-	-	-
F. Hydrophilidae											
Anacaena	-	-	-	-	-	-	-	-	-	-	-
Berosus	-	-	-	-	-	-	-	-	-	-	-
Hydrobius	-	-	-	-	-	-	-	-	-	-	-
immature	1	-	-	-	-	-	-	-	-	-	-
F. Psephenidae											
Ectopria	-	-	-	-	-	-	-	-	-	-	4
Psephenus	-	-	-	-	-	1	3	4	4	-	2
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES											
O. Ephemeroptera											
F. Baetidae											
Baetis ?brunneicolor	-	1	-	-	-	-	-	-	-	-	-
Baetis flavistriga	-	-	-	-	-	2	2	4	25	4	25
Callibaetis	-	-	-	-	-	-	-	-	-	-	-
F. Caenidae											
Caenis	-	-	-	-	-	5	8	29	3	-	-
F. Ephemeridae											
Hexagenia	-	-	-	-	-	-	-	-	-	-	-
F. Ephemerellidae											
Serratella	-	-	-	-	-	-	4	15	-	-	-
F. Heptageniidae											
Stenacron	-	-	-	-	-	4	11	28	-	-	-
Stenonema mediopunctatum	-	-	-	-	-	5	6	9	-	-	-
Stenonema vicarium	-	-	-	-	-	9	22	13	1	-	-
F. Leptohyphidae											
Tricorythodes	-	-	-	-	-	-	2	-	23	29	44
F. Leptophlebiidae											
Paraleptophlebia	3	2	-	-	-	-	-	-	-	-	-
F. Siphlonuridae											
Siphlonurus	-	-	-	-	-	-	-	-	-	-	-
O. Megaloptera											
FISHFLIES & DOBSONFLIES											
F. Corydalidae											
Nigronia	-	-	-	-	-	-	3	3	1	-	2
ALDERFLIES											
F. Sialidae											
Sialis	-	-	-	-	-	1	3	4	-	-	-
O. Odonata											
DRAGONFLIES											

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station			F4			M1			M2		
Replicate	2	3	1	2	3	1	2	3	1	2	3
F. Aeshnidae											
indeterminate	1	-	-	-	-	-	-	-	-	-	-
F. Corduliidae											
Somatochlora	1	-	-	-	-	-	-	-	-	-	-
F. Libellulidae											
Ladona julia	-	-	-	-	-	-	-	-	-	-	-
Sympetrum	-	-	-	-	-	-	-	-	-	-	-
STONEFLIES											
O. Plecoptera											
F. Leuctridae											
Leuctra	14	7	-	-	-	-	-	-	-	-	-
F. Nemouridae											
Amphinemura	-	-	-	-	-	-	-	-	1	-	-
F. Perlidae											
Acroneuria	-	-	-	-	-	1	-	1	-	-	-
Perlesta	-	-	-	-	-	-	9	6	6	5	28
BUGS											
O. Hemiptera											
F. Corixidae											
Palmacorixa nana	-	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES											
O. Trichoptera											
F. Brachycentridae											
Micrasema	-	-	-	-	-	-	-	2	-	-	-
F. Helicopsychidae											
Helicopsyche	-	-	-	-	-	-	-	-	29	48	41
F. Hydropsychidae											
Cheumatopsyche	-	1	-	-	-	10	59	103	142	190	376
Hydropsyche betteni	-	-	-	-	-	-	-	2	4	15	12
Hydropsyche bronta	-	-	-	-	-	-	-	-	4	9	3
Hydropsyche morosa	-	-	-	-	-	-	2	11	40	82	147
Hydropsyche sparna	-	-	-	-	-	-	-	2	-	2	10
Parapsyche	-	-	-	-	-	-	-	2	-	-	-
pupae	-	-	-	-	-	-	**1**	**2**	-	-	-
F. Hydroptilidae											
Hydroptila	-	-	-	-	-	-	4	2	1	-	4
Ochrotrichia	-	-	-	-	-	-	-	2	-	-	-
F. Lepidostomatidae											
Lepidostoma	-	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae											
Ironoquia	-	-	-	-	-	-	-	-	-	-	-
Limnephilus	-	2	-	-	-	-	-	-	-	-	-
Platycentropus	-	1	-	-	-	-	-	-	-	-	-
Pycnopsyche	-	-	-	-	-	-	-	-	2	7	6
pupae	-	-	-	-	-	-	-	-	-	-	-
F. Phryganeidae											
immature	-	-	-	-	-	-	-	-	-	-	-
F. Polycentropodidae											
Nyctiophylax	-	-	-	-	-	1	-	-	-	-	-
Polycentropus	-	-	-	-	-	-	-	-	-	-	-
F. Uenoidae											
Neophylax	-	-	-	-	-	-	2	-	-	1	-
TRUE FLIES											
O. Diptera											
pupae	-	-	-	-	-	-	-	-	-	-	-
indeterminate	-	-	-	-	-	-	-	-	-	-	-
BITING-MIDGE											
F. Ceratopogonidae											
Alluaudomyia	-	-	-	-	-	-	-	-	-	-	-
Bezzia	5	17	4	-	-	1	-	-	1	-	-
Mallochohelea	-	-	-	-	-	-	1	-	-	-	-
Probezzia	1	7	-	-	-	1	1	-	-	-	-
Serromyia	-	-	-	-	4	-	-	-	-	-	-
pupae	**1**	-	-	-	-	-	-	-	-	-	-
MIDGES											
F. Chironomidae											
chironomid pupae	**66**	**13**	-	-	**4**	**2**	**8**	**24**	**8**	**10**	**17**
S.F. Chironominae											
Chironomus	-	-	-	-	-	-	-	-	-	-	-
Cladotanytarsus	-	-	-	-	-	-	-	-	2	-	-
Cryptochironomus	-	-	-	-	-	1	-	-	-	-	-
Micropsectra	9	38	4	8	16	1	-	-	-	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station			F4			M1			M2		
Replicate	2	3	1	2	3	1	2	3	1	2	3
Microtendipes	-	-	-	-	-	91	114	150	9	-	6
Parachironomus	-	-	-	8	8	-	-	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	-	-	-	-	-
Paratendipes	-	-	-	-	4	-	-	-	-	-	-
Phaenopsectra	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	4	6	14	5	8	14
Polypedilum flavum	-	-	-	-	-	-	-	-	-	-	-
Polypedilum halterale	-	-	-	16	16	-	-	-	-	-	-
Polypedilum illinoense group	-	2	-	-	-	-	-	-	-	-	-
Polypedilum scalaenum	-	2	-	-	-	4	4	6	-	-	-
Polypedilum ?trigonus	-	2	-	40	-	-	-	-	-	-	-
Polypedilum	1	-	-	-	-	-	-	-	-	-	-
Rheotanytarsus	-	-	-	-	-	4	4	10	-	4	-
Stempellinella	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus	-	-	-	40	4	1	4	-	2	-	-
S.F. Diamesinae											
Diamesa	-	-	-	-	-	-	-	2	-	-	-
Pagastia	-	-	-	-	-	2	4	14	1	-	-
Potthastia	-	-	-	-	-	-	-	-	1	-	-
S.F. Orthocladiinae											
Abiskomyia	-	-	-	-	-	-	-	-	-	-	-
Brillia	-	-	-	-	-	1	-	-	-	-	-
Chaetocladius	-	-	-	-	-	-	-	-	-	-	-
Corynoneura	-	-	-	-	-	-	-	-	-	-	-
Cricotopus	-	2	-	-	-	1	2	8	4	16	14
Cricotopus (Isocladius)	-	-	-	-	-	-	-	-	-	-	-
Cricotopus trifascia	-	-	-	-	-	-	-	2	-	-	-
Cricotopus/Orthocladius	-	-	-	-	-	-	2	8	18	56	8
Eukiefferiella	-	1	-	-	-	-	-	2	1	-	2
Heterotrissocladius	-	-	-	-	-	-	-	-	-	-	-
Parametriocnemus	289	37	-	-	-	1	2	6	-	-	-
Rheocricotopus	-	-	-	-	-	1	-	-	-	-	4
Thienemanniella	-	-	-	-	-	1	-	-	-	-	-
Tvetenia	-	-	-	-	-	1	-	-	-	-	4
S.F. Tanypodinae											
Ablabesmyia	-	-	-	-	-	1	-	-	-	-	-
Clinotanypus	-	-	-	-	-	-	-	-	-	-	-
Conchapelopia	-	1	-	-	-	-	2	-	-	-	-
Helopelopia	-	-	-	-	-	-	6	8	1	-	-
Larsia	-	-	-	-	-	-	-	-	-	-	-
Natarsia	2	-	-	-	-	2	2	-	-	-	-
Procladius	-	-	4	16	4	-	-	-	-	-	-
Thienemannimyia complex	38	8	-	-	-	12	2	6	-	-	4
Trissopelopia	-	-	-	-	-	-	-	-	-	-	-
Zavrelimyia	-	1	-	-	-	-	-	-	-	-	-
F. Dolichopodidae	-	-	-	-	-	-	-	-	-	-	-
F. Empididae											
Chelifera	-	-	-	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	1	2	2	1	5	4
pupae	-	-	-	-	-	-	**4**	**9**	-	-	**3**
F. Ephydridae	-	-	-	-	-	-	-	-	-	-	-
F. Simuliidae	-	-	-	-	-	-	2	-	-	-	-
F. Stratiomyiidae											
Odontomyia	1	-	-	-	-	-	-	-	1	-	-
F. Tabanidae											
Chrysops	1	1	-	-	1	2	-	-	-	-	-
F. Tipulidae											
Antocha	-	-	-	-	-	-	4	-	1	6	6
Dicranota	-	-	-	-	-	-	-	-	-	-	-
Limnophila	-	-	-	8	-	-	-	-	-	-	-
Limonia	-	-	-	-	-	-	-	-	-	-	-
Pedicia	1	-	-	-	-	1	-	-	-	-	-
Pilaria	-	-	-	-	-	-	-	-	-	-	-
Pseudolimnophila	-	3	-	-	-	-	1	-	-	-	-
Tipula	-	-	-	-	-	-	-	-	1	-	-
MOLLUSCS											
P. Mollusca											
SNAILS											
Cl. Gastropoda											
indeterminate	-	-	-	-	-	-	-	-	-	-	-
F. Ancylidae											
Ferrissia	-	-	-	-	-	-	-	4	3	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station			F4			M1			M2		
Replicate	2	3	1	2	3	1	2	3	1	2	3
F. Hydrobiidae											
Amnicola	-	-	-	-	-	-	-	-	-	-	-
F. Lymnaeidae											
Fossaria	-	-	-	-	-	-	-	-	-	-	-
Stagnicola elodes	3	8	14	16	16	-	-	-	-	-	-
indeterminate	-	-	-	-	-	-	-	-	-	-	-
F. Physidae											
Physella	49	37	-	-	-	1	-	-	8	9	19
F. Planorbidae											
Armiger crista	-	-	-	-	-	-	-	-	-	-	-
Gyraulus	6	57	-	8	-	-	-	-	-	-	-
Helisoma anceps	-	-	-	-	-	-	-	-	5	-	2
Planorbella pilsbryi	-	-	-	-	-	-	-	-	-	-	-
Planorbella trivolvis	-	-	-	-	-	-	-	-	-	-	-
Planorbula armigera	-	-	-	-	-	-	-	-	-	-	-
F. Valvatidae											
Valvata lewisi	-	-	-	-	-	-	-	-	-	-	-
CLAMS											
Cl. Bivalvia											
F. Sphaeriidae											
Pisidium	7	10	176	160	36	19	-	8	20	32	24
Sphaerium rhomboideum	-	-	-	-	-	-	-	-	-	-	-
Sphaerium striatinum	-	-	-	-	-	5	19	28	-	1	-
Total Number of Organisms	548	370	357	736	499	242	409	651	599	1169	1193
Mean Number of Organisms ¨	468			531			434			987	
Total Number of Taxa ¨	32	39	18	18	21	43	45	45	48	32	37
Mean Number of Taxa ¨	34			19			44			39	

¨ Mean numbers calculated from quantit

¨ Bold entries excluded from taxa count

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	M3		
Replicate	1	2	3
HYDROIDS			
P. Coelenterata			
Hydra	4	16	6
ROUNDWORMS			
P. Nemata	7	4	6
FLATWORMS			
P. Platyhelminthes			
Cl. Turbellaria			
indeterminate	-	-	-
O. Tricladida	-	-	-
UNSEGMENTED WORMS			
P. Nemertea			
Prostoma	-	-	-
ANNELIDS			
P. Annelida			
WORMS			
Cl. Oligochaeta			
F. Enchytraeidae	-	10	-
F. Naididae			
Dero digitata	-	-	-
Dero	-	-	-
Nais bretscheri	-	10	8
Nais communis	-	-	-
Nais variabilis	8	38	-
Slavina appendiculata	-	-	-
F. Tubificidae			
Aulodrilus pigueti	-	-	8
Ilyodrilus templetoni	-	-	4
Limnodrilus hoffmeisteri	6	19	8
Limnodrilus udekemianus	-	-	-
Tasserkidrilus harmani	-	-	-
Tasserkidrilus superiorensis	-	-	-
immatures with hair chaetae	4	38	44
immatures without hair chaetae	18	125	28
F. Lumbriculidae			
Lumbriculus variegatus	-	-	-
F. Lumbricidae			
Eiseniella tetraedra	-	-	-
F. Sparganophilidae			
Sparganophilus	-	1	-
LEECHES			
Cl. Hirudinea			
F. Erpobdellidae			
Erpobdella punctata	-	-	-
Mooreobdella fervida	4	-	2
Mooreobdella	-	-	-
F. Glossiphoniidae			
Actinobdella	-	-	-
Glossiphonia complanata	-	-	-
Helobdella stagnalis	-	-	-
Placobdella ornata	1	-	-
ARTHROPODS			
P. Arthropoda			
MITES			
Cl. Arachnida			
O. Acarina	16	20	4
HARPACTICOIDS			
O. Harpacticoida	-	8	-
SEED SHRIMPS			
Cl. Ostracoda	-	8	2
WATER SCUDS			
O. Amphipoda			
F. Crangonyctidae			
Crangonyx	-	-	-
F. Hyalellidae			
Hyalella	18	16	5
AQUATIC SOW BUGS			
O. Isopoda			

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	M3		
Replicate	1	2	3
F. Asellidae			
Caecidotea	30	24	75
CRAYFISH			
O. Decapoda			
F. Cambaridae			
Orconectes propinquus	-	1	2
SPRINGTAILS			
Cl. Entognatha			
O. Collembola	-	-	-
INSECTS			
Cl. Insecta			
BEETLES			
O. Coleoptera			
F. Curculionidae	-	-	1
F. Dytiscidae			
Agabus	-	-	-
Heterosternuta	-	-	-
Neoporus carolinus	-	-	-
Neoporus	-	-	1
F. Elmidae			
Dubiraphia minima	-	4	-
Dubiraphia vittata	-	-	-
Dubiraphia larvae	4	**12**	3
Macronychus glabratus	-	8	-
Optioservus fastiditus	-	-	-
Optioservus trivittatus	4	-	-
Optioservus larvae	**14**	44	4
Stenelmis crenata	44	12	7
Stenelmis larvae	**20**	**52**	**4**
F. Haliplidae			
Haliplus	2	-	2
Peltodytes	-	4	-
F. Hydrophilidae			
Anacaena	-	-	-
Berosus	-	-	-
Hydrobius	-	-	-
immature	-	-	-
F. Psephenidae			
Ectopria	8	-	-
Psephenus	-	-	-
F. Staphylinidae	2	-	-
MAYFLIES			
O. Ephemeroptera			
F. Baetidae			
Baetis ?brunneicolor	-	-	-
Baetis flavistriga	14	8	2
Callibaetis	-	4	-
F. Caenidae			
Caenis	4	12	4
F. Ephemeridae			
Hexagenia	-	-	1
F. Ephemerellidae			
Serratella	4	-	1
F. Heptageniidae			
Stenacron	4	-	12
Stenonema mediopunctatum	8	1	2
Stenonema vicarium	8	-	1
F. Leptohyphidae			
Tricorythodes	-	4	-
F. Leptophlebiidae			
Paraleptophlebia	-	-	-
F. Siphlonuridae			
Siphlonurus	-	-	-
O. Megaloptera			
FISHFLIES & DOBSONFLIES			
F. Corydalidae			
Nigronia	-	-	-
ALDERFLIES			
F. Sialidae			
Sialis	-	-	1
O. Odonata			
DRAGONFLIES			

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	M3		
Replicate	1	2	3
F. Aeshnidae			
indeterminate	-	-	-
F. Corduliidae			
Somatochlora	-	-	-
F. Libellulidae			
Ladona julia	-	-	-
Sympetrum	-	-	-
STONEFLIES			
O. Plecoptera			
F. Leuctridae			
Leuctra	-	-	-
F. Nemouridae			
Amphinemura	-	-	-
F. Perlidae			
Acroneuria	-	-	-
Perlesta	39	19	8
BUGS			
O. Hemiptera			
F. Corixidae			
Palmacorixa nana	2	-	-
immature	-	8	3
CADDISFLIES			
O. Trichoptera			
F. Brachycentridae			
Micrasema	-	-	-
F. Helicopsychidae			
Helicopsyche	8	1	-
F. Hydropsychidae			
Cheumatopsyche	333	373	27
Hydropsyche betteni	2	2	1
Hydropsyche bronta	1	32	-
Hydropsyche morosa	28	-	4
Hydropsyche sparna	-	-	-
Parapsyche	-	-	-
pupae	**8**	-	**2**
F. Hydroptilidae			
Hydroptila	2	27	-
Ochrotrichia	-	-	-
F. Lepidostomatidae			
Lepidostoma	-	-	-
F. Limnephilidae			
Ironoquia	-	-	-
Limnephilus	-	-	-
Platycentropus	-	-	-
Pycnopsyche	19	14	6
pupae	-	-	-
F. Phryganeidae			
immature	-	-	-
F. Polycentropodidae			
Nyctiophylax	-	-	-
Polycentropus	-	-	-
F. Uenoidae			
Neophylax	15	18	3
TRUE FLIES			
O. Diptera			
pupae	-	-	-
indeterminate	-	-	-
BITING-MIDGE			
F. Ceratopogonidae			
Alluaudomyia	-	-	-
Bezzia	-	-	-
Mallochohelea	-	-	1
Probezzia	-	-	-
Serromyia	-	-	-
pupae	-	-	**1**
MIDGES			
F. Chironomidae			
chironomid pupae	**8**	**56**	**4**
S.F. Chironominae			
Chironomus	-	-	-
Cladotanytarsus	-	76	4
Cryptochironomus	-	12	2
Micropsectra	-	-	-

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	M3		
Replicate	1	2	3
Microtendipes	18	180	76
Parachironomus	-	-	-
Paratanytarsus	2	12	-
Paratendipes	-	-	-
Phaenopsectra	-	-	-
Polypedilum aviceps	36	72	11
Polypedilum flavum	-	-	-
Polypedilum halterale	-	-	-
Polypedilum illinoense group	-	-	-
Polypedilum scalaenum	-	4	-
Polypedilum ?trigonus	-	-	1
Polypedilum	-	-	-
Rheotanytarsus	-	-	-
Stempellinella	2	-	1
Tanytarsus	2	-	4
S.F. Diamesinae			
Diamesa	-	-	-
Pagastia	10	8	-
Potthastia	-	24	-
S.F. Orthocladiinae			
Abiskomyia	-	-	-
Brillia	-	-	-
Chaetocladius	-	-	-
Corynoneura	-	-	-
Cricotopus	-	32	2
Cricotopus (Isocladius)	-	-	-
Cricotopus trifascia	-	-	-
Cricotopus/Orthocladius	4	8	2
Eukiefferiella	12	-	-
Heterotrissocladius	-	-	-
Parametriocnemus	2	4	-
Rheocricotopus	-	-	-
Thienemanniella	-	-	-
Tvetenia	-	4	-
S.F. Tanypodinae			
Ablabesmyia	-	-	-
Clinotanypus	-	-	1
Conchapelopia	-	-	-
Helopelopia	6	8	4
Larsia	-	4	-
Natarsia	-	-	-
Procladius	-	-	-
Thienemanniella complex	4	-	-
Trissopelopia	-	-	-
Zavrelimyia	-	-	-
F. Dolichopodidae	-	-	-
F. Empididae			
Chelifera	-	-	-
Hemerodromia	2	-	2
pupae	**4**	4	**3**
F. Ephydridae	-	-	-
F. Simuliidae	-	-	-
F. Stratiomyiidae			
Odontomyia	-	-	-
F. Tabanidae			
Chrysops	-	-	-
F. Tipulidae			
Antocha	6	-	-
Dicranota	-	8	-
Limnophila	-	-	-
Limonia	-	-	-
Pedicia	-	-	-
Pilaria	-	-	-
Pseudolimnophila	-	-	-
Tipula	-	-	-
MOLLUSCS			
P. Mollusca			
SNAILS			
Cl. Gastropoda			
indeterminate	-	-	-
F. Ancylidae			
Ferrissia	2	8	3

Appendix G: Quantitative Benthic Macroinvertebrate Data Collected From Flamborough and Mountsberg Creeks (June 2004)

Station	M3		
Replicate	1	2	3
F. Hydrobiidae			
Amnicola	-	24	-
F. Lymnaeidae			
Fossaria	2	-	-
Stagnicola elodes	-	-	-
indeterminate	-	-	-
F. Physidae			
Physella	48	17	19
F. Planorbidae			
Armiger crista	-	-	-
Gyraulus	19	-	3
Helisoma anceps	10	36	22
Planorbella pilsbryi	-	-	-
Planorbella trivolvis	1	-	-
Planorbula armigera	-	-	-
F. Valvatidae			
Valvata lewisi	-	-	-
CLAMS			
Cl. Bivalvia			
F. Sphaeriidae			
Pisidium	6	-	3
Sphaerium rhomboideum	-	-	-
Sphaerium striatinum	89	147	7
Total Number of Organisms	1008	1745	478
Mean Number of Organisms ¨		1077	
Total Number of Taxa ¨	54	55	54
Mean Number of Taxa ¨		54	

¨ Mean numbers calculated from quantit
¨ Bold entries excluded from taxa count