Central Lake Ontario Conservation

Terrestrial Watershed Monitoring (Long Term)

May 2009

What we do on the land is mirrored in the water.

Working In Partnership

DURHAM REGION

Conservation ONTARIO *Natural Champions*

Report No.: 2009-03MM

TERRESTRIAL WATERSHED MONITORING
Table of Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

The Central Lake Ontario Conservation Authority (CLOCA) conducts regular watershed monitoring to evaluate the health of wildlife habitat and aquatic environments. This document will focus on the Terrestrial Monitoring Program within the Natural Heritage Department; the Aquatic Monitoring Program (CLOCA, 2008-02MM) and Wildlife Monitoring Program (CLOCA, 2008-01MM) are described in two separate CLOCA documents. The information collected will help to identify ecological trends, understand existing conditions and provide a basis to measure the success of stewardship initiatives and change associated with development throughout the local watersheds. Monitoring provides valuable information to core Authority programs including Conservation Area Management Planning and Implementation, Watershed Planning and Stewardship and Outreach. This information also enables CLOCA to provide guidance to municipalities and planning agencies to assist them in making informed land-use decisions.

During many of these management processes, CLOCA uses government policies, guidelines and GIS modeling to determine the cover and extent of the natural heritage system. Environment Canada's (2004) How Much Habitat Is Enough? is used to establish the minimum natural heritage cover CLOCA strives to achieve throughout their jurisdiction. While this approach suggests an adequate quantitative amount of cover, it does not take into account the quality of the systems and habitat potential. Monitoring these systems, however, will allow for assessment of the integrity of these communities and will help give a clearer picture as to the overall health and trends of these systems.

To ensure that monitoring is done using standardized protocols whenever possible, CLOCA participates in national, provincial or municipal networks. Our partners include Environment Canada (EC), Environmental Monitoring Assessment Network (EMAN), Ministry of Natural Resources (MNR), Ministry of Environment (MOE) and other Conservation Authorities.

1.1 Background

CLOCA's jurisdiction is approximately 627km^2 and its boundaries are defined by the 15 watersheds that drain this area. There are four main watersheds originating on the Oak Ridges Moraine. They are:

- Lynde
- Oshawa
- Bowmanville/Soper
- Black/Harmony/Farewell

These watersheds, as they are grouped above, define the monitoring areas for watershed management and planning. The remaining watersheds are relatively small and for monitoring purposes are generally grouped together, and referred to as the Small Watersheds. This grouping includes:

- Cranberry
- Pringle
- Corbett
- Robinson
- Tooley
- Darlington
- Westside
- Bennett

Seven municipalities are located in whole or in part within the CLOCA jurisdiction. They are the Cities of Oshawa and Pickering, the Towns of Ajax and Whitby, the Municipality of Clarington, and the Townships of Scugog and Uxbridge, which are all located within the Regional Municipality of Durham, hereafter referred to as Durham Region. CLOCA works in partnership with each of these planning agencies to provide information on the terrestrial and aquatic conditions within their boundaries and assists them in making planning decisions that are consistent with the natural heritage values set out in the Provincial Policy Statement (2005). Figure 1 depicts the CLOCA jurisdiction, its watersheds, and the municipalities within its boundaries.

Figure 1 CLOCA jurisdiction

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1.2 Goals and Objectives

Goal: To monitor and report on the health and ecological integrity of the Terrestrial Natural Areas within the CLOCA jurisdiction both now and in the future.

Scope: This project will focus at first on CLOCA owned lands, with a long term vision to extend the program to municipal landholdings and private lands within the jurisdiction.

Objectives:

1. To apply monitoring techniques to adequately assess and report on the current condition of natural areas within the CLOCA watersheds, focusing on community diversity, species diversity and habitat quality.
2. To identify and report on trends and impacts occurring in the Terrestrial Natural Areas within CLOCA's jurisdiction.
3. To provide detailed information to inform the various authority programs including Watershed Planning, Conservation Area Management Planning and Implementation, Watershed Reporting and to inform various municipal programs including plan review and official plan amendments.

1.3 Terrestrial Monitoring Methodology Development

Currently, the terrestrial conditions monitored in CLOCA's jurisdiction focus primarily on wildlife. Monitoring terrestrial vegetation with the above objectives in mind, will offer a more comprehensive and complimentary dataset to the existing known watershed conditions. Yet, identifying the health of a watershed can be difficult as it depends on many variables. To refine the scope of the monitoring program, we will refer to the Parks Canada Agency's Panel (1998) definition of Ecological Integrity, "an ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes. In plain language, ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact."

Ecological indicators will be used to help determine if the vegetation communities being studied are in decline and how the systems are changing over the long-term. From the Park's Canada definition for ecological integrity, it was determined that the following ecological indicators that will be measured are:

- ground vegetation,
- non-native invasive species,
- biodiversity,
- tree health,
- and regeneration of saplings.

By using these indicators, staff will be able to determine if the systems have their native components (ground vegetation and trees) intact, and to identify the threat of non-native species. Also, by monitoring ground vegetation and regeneration, the rate of growth and reproduction of the vegetation communities can also be tracked.

The indicators to be monitored have been selected according to a number of factors that include ease of implementation, coverage of communities, the ability to partner and collaborate with other Conservation Authorities and environmental government organizations, and most importantly the ability to relate information on function, structure and ecological integrity of the natural systems. For this reason, monitoring protocols from the Ecological Monitoring Assessment Network (EMAN) will form the basis of the Terrestrial Monitoring Program. EMAN is a branch of Environment Canada, and is a nation-wide monitoring initiative that has created a set of standardized monitoring protocols and collects data associated with the protocols to provide comprehensive and comparable monitoring across similar eco-regions within Canada (EMAN, 2009). By using EMAN protocols, it will allow us to partner up and share data with other CAs including Credit Valley Conservation (CVC), Toronto Region Conservation Authority (TRCA), Halton Region Conservation Authority (HRCA) and many others. It could also potentially provide a provincial comparison if all CA's were to adopt these standards.

The ecological indicators, as discussed above will be monitored in selected community types that occur throughout CLOCA's watersheds. The following vegetation communities were selected using Ecological Land Classification (ELC) communities and are grouped as; forested systems; non-forested systems (thickets, meadows) and non-coastal wetland systems (ELC classification of wetlands restricted to Swamps). These major systems can be monitored to site level, watershed level and jurisdictional level and are comparable across the landscape.

The larger watersheds, as described in Section 1.1, will be monitored once every five years, following the schedule outlined in Table 1. This schedule is consistent with CLOCA's aquatic monitoring and wildlife monitoring programs which allows for integration of the datasets. Monitoring sample plots within a specific watershed in a given year will help reduce any temporal variations associated with evaluating the health of a given watershed during different years. Along with temporal variations, it is also important to account for physiographic variations which could affect the vegetation composition at sites within the same watershed. Due to these physiographic variations within the CLOCA jurisdiction, the terrestrial watershed monitoring will focus on a North/South study area for individual watersheds, with monitoring areas located within three specific physiographic regions, the Oak Ridges Moraine, the Iroquois Shoreline and the southern Lacustrine Plain. Once all the watersheds have been monitored within the first five years, it will be possible to compare data within an East/West study area, recognizing any potential influence from physiographic variables. This will lead to observations being made across similar physiographic conditions and allow for control over some of the spatial differences that may arise between the northern and southern portions of the watersheds. When possible, monitoring stations for each community class will be located in all three physiographic regions, however, due to land access restrictions, some community class monitoring stations will not be implemented within the first year. This will be an ongoing project, working with municipalities and private landowners to establish plots representatively across the watershed.

Watershed	**Year**
Bowmanville/Soper	2009
Lynde	2010
Small Watersheds & Bowmanville/Soper	2011
Oshawa	2012
Black/Harmony/Farewell	2013
Lynde	2014
Small watersheds	2015
Bowmanville-Soper	2016
Special Projects	Yearly

Table 1 Five Year Watershed Monitoring Schedule

As stated in Section 1.2 *Scope*, the initial Terrestrial Monitoring Program will begin within the Conservation Areas, and as a long-term goal, they will be expanded to municipal and privately owned lands. The Terrestrial Monitoring Program will be divided into two sections, Terrestrial Watershed Monitoring and Special Projects.

Terrestrial Watershed Monitoring will occur on a schedule of one watershed being monitored per year, according to a five year rotation. Unless there are drastic changes in conditions (ie. presence of Emerald Ash Borer), monitoring should not have to be done more than the scheduled rotation, as it may cause damage to the sites being monitored, remembering that our purpose is to monitor and report on changes that occur over the long-term.

Typically, a special project will be more refined in scope and as such will possess different levels of effort and different timelines than the Terrestrial Watershed Monitoring Program. The number, type and focus of special projects will continually change over time and will be subject to availability of resources. Special projects could include specie specific monitoring, examination of anthropogenic impacts, and assessing the success rate of various stewardship projects.

The Special Projects in 2009 will include a study on trail usage and the spread of invasive species, focusing specifically on Dog Strangling Vine (DSV). Another study will aim to monitor the success rate of CLOCA's tree plantings and provide recommendations on planting strategies. A third study will look at the change of ground water levels at Heber Down Provincially Significant Wetland and how this is being affected by surrounding land use changes. The implementation of a new special project will be discussed in the annual monitoring reports as will the findings of special projects.

2 Terrestrial Watershed Monitoring

CLOCA, in partnership with each municipality, is responsible for creating and implementing Watershed Management Plans for the watersheds within its jurisdiction. The data collected in the Terrestrial Watershed Monitoring program can be used as a tool to help assess the quality and quantity of the natural terrestrial systems within the watersheds. It will also help to identify changes that may occur over the long-term. With increasing development occurring within the CLOCA jurisdiction it is important to maintain healthy watersheds and monitor how these land use changes are affecting vital natural heritage features.

At the on-set of the Terrestrial Watershed Monitoring program, monitoring plots will be focused within Conservation Area lands. After the first year of establishment, municipalities and private land owners will be contacted to create partnerships, for the purpose of plot establishment. Since the initial plots will be within Conservation Area (CA) lands, the data collected from these sites can be used in management decisions and guide maintenance initiatives within the Conservation Areas. It is vital that any management recommendations for the general areas being monitored do not occur within the monitoring plots or subplots. These plots must be maintained in their natural condition to ensure integrity of the data collected. Maintaining the plots natural state will also allow for the success of the management initiatives to be measured and monitored. Special Projects are also being implemented within the Conservation Areas to monitor the success of certain restoration activities or management practices, and to help inform future management recommendations.

As stated in the introduction, there are a variety of ELC community series where ecological indicators will be monitored. All of the communities to be studied are grouped within three systems, Forested Systems, Non-Forested Systems and Non-Coastal Wetlands, and have been identified through aerial photographic interpretation. To confirm these ELC community sites and to add to the ELC database, these sites will be classified according to the ELC protocol if time allows during the field season. Within forested systems, tree health, regeneration, ground vegetation and biodiversity will be monitored. Non-forested systems will include ground vegetation and biodiversity monitoring. Non-coastal wetlands will be comprised of the following ELC classifications, Coniferous Swamps, Deciduous Swamps and Mixed Swamps, all of which are forested swamps. For this reason, the non-coastal wetlands monitoring will include the same indicators as the forested systems; tree health, regeneration, ground vegetation and biodiversity. The ecosystem and corresponding ecological indicators monitored within it are outlined in table 2.

Ecosystem Type	**Ecological Indicator**
Forested Systems	Tree Health Regeneration Ground Vegetation Biodiversity
Non-Forested Systems	Ground Vegetation Biodiversity
Non-Coastal Wetland Systems	Tree Health Regeneration Ground Vegetation Biodiversity

Table 2 Ecosystem types with corresponding ecological indicators

2.1 Forested Systems

Forest cover throughout all of the watersheds (including ELC community series classifications CUW, CUP, FOD, FOM, FOC, SWM, SWC and SWD) occupies approximately 20% of the land cover. This section will focus specifically on Cultural Woodlots (CUW), Cultural Plantations (CUP), Deciduous Forests (FOD), Mixed Forests (FOM) and Coniferous Forests (FOC) which accounts for 14% of the natural cover in the CLOCA jurisdiction. Section 2.3 Non-Coastal Wetlands, will go into more detail regarding Mixed Swamps (SWM), Coniferous Swamps (SWC) and Deciduous Swamps (SWD).

For monitoring watershed health, forests are an important feature to observe as they are a major contributor to the health and success of many wildlife species, and account for much of the habitat within CLOCA's jurisdiction. Forest systems, however, work on a long time scale, which will require long-term monitoring of the systems in order to observe any potential trends and changes. Since forests are such significant habitat features, much attention will be placed in establishing monitoring stations within close proximity to the already established Forest Breeding Bird Survey points and Salamander Monitoring plots, the reader is referred to the *Wildlife Monitoring Program* document (2008-01MM) for further details on Wildlife Monitoring. By placing these monitoring stations close together, further analysis can be conducted to help understand the presence or absence of wildlife and trends seen within the data.

For all forested systems, permanent 20mx20m plots will be established and distributed across the watersheds. The only exception to this is ELC community series Cultural Plantations (CUP). Due to the high number of trees found in a 20mx20m plot CUP, it has been determined through previous year's experience that it will not be feasible to map and measure all species within a 20mx20m plot for a CUP. Any site that is classified as a CUP will have a 10mx10m permanent plot established instead of a 20mx20m plot. The CUPs will still receive the same dimensions of *Regeneration* and *Ground Vegetation* subplots that will be discussed later in this section.

Since plots will be monitored once every five years, it will be essential to establish permanent plots that are resilient to extreme weather and possible vandalism. These plots will be established with 4ft T-bar posts at each of the four corners, representing ordinal directions (ie., NW, NE, SW, SE). Within and surrounding each of the plots, five 2mx2m and five 1mx1m subplots will be created for the purpose of monitoring *Regeneration* and *Ground Vegetation* respectively (Figure 2). The 1mx1m subplots will be located within the 2mx2m subplots. Four subplots will be on the outside boundary of the 20mx20m plot to reduce the amount of trampling and impact that may occur from monitoring the forested plot. The fifth subplot will be in the centre of the forested 20mx20m plot to create even distribution and observation of the indicators being monitored. For a more detailed look at the plot set-up refer to Appendix A-1.

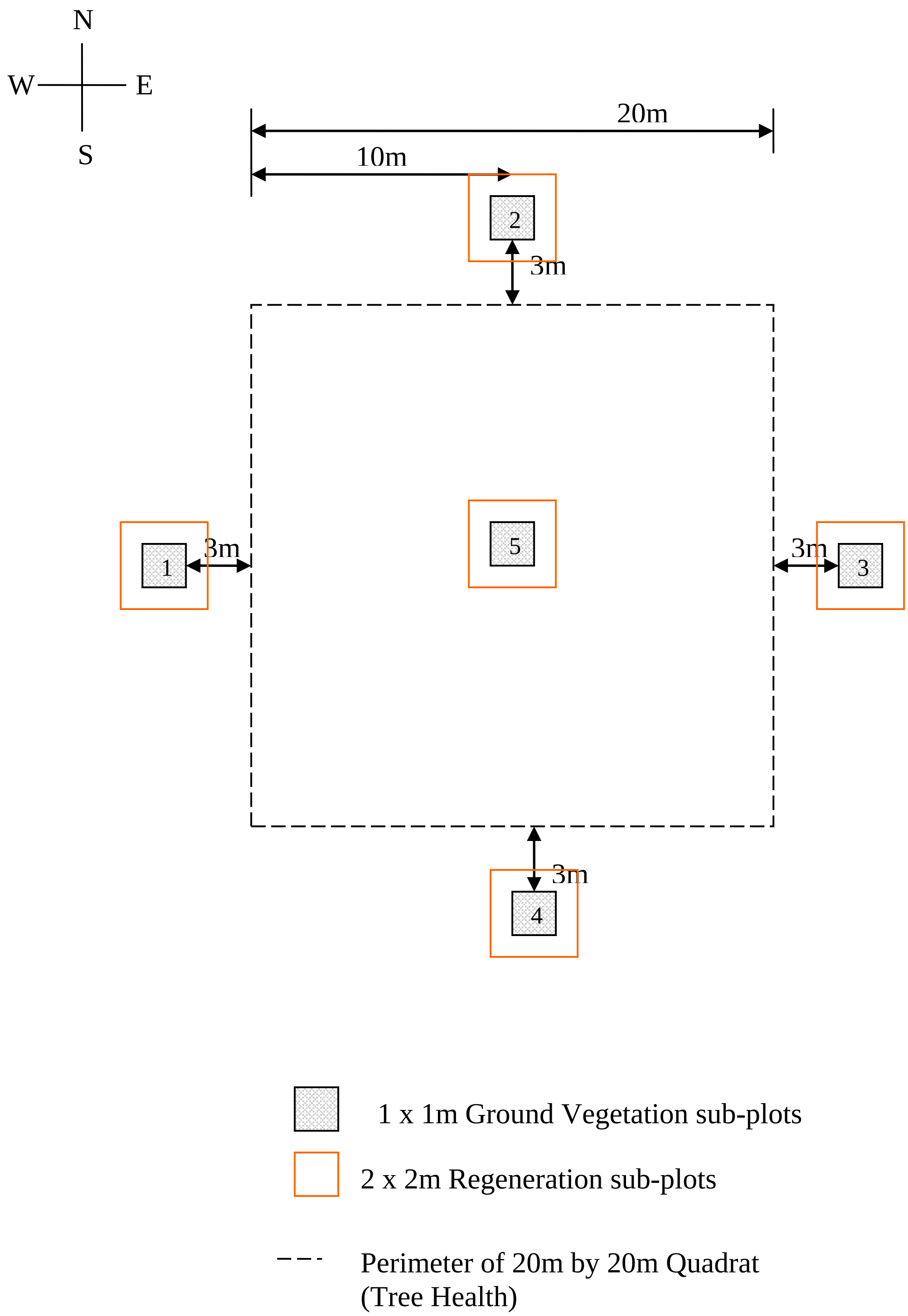

Figure 2 20mx20 Forested plot with subplots

2.1.1 Ecological Indicators Monitored

Tree Health

The EMAN protocol for tree health will be used to monitor the structure and health of the systems, according to a nationally recognized protocol. Tree size and disturbance history can help in understanding how the forest structure is changing, and when regularly monitored, can often help identify both short-term and long-term stresses on the system. These short-term stresses may include extreme weather, insect defoliation and many other factors. While, long-term stresses may be more difficult to isolate and can be related to surrounding land use changes, recreational uses, climate change, and an array of other factors. To account for these stresses, the ELC disturbance sheet will be filled out and attached to the other datasheets for each of the forested plots (Appendix F).

The now retired Canadian Forest Service (Sajan, 2006) states that average annual mortality rates of 1% to 3% are considered normal, but a red flag should be raised at 5% mortality rates. This threshold will be used when monitoring and analyzing data, while recommendations to management practices will be made if mortality rates exceed this rate.

Recently, Emerald Ash Borer (EAB) has been discovered within Pickering. To help monitor and slow the spread of EAB, the presence of EAB will be monitored within the *Tree Health* plots. This will include looking for stressed trees and identifying symptoms that are indicative of EAB. Appendix H goes into further detail regarding the methodology for EAB monitoring, and the symptoms that affected trees may show. Upon confirmation of EAB within *Tree Health* plots, these plots will receive yearly monitoring to identify the rate of spread. The Canadian Food Inspection Agency will be contacted and sent the appropriate evidence.

For each of the 20mx20m plots, all trees within the plots will be identified and mapped. The diameter at breast height (dbh), tree height, tree status (dead or alive), stem defect, crown class and rating will also be recorded for each tree. For a full view of the equipment needed and methodology for *Tree Health* monitoring, refer to Appendix B-1.

Regeneration
Monitoring the regeneration of saplings is another important feature used to understand the structure and observe the succession of the forest. Also, it is possible to observe any problems in tree regeneration and offer management recommendations to deal with these issues.

These monitoring plots will be established in conjunction with the *Tree Health* and *Ground Vegetation* protocol, and will be sub-plots of the *Tree Health* monitoring plots. The regeneration sub-plots will consist of five 2mx2m plots for each 20mx20m *Tree Health* plot (Figure 2). Four of the plots will be located at the midpoint (10m mark) of the 20m transects, 3m outside the boundary. The fifth plot will be located in the centre of the 20mx20m plot. All tree species and heights will be recorded for saplings within 16cm to 200cm in height that lie within the subplot boundaries. For a more detailed look at the methodology and list of equipment needed for the regeneration protocol refer to Appendix B-2.

Ground Vegetation
Monitoring ground vegetation within a forested system can provide information regarding rate of germination, growth and development of seedlings, and the quality of habitat. Ground vegetation is defined as all herbaceous material and ground layer vegetation, including lichens, mosses, fungi and small trailing and rosette plants. It also encompasses woody stemmed material that is less than 1m in height. Ground vegetation can vary depending on many factors, including forest canopy cover, soil substrate, moisture variation, and the time of year. Due to these variables, monitoring will occur across different physiographic regions that may affect the vegetative communities, and to monitor twice a year in early and late summer. By monitoring twice a year, data can be collected for both early and late blooming flowers.

The sites will be visited once during the month of June, and again in late summer during the end of July or beginning of August. It is important that each reoccurring visit happens as close to the original date as possible (ie. if the first visit was done in the first week of June, conduct the following years survey during the first week of June).

Within forested systems, ground vegetation will be monitored within 1mx1m subplots. *Ground Vegetation* monitoring will be conducted in conjunction with *Tree Health* and *Regeneration* monitoring and consist of subplots surrounding the *Tree Health* plots. There will be five 1mx1m subplots for each 20mx20m plot. Four of the five plots will be located at the midpoint (10m mark) of the 20m transects, 3m outside the boundary. The fifth plot will be located in the centre of the 20mx20m plot (Figure 2). At each of the subplots, non-native and native species will be identified and mapped. This will allow for monitoring to watch the spread and rate of non-native species and how native species react to them. Refer to Appendix B-3 for the full methodology and equipment required to conduct the *Ground Vegetation* protocol.

Invasive Species
Non-native species will be monitored through the *Ground Vegetation* and *Tree Health* monitoring protocols. Within each of the respective plots (either 1mx1m or 20mx20m), species will be identified as either native or non-native. Species richness and percent of cover will be calculated for all herbaceous plant, shrub and tree species within the plots. Any areas that are inundated with non-native species will be recorded in the data sheets, and this information can be incorporated into the development of management plans for those areas. Within Southern Ontario, invasive species are a widespread problem as they have the ability to change the growing conditions for other plants resulting in the loss of native species. It is vital to map out and control the spread of non-native species; however control of these plants can be very difficult due to their methods of reproduction.

2.1.2 Data Analysis

Biodiversity
Species diversity refers to the variety of organisms within a single ecosystem. Within the context of this monitoring program, biodiversity will relate to plant diversity and be monitored for all ecological indicators, *Tree Health*, *Regeneration*, and *Ground Vegetation*. It will be assessed using the collected data from each of the above mentioned protocols. This will be done through data analysis at the end of the field season by assessing species richness and the coefficient of conservatism for each plot. Species richness refers to the number of different species within a sample plot (ie. 12 different species of plants were found in a plot, however over 20 plants in total were mapped). The coefficient of conservatism was developed for Ontario by the Natural Heritage Information Centre, a department of the Ministry of Natural Resources (Oldham, *et al.*, 1995) to identify the sensitivity of an individual species and its ability to adapt to disturbances and to different community types. All native Ontario species were given a coefficient of conservatism rank from 0 to 10; the lower end relating to plants that were found in a variety of community types including disturbed areas, while plants in the higher range were found in more specific community types that had experienced minimal disturbances (Oldham, *et al.*, 1995). By calculating the mean coefficient of conservatism for a site, the approximate sensitivity of the site can be assessed. The Natural Area Index (NAI) can also be calculated using the coefficient of conservatism, which combines the conservatism of the species present with a measure of species richness at the site (MNR, 1994). The Natural Area Index formula is shown below:
I=R/N*squareroot of N
Where
I = the Natural Area Index
R = the sum of the valuation coefficients
N = the number of native species recorded
(MNR, 1994)

Data Analysis
The data collected will be entered into an excel database and the EMAN data management system. The data will be summarized and reported at the end of each field season, and will be presented in a yearend report. Appendix M is a table that shows the data that will be collected, the questions it is expected to answer, and how it will be presented.

2.2 *Non-Forested Systems*

Non-forested systems will be defined by the Ecological Land Classification (ELC) protocol and include both cultural thickets (CUT) and cultural meadows (CUM). These community classes account for 8.1% of the land cover within the CLOCA jurisdiction. Cultural thickets often contain greater than 25% shrubs and can contain small trees. Shrubs are defined as multi-stemmed woody plants less than 4cm dbh, with most of their stems beginning near ground level. Small trees are woody species greater than one metre in height, and under 10cm dbh. Cultural Meadows (CUM) are sites with less than 25% shrub species, containing predominantly ground vegetation, which is herbaceous plants, including vines (Lee, et al. 1998). Monitoring within these systems will focus on ground vegetation, invasive species and biodiversity. Similar subplot sizes that are used in the Forested Systems will be adopted for the Non-Forested Systems to remain consistent, and allow for comparisons across the different community types.

2.2.1 Ecological Indicators Monitored

Ground Vegetation

Ground vegetation is defined as all herbaceous material and ground layer vegetation (lichens, mosses, fungi and small trailing and rosette plants). It also encompasses woody stemmed material that is less than 1m in height. In non-forested systems, ground vegetation can be a good indicator of urban pressures, climate change and other disturbing factors, since they are expected to respond more rapidly to such pressures due to their rate of exposure (EMAN, 1999). These organisms can act as early warning systems for forested ground vegetation, since herbaceous material in forests tend to react more slowly to such environmental pressures, due to the lack of environmental exposure and the protection they receive from the more stable forested system.

Ground vegetation can vary depending on many factors, including soil substrate, moisture variation, exposure to environmental conditions, and the time of year. Due to these variables, monitoring will occur across different physiographic regions that may affect the vegetative communities. Monitoring will occur twice a year in early and late summer to account for both early and late blooming flowers. The sites will be visited once during the month of June and again in late summer during the end of July or beginning of August. It is important that each reoccurring visit happens as close to the original date as possible (ie. if the first visit was done in the first week of June, conduct the next years survey during the first week of June).

Ground vegetation will be monitored in 1mx1m plots, with approximately 6 plots at each site, dependent on completion of a species accumulation curve Figure 3. A species accumulation curve is a tool that helps determine the necessary number of plots needed for sampling a single vegetative community. Plotting the number of species identified within each numbered plot will help determine the minimum number of plots needed. Once the number of species has reached a plateau, it can then be determined that the plot number that achieved the plateau is the number of plots required to sample your area. The plots will be established, using two permanent base stakes and from these points two perpendicular lines will be used to create the plots. Along each of the lines, 6 plots in total will be created, three plots along each base stake line. Figure 4 shows an example of the plot establishment. For the complete set-up methodology and equipment required, refer to Appendix A-2.

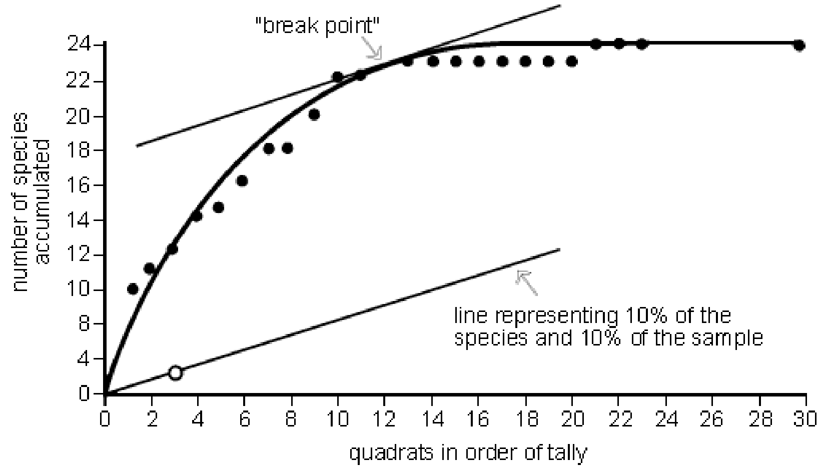

Figure 3 Species Accumulation Curve (EMAN, 1999)

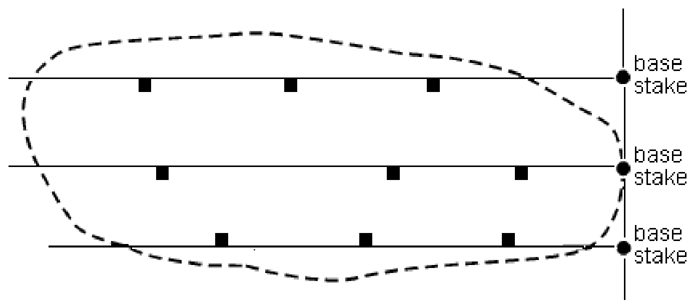

Figure 4 Non-Forested 1mx1m Plot Set-up (EMAN, 1999)

Invasive Species
Non-native species will be monitored through the *Ground Vegetation* monitoring protocol. Within each of the 1mx1m subplots, species will be identified as either native or non-native. Species richness and percent of cover will be calculated for all plant species within the plots. Any areas that are inundated with non-native species will be recorded in the data sheets, and this information can be incorporated into the management plans for those areas.

2.2.2 Data Analysis

Biodiversity
Species diversity refers to the variety of organisms within a single ecosystem. Within the context of this monitoring program, biodiversity will relate to plant diversity and be monitored through analysis of the *Ground Vegetation* data. This will be done through data analysis at the end of the field season by assessing species richness and the coefficient of conservatism for each plot. Refer to the Biodiversity section in 2.1 for a description of species richness and coefficient of conservatism.

Data Analysis
The data collected will be entered into an excel database and the EMAN data management system. The data will be summarized and reported at the end of each field season, and will be presented in a yearend report. Appendix M is a table that shows the data that will be collected, the questions it is expected to answer, and how it will be presented.

2.3 *Non-Coastal Wetland Systems*

The wetlands being monitored as part of this program are non-coastal wetlands, as all of the coastal wetlands within the CLOCA jurisdiction are monitored through the Durham Region Coastal Wetland Monitoring Project (DRCWMP). The wetlands to be monitored within the Terrestrial Watershed Monitoring program will include the ELC community class Treed Swamps, which is comprised of Coniferous Swamps (SWC), Deciduous Swamps (SWD) and Mixed Swamps (SWM). These communities account for approximately 6% of CLOCA lands. They have been limited to these specific community types because wetland communities, such as marshes and thicket swamps are very difficult to establish monitoring plots within, and in the CLOCA jurisdiction, marshes and swamp thickets account for less than 3% of the land cover, some of which is monitored within the DRCWMP.

Since the wetland system being monitored is Treed Swamps, it is justifiable to use the same monitoring protocols used to assess the ecological integrity of Forested Systems. By using the same protocols within the different community classes, comparisons and observations can be made between the two community types once efficient amounts of data have been collected. The ecological indicators to be monitored are Tree Health; Regeneration; Ground Vegetation; Invasive Species; and Biodiversity.

For all Treed Swamp systems, permanent 20mx20m plots will be established and distributed across the watershed. Since plots will be monitored once every five years, it will be essential to establish permanent plots that are resilient to extreme weather and possible vandalism. These plots will be established with 4ft T-bar posts at each of the four corners, representing ordinal directions (ie., NW, NE, SW, SE). Within and surrounding each of the plots, five 2mx2m and five 1mx1m subplots will be created for the purpose of monitoring *Regeneration* and *Ground Vegetation* respectively (Figure 2). The 1mx1m subplots will be located within the 2mx2m subplots. Four subplots will be on the outside boundary of the 20mx20m plot to reduce the amount of trampling and impact that may occur from monitoring the Treed Swamp plot. The fifth plot will be in the centre of the forested 20mx20m plot to create even distribution and observation of the indicators being monitored.

For each of the 20mx20m plots, coordinates will be recorded for each of the corners and all trees within the plots will be identified and mapped. The diameter at breast height (dbh), tree height, tree status, stem defect and crown class and rating will also be recorded for each tree. By gathering this information, it will assist with understanding the structure, age and condition of the treed swamp. The 20mx20m plots will be established in areas that are representative of the swamp community in which it is located, especially focusing on vegetation cover, canopy cover and moisture gradients. Refer to Appendix A-1 and B-1 for the methodology and equipment required for the plot set-up and tree health analysis.

2.3.1 Ecological Indicators Monitored

The non-coastal wetlands will be monitored using the same ecological indicators as the forested systems, the reader is referred to section 2.1.1 **Forested System/Ecological Indicators Monitored** to view the monitoring protocols in detail.

2.3.2 Data Analysis

Biodiversity

Biodiversity refers to the variety of organisms within a single ecosystem. Within the context of this monitoring program, biodiversity will relate to plant diversity and be monitored through analysis of the *Ground Vegetation* data. This will be done through data analysis at the end of the field season by assessing species richness and the coefficient of conservatism for each plot. Refer to the Biodiversity section in 2.1 for a description of species richness and coefficient of conservatism.

Data Analysis
The data collected will be entered into an excel database and the EMAN data management system. The data will be summarized and reported at the end of each field season, and will be presented in a yearend report. Appendix M is a table that shows the data that will be collected, the questions it is expected to answer, and how it will be presented and analyzed.

3 Special Projects

Special Projects have been developed to answer specific questions and will help to further CLOCA's understanding of the interactions between specific environmental changes and human influence. A description of three projects to be initiated at this time is provided below.

3.1 *Dog-Strangling Vine at Crow's Pass Conservation Area*

Invasive species are an on-going problem across southern Ontario, especially within Durham Region. There is an ever-increasing spread of Dog Strangling Vine (DSV) (*Vincetoxicum rossicum syn. Cynanchum rossicum*) throughout the conservation areas. The question was raised as to whether the creation of new trails facilitates the spread of DSV?

In July 2007, the Oak Ridges Moraine Trail Association connected 2 existing trails within the Crow's Pass Conservation Area through the creation of a new trail in a relatively undisturbed patch of deciduous forest. There is a known population of DSV within this Conservation Area, however not within the forest patch where the new trail was created. On July 18th, 2007, following the marking of the new trail by Staff, the site was surveyed for any evidence of DSV within the trail vicinity. A series of 'sweeps' (perpendicular to the new trail) were done to confirm that no DSV plants were already in existence within the trail area. This information will act as the baseline data for comparison with future trail surveys.

A monitoring transect was also set up 25m to the east of the new trail. This transect runs parallel to the new trail and was marked with yellow flagging tape. Its GPS coordinates were recorded. This transect will act as a comparison with the new trail to see if DSV arrives on the public trail before it establishes itself in non-trail areas.

In 2007, no evidence of DSV was found within the trail area. The closest patch of the vine was found along a connecting trail approximately 377m from the new trail.

To record the severity of the populations at a site, both their presence and distribution will be recorded. Their presence will be recorded as absent, rare, occasional or abundant, while their distribution will be recorded as absent, local, widespread or extensive, both of which follow the ELC ranking for presence and distribution. Each of these will receive a rank between 0 and 3. To determine the overall severity within a patch, the rank for presence will be multiplied by the rank for distribution. Using a ranking system like this will quantify the results to determine which sites are suitable for management and which may not be feasible.

Rank	***Presence***	***Definition***	***Rank***	***Distribution***	***Definition***
0	Absent	No representation of plant species in polygon	0	Absent	No presence of species in polygon
1	Rare	Less than three to five small clumps or individuals present in polygon	1	Local	Species distribution is contained in a small area of the polygon
2	Occasional	Present as scattered individuals throughout the polygon or by one or more large clumps of many individuals	2	Widespread	Plant is present throughout entire polygon
3	Abundant	Likely to be encountered anywhere in the polygon, usually forming >10% ground cover	3	Extensive	Plant is present throughout entire polygon and adjacent polygons

Table 3 Intensity and Distribution Codes for invasive species occurrences

Prior to field work:

1. Prepare maps with access route and parallel transect
2. Prepare datasheets for Trail Monitoring

Field Work

Equipment

Standard list of field equipment
Maps and data sheets
GPS

Monitoring Plan:

1. Once arriving at Crow's Pass Conservation Area, walk the new trail to note the presence of any DSV along the trail. For each presence of DSV, take GPS coordinates, and estimate the location on the map. **Mark these locations down on the data sheets**.
2. Following the same access route from previous years, walk out to the transect, looking for any signs of DSV on the way. If there is evidence of DSV, take the GPS coordinates and estimate the location on the map. **Mark these locations down on the data sheets.**
3. For any DSV that is close to the transect, measure the distance from the transect and the direction to the transect (whether it is NE, SE, etc).
4. Walk along the old trails, and observe the location of DSV on the trails. Mark the furthest distance the DSV reaches, take the GPS coordinates and flag this location with flagging tape. On the flagging tape, mark the year and CLOCA. These points will be plotted on the map when back in the office to observe the rate of spread.

3.2 *Tree Planting*

One of CLOCA's yearly initiatives is to plant trees on both CLOCA lands and privately owned lands within its jurisdiction. This tree planting is often done with funding assistance from the Ministry of Natural Resources, Trees Ontario Foundation, Oak Ridges Moraine Foundation, and CLOCA's Clean Water Land Stewardship Program. As part of this yearly tree planting program, monitoring in these areas is conducted in late summer to observe the survival rate of the newly planted trees. In addition to this, CLOCA plans to conduct further monitoring to identify the success rate of these seedlings beyond the first year of establishment, in order to determine if further management is necessary (spraying, mowing, grass removal, etc.), and whether these management practices have been successful. Once the trees have emerged past the height of the grass, and reached the free to grow stage, monitoring to observe the viability and success rate of each species will be implemented.

3.2.1 Survival Rate of Saplings

At each of the tree planting sites, depending on the number of trees planted, 5-10% of the trees will be assessed for their condition (alive or dead), species, and height. Any notes regarding the surrounding vegetation will also be made, for example the height of grasses, and if they are over shading the plants. For each of the sites, pictures will be taken to show the condition of the surrounding vegetation and the possible effects on the saplings.

The number of trees that are chosen for observation will depend on the number of trees planted on the site and the percentage of coverage required for statistical significance. The number of trees selected for observation will be divided amongst the number of rows at the site. Beginning at the first row, the condition, height and species will be recorded. Once the desired number of trees in a row has been surveyed, the surveyor will move to the second row. It is important to note that for each row the surveyor does not start at the beginning of the row, but instead moves laterally from the previous row. These steps should be completed until the pre-determined percent of trees has been assessed. This data will be used to assess future management practices and help guide future plantings. For a more detailed view of the methodology and equipment required, refer to Appendix D. This monitoring will be done in the late summer (September) for the first two years of each new tree planting initiative.

3.2.2 Five Year Success Rate of Species

Monitoring of planting initiatives greater than five years old will be conducted once every five years. This will be done to assess the success rate of species and to provide data that will help guide future management of the plantings.

A transect will be run in a zigzag pattern diagonally across the longest axis at each site, beginning at a randomly chosen corner. The centre point for each 10mx10m plot is placed every 30 metres along the axis to ensure that a spacing of at least 20m between each quadrat is reached. When the transect reaches the edge of the site, another transect which will run in the opposite direction of the first, is positioned and used for quadrat placement until it comes to another property edge or the site is completed (Figure 5). Within these non-permanent plots, height, dbh (if >10cm), species and defects (disease and mammalian browsing) will be noted for all tree species. This data will assist in assessing the success rate of different species and the rate of disease or defects on particular species. For a more detailed view of the methodology and equipment required, refer to Appendix D.

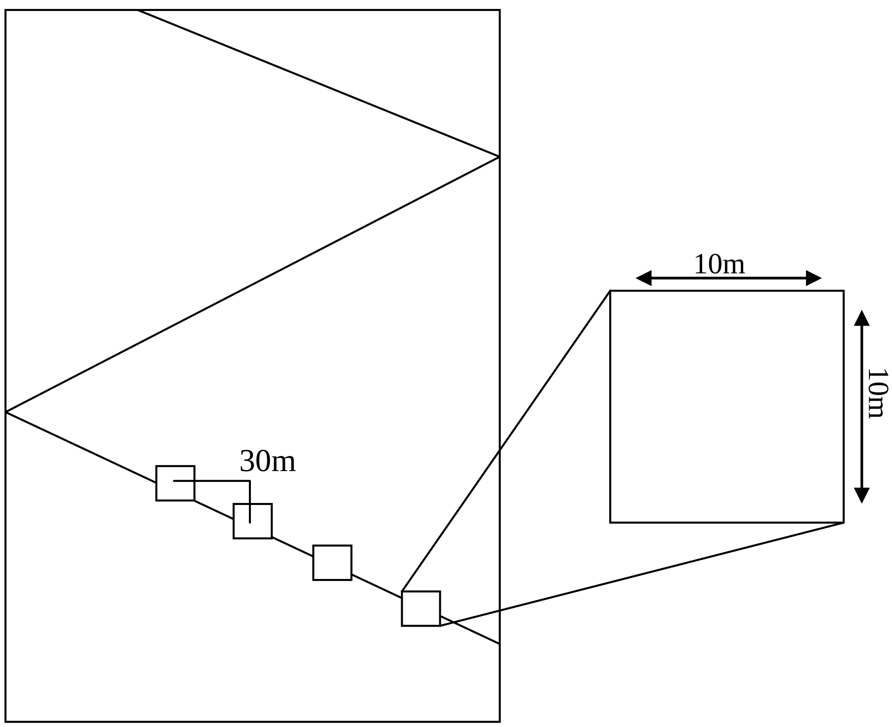

Figure 5 Zigzag monitoring transect for tree planting surveys

3.3 *Heber Down Water levels*

CLOCA staff have made informal observations of water level changes occurring in the wetlands at Heber Down Conservation Area. Due to the nature of wetlands and their dependency on annual precipitation, this is an expected occurrence. However, due to the increased development occurring in the Brooklin area and anticipated future development, monitoring will be conducted within Heber Down Conservation Area to observe and document these changes. Wetlands can be identified by their vegetation composition, as they are largely composed of hydrophytic plants that are dependent on wet soils and are recorded by wetness (Oldham *et al*., 1995). Plants within southern Ontario have been designated as obligate wetland, facultative wetland, facultative, facultative upland or obligate upland, depending on their moisture requirements and habitat preferences (Oldham *et al.*, 1995). Depending on its designation, plants are ranked between +5(obligate upland) to -5(obligate wetland). To observe if there are long-term water level changes occurring at Heber Down, the vegetation gradient will be monitored and any changes will be observed. Yearly changes will be expected, however CLOCA's interest is in the long-term trends of these changes and if there is a continual shift occurring.

Monitoring only the vegetation however will not determine if the groundwater levels are changing. To supplement the vegetation monitoring, ground water will be monitored using piezometers. A piezometer is a pipe installed in the ground (Figure 6) and is used to measure the hydraulic head at a specific point, this information can be used to determine ground water levels and flow direction (Sanders, L, 1998). These piezometers will be established in close proximity to the vegetation monitoring plots, and will be used in conjunction with the Provincial Ground Water Monitoring Station (PGWMS) already established in the north extent of Heber Down Conservation Area. While measurements from the piezometers will be taken on a bi-monthly schedule, information from the PGWMS is recorded on an hourly basis. This information will be used in conjunction with the vegetative gradient monitoring to observe how the ground water variations are affecting the vegetation and the wetland boundaries.

Vegetative monitoring will occur at four locations in Heber Down Conservation Area, and will monitor the gradient along a 50m transect (CVC, 2009). Due to the long-term nature of this study, a permanent 50m transect will be installed for yearly monitoring. The center of the transect will be positioned at the edge of the wetland-upland interface and will be oriented perpendicular to the vegetation gradient. Along the 50m transect, there will be two 1mx1m plots at every 10m point and are 5m away from the 50m transect. The ground vegetation within each of these plots will be mapped, identified, counted and the percent cover will be determined. For a detailed guide on transect establishment and vegetative gradient monitoring, refer to Appendix A-3 and B-4, for the project proposal refer to document Terrestrial Monitoring Special Project: Heber Down Wetland Groundwater Monitoring (CLOCA 2009-04MM).

4 Equipment

4.1 Introduction

Technology plays a vital role in the collection of quality data for various CLOCA projects. The quality of the data produced from the equipment is dependent on a knowledgeable operator. Along with personnel communication about how to operate a piece of equipment, the owner's manual should be reviewed for technical details that may have been omitted.

Scientific equipment (e.g., thermometers) often have a certificate of calibration, which states the accuracy of the product and how it was determined by the manufacturer (e.g., "This Instrument was calibrated using Instruments Traceable to National Institute of Standards and Technology.", Control Company). When possible the serial number of the equipment that is being used to collect data should be recorded on the field data sheet. This becomes critically important if data collected is used for legal purposes and needs to be qualified (e.g., OMB proceeding).

For all of the monitoring protocols, a standard list of equipment is required that is used for all field work (Appendix E). Any additional equipment needed is included in the equipment list for the specific protocols and is available in the respective Appendix.

4.2 Groundwater Level Information

A piezometer is a pipe that is installed in the ground and is used to measure the hydraulic head at a specific point (Figure 6), this information can be used to determine ground water levels and flow direction (Sanders, L, 1998). The piezometer used will be a Model 615 Drive-Point Piezometer. These are designed for water level monitoring, and a variety of other sampling procedures. These will be installed using a post-pounder, and the depth they can go will vary depending on the substrate. The minimum ideal depth for each piezometer is 4ft, since CLOCA is also observing vegetative data which will change in respect to the surface ground water.

A metre-tape will be used and inserted into the piezometer to determine the water-level depth. This data will be collected on a bi-monthly basis depending on the results of the data after the first season of monitoring, and future data collection of water-levels will vary accordingly.

Figure 6 Model 615 Drive Point Piezometer (Solinst, 2009)

4.3 Distance Information

Trees are mapped out in the forested and non-coastal wetlands plots. The distance is taken from each corner post to the tree and recorded. To ensure accuracy of these measurements and to provide ease and lessen the time of mapping an automatic range finder will be used. A Sonin 10300 Multi-Measure Combo Pro – Long Range Indoor/Outdoor Ultrasonic Distance Measuring Tool will be used to determine the distance of trees in the forested plots. This tool uses a sender and receiver and sonar technology to determine the distance between each of the units. For further information regarding the use, see Appendix A-1, and for more information on the equipment refer to the operating manual (attached as Appendix N) for further information.

4.4 Location Information

The following information was taken from the Natural Heritage Information Centre Website (http://nhic.mnr.gov.on.ca/MNR/nhic/species/species_report_guide.cfm).

UTM Coordinates: UTM stands for Universal Transverse Mercator. It is a numerical value that represents the precise location of a site using a type of grid system. A UTM consists of three sets of numbers. A two-digit "Zone", a six-digit "Easting", and a seven-digit "Northing". Together, these three numbers refer to a precise location. An example of a full UTM would be 17 693455 5071456.

There are several ways to generate an UTM. Hand-held GPS (Global Positioning System) units are the easiest and most accurate way to generate a coordinate (either a UTM or Latitude and Longitude) for a location, provided you are physically at that location with your GPS unit. These units are relatively inexpensive, small in size and easy to carry around in the field, and are available at most outdoors and camping stores. They will display geographic coordinates in UTM, Latitude and Longitude, or both.

A UTM grid reference can also be generated from an NTS (National Topographic System) mapsheet. This method can be used regardless of whether or not you are physically at the site. Such mapsheets are available at camping and outdoors stores, as well as map stores. NTS maps are available at two scales, 1:50,000 and 1:250,000. A scale of 1:50,000 is the most useful for fieldwork. More information on where to buy these maps can be found at: **http://maps.nrcan.gc.ca/cmo/dealers.html**. Instructions on generating a UTM from an NTS mapsheet can be found at: **http://maps.nrcan.gc.ca/maps101/grid_ref.html** and can also be found on the right margin of the mapsheet.

Datum: When reporting a location using a UTM, there are two grid systems that are used in Canada - NAD27 (North American Datum 1927) and NAD83 (North American Datum 1983). The datum used on an NTS mapsheet is indicated somewhere on the bottom of the map. In addition, when using a hand-held GPS unit, you can program your unit to display the coordinates in either NAD27 or NAD83. It is important to indicate the "datum" with any UTM because, in Ontario, they differ by approximately 200 metres in the Northing (and a little in the Easting). Naturally, NAD83 is the more up-to-date system and is preferred, but as long as the datum system used is provided with the coordinates, a conversion can be made.

UTM Source: The UTM Source field allows you to report what method you used to generate a UTM (or any other coordinates - e.g. Latitude, Longitude). The following codes are used:

GPS - generated using a hand-held GPS unit
NTS - read from a National Topographic System map sheet
OBM - read from an Ontario Base Map sheet
Other - derived in some other fashion (e.g. Latitude and Longitude derived from a gazetteer or atlas)

5 Reporting

Every year, CLOCA reports on the monitoring that was conducted throughout the year. The data within the report will be used to supplement Watershed Planning and Conservation Area Management Planning and Implementation, and will also be used to raise public awareness of the terrestrial condition of the watershed. Monitoring information may also be used to inform municipal decisions regarding land use, municipal policy or capital projects. During the first five years the report will be primarily summarized base data from the Terrestrial Watershed Monitoring Program, and site comparisons will not be reported on until a full cycle of the monitoring program has been completed.

Due to the nature of the Special Projects, reporting will be included within the year-end report but may also be done on a separate occasion once enough data has been collected. Monitoring is always a long-term project and because of this, trends will not become apparent until enough data has been collected.

This document and the protocols within it are subject to change. Over time, new science may emerge that will require the monitoring methodologies to be amended. Also, depending on the quality of data collected or any other unexpected issues that may arise, this document may be revised to account for these issues.

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