Evaluating the Effectiveness of 'Natural' Channel Design Projects:

An Introduction and Preliminary Assessment of Sites in TRCA's Jurisdiction

Prepared by:
Geomorphic Solutions, Sernas Group Inc.
The Toronto and Region Conservation Authority
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Final Report 2009

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EXECUTIVE SUMMARY

The Toronto and Region Conservation Authority (TRCA) has initiated a 'Natural' Channel Design Monitoring Program in response to an identified deficiency in rigorous or quantitative post-construction monitoring of 'natural' channel designs, despite their widespread use in Ontario. The goal of the program is to catalogue, monitor and evaluate 'natural' channel designs in the TRCA jurisdiction, and eventually throughout the Greater Toronto Area. A rigorous review of the existing scientific and applied literature was undertaken, along with preliminary site assessments of 29 constructed 'natural' channel designs. This report provides the results of this review and assessment. A separate report entitled *'Evaluating the Effectiveness of Natural Channel Design Projects: A Protocol for Monitoring New Projects'* synthesizes the various existing methods for monitoring into a coherent standardized protocol. It is intended that this monitoring protocol will be applied to all new watercourse realignment projects involving 'natural' channel design principles in the TRCA jurisdiction and serve as an example for other jurisdictions.

'Natural' channel design effectiveness monitoring allows for evaluation of project success through meeting or exceeding pre-determined project goals, which has not been done effectively to date. Monitoring data provides information for potential adaptations if project goals are not achieved, and provides a mechanism to identify and explain processes of success and failure that can be used to improve upon future designs. It also allows proponents to document and demonstrate compliance throughout the regulatory permitting process. Effectiveness monitoring includes assessment of fluvial geomorphology, physical habitat, aquatic biota, riparian conditions, engineering elements, hydrology, water quality, and social and cultural indicators.

This document provides:

→ An overview of 'natural' channel design as a restoration practice;
→ A concise summary of the existing scientific and applied literature concerning 'natural' channel design monitoring, and
→ A qualitative review and evaluation of the types and state of designs that have been permitted and implemented within the TRCA jurisdiction.

Based on this information, the second report in this series provides a methodology tool box and framework for tailoring monitoring and assessment plans to individual 'natural' channel designs. The approach presented is consistent with guiding documents for the 'natural' channel design process in Ontario, such as *Adaptive Management of Stream Corridors in Ontario* (MNR and WSC 2002). It is envisioned that through standard application of this protocol, 'natural' channel design success will continue to improve, techniques and the state of the science will be enhanced, and proponents will have a consistent set of tools by which project performance and regulatory compliance can be efficiently assessed.

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1.0 INTRODUCTION

1.1 Identification of Project Goals and Objectives

NCD is a practice used in stream realignment and restoration projects that attempts to reconstruct channels to emulate the self-sustaining geomorphic and ecological functions of natural watercourses. The practice has become common in Ontario and elsewhere during the past ten to fifteen years, and is now applied frequently in watercourse realignment and/or restoration projects. Despite the common usage however, NCD principles continue to be subject to the interpretation of individual practitioners, resulting in channels that are designed and constructed according to widely varying objectives and methods. In addition, selective application of NCD principles has resulted in hybrid designs that have yet to be evaluated in terms of overall performance and effectiveness. In general, there has been little or no comprehensive monitoring performed to evaluate the success and performance of channel realignment projects that have employed NCD principles. As a result, it has been difficult to evaluate the success of varying design techniques, and to validate or improve the practice of NCD as a whole.

Monitoring and evaluating the effectiveness of NCD's is part of an adaptive management process. The adaptive management framework integrates experience into the overall process to improve the potential for reaching project goals (Figure 1.1). However, monitoring to determine the success of a project and effectiveness of stream restoration techniques is rarely undertaken. Therefore, the adaptive management loop is often incomplete and insufficient information is returned to practitioners. The intent of the NCD Monitoring Program is to close this loop through standardized implementation of monitoring protocols, to generate an information source from which existing designs can be evaluated. Evaluating NCD's using monitoring data furthers the science of watercourse restoration by allowing practitioners to understand the effectiveness of the designs, and modify techniques where effectiveness is sub-optimal or restoration goals were not met.

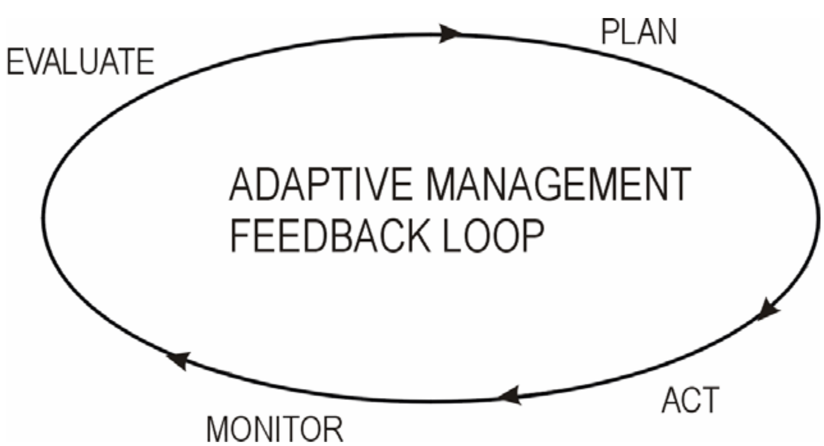

Figure 1.1: The adaptive management loop (from Gaboury and Wong 1999).

Following guiding documents for the NCD process in Ontario, such as the MNR's Adaptive Management of Stream Corridors in Ontario document (MNR and WSC 2002), the adaptive management approach is designed to ensure that an iterative feedback loop is employed throughout the duration of a project. This approach allows for subsequent reconsideration of decisions made at previous stages as better and more detailed information becomes available.

There are five key steps to implementing an adaptive management approach to monitoring NCD's, which are summarized in Table 1.1.

Table 1.1: Steps to an adaptive management approach (adapted from MNR and WSC 2002).

Step 1	Define the project goals in simple terms, as a framework for determining what the monitoring performance criteria should be.
Step 2	Based upon the project goals, determine what the specific monitoring requirements are, and what the spatial extent of the monitoring should be.
Step 3	Choose appropriate monitoring methods to assess project goals, and determine what the performance thresholds will be for the parameters being assessed.
Step 4	Conduct the monitoring program, and evaluate the data against the pre-defined performance thresholds. Determine if the results are acceptable, or if further refinements need to be made to delineation of performance thresholds or overall monitoring design. It is important to determine whether unacceptable results are a product of design malfunction or inappropriate performance criteria.
Step 5	Modify and redefine the monitoring program as necessary, and continue monitoring the project until there is satisfaction that the project is performing at an acceptable level.

During the initial period following project construction, standard methods are required to characterize and evaluate the performance of an NCD, relative to project goals and expectations for the design. But, there is a fundamental underlying expectation that over the long-term NCD's will replicate natural form and function. Therefore, NCD monitoring is finite; once a designed channel has become established and natural processes are being maintained, post-construction monitoring methods become less relevant. Instead, efforts can be focused on using watershed-scale indicators to monitor the on-going function of the channel as an integrated part of the natural system.

1.2 Rational and Objectives

Although NCD practices have been utilized for over a decade throughout North America, southern Ontario and the GTA, there has been limited comprehensive monitoring of the installed designs. As such, there has been limited assessment of the numerous design approaches, or detailed quantitative post-construction monitoring and subsequent evaluation of the success and performance of these works (Kondolf and Micheli 1995; Ness and Joy 2002). Without baseline data, or a standardized method for monitoring and evaluating NCD's, it is difficult to measure success, evaluate design methods or improve the state of the science. The literature and regulatory agencies have called for an initiation of comprehensive monitoring programs, but there has not been an appreciable response to date.

The TRCA has responded to this deficiency by initiating a program to catalogue, monitor and evaluate the NCD's in its jurisdiction, and eventually the GTA. A key component of the program is to develop a standardized NCD monitoring protocol to apply to all new watercourse realignment projects involving NCD principles in the TRCA jurisdiction. This report provides that protocol, with consideration for future integration with the ongoing TRCA Regional Monitoring Network (RMN). From a review of previously installed NCD's in the TRCA jurisdiction, it is evident that design criteria and methodologies varied, but there were also common goals and design themes underlying each project (e.g. increase channel stability and improve aquatic habitat). To address the issue of variability in project objectives and design, a standardized protocol outlining minimum monitoring requirements was developed to be used as a toolbox for application on a project-specific basis.

In southern Ontario, most stream channel restoration works involve a review under the federal *Fisheries Act*, and a subsequent authorization from the Department of Fisheries and Oceans (DFO) detailing required compensation measures and monitoring activities. Methods for monitoring are not typically specified in detail in authorization documents, resulting in application of varying monitoring methods that may or may not meet the standards of the various regulatory review agencies or that may not be adequate to support the adaptive management process. By implementing a standardized NCD monitoring tool-kit, compliance with regulatory monitoring requirements can be made more predictable and efficient for both the proponent and the regulatory review agencies.

The four key goals of the monitoring program are to:

1. Provide a standardized tool kit for NCD monitoring in the TRCA jurisdiction, incorporating geomorphic, ecological, engineering, water quality and social considerations.
2. Provide a tool kit for assessing the effectiveness of current NCD projects and techniques.
3. Provide a standardized information base from which to learn about the effectiveness of installed designs and evaluate the state of the science.
4. Complete the adaptive management loop.

There have been several studies that have evaluated the performance of habitat enhancement projects (Shields *et al.* 1995; Gortz 1998; Shields *et al.* 2001; Opperman and Merenlender 2004), but there have been few evaluations of NCD projects. A review of monitoring and evaluation activities was undertaken to determine which parameters are commonly measured and what techniques have been employed. In general, it was found that some studies provided valuable information as to what measures were effective and how the overall NCD improved biological, chemical and physical components of the stream corridors. However few studies provided details of sample replication, statistical design or quantitatively tested results.

Most monitoring protocols for streams have been designed for natural channels and do not consider newly constructed channels. Many do not account for construction impact to vegetation and time needed to re-establish riparian vegetation. Most do not specifically gauge success of bioengineering elements and/or identify mechanisms for NCD failure. Existing stream assessment protocols may not be completely appropriate for monitoring newly constructed NCD's, as quality of terrestrial habitat, riparian cover, and channel stability are influenced by the initial immature development of vegetation and soil horizons, lack of hydraulic sorting/compaction and limited colonization of aquatic organisms. It should be noted that monitoring and evaluating the effectiveness of NCD's requires not only characterization of the system but also an evaluation of initial performance. Therefore modification to conventional monitoring protocols for natural streams was required.

In development of this protocol, a thorough literature review was conducted to determine the current state of knowledge regarding monitoring of NCDs and other restoration projects, and practice regarding monitoring methods and techniques. A review of the TRCA RMN protocols and the Ontario Stream Assessment Protocol was also included to assess the applicability of these methods for evaluating NCDs, to ensure that existing protocols were utilized in an efficient manner where applicable. Furthermore, by using existing protocols where possible, data sets may be available for incorporation into long-term evaluation of trends over time.

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

The literature review was conducted to document the current state of NCD monitoring science, and determine which indicators are meaningful, affordable and repeatable for monitoring and evaluating NCD projects. An effective method is one that provides the most quantitative information while balancing time and financial constraints. It is important that indicators be sensitive enough to show change, be measurable and detectable, and have statistical validity (FISRWG 2001). The number of indicators included in a monitoring plan is dependent on the scale and objectives of the NCD project, as well as time and cost constraints of the monitoring program.

From the literature review, it is apparent that limited detailed or quantitative post-construction monitoring and subsequent evaluation of the success and performance of NCD projects occurs (Kondolf and Micheli 1995; Ness and Joy 2002). Without a standardized method for monitoring and evaluating NCD's, it is difficult to measure success, evaluate design methods or improve the state of the science. Most of the literature agrees that monitoring is important, but the methods and techniques described are largely conceptual in nature. It has been suggested by Wissmar and Beschta (1998) that an effective restoration project, and specifically NCD projects, require: i) clear restoration objectives; ii) pre-construction baseline data; iii) project design that recognizes natural processes and functions (geomorphic and ecological); iv) long-term monitoring; and v) willingness to learn from successes and failures. A series of objective defining questions were proposed:

> **What** physical and biological factors presently limit riparian populations and communities?
>
> **What** geomorphic and hydrological regimes have been historically modified and presently limit the connectivity of riparian and aquatic ecosystems?
>
> **What** native riparian species have been extirpated or displaced?
>
> **What** exotic plant species have invaded the riparian system?
>
> **What** geomorphic and hydrological regimes provide the most favourable future physical habitat and biological conditions?
>
> **What** are the target species or desired future riparian communities?
>
> **What** are the expected recovery times and successional patterns for the riparian communities?

Gillilan *et al*. (2005) found that misuse of the term restoration, failure to create guiding images, and lack of commitment to monitoring, were factors limiting effective ecological restoration. To remedy the misuse of terminology, it was recommended that the specific project be placed in a project type continuum (Figure 2.1). By doing so, practitioners can become aware of restoration projects and how they differ from enhancement or erosion control or containment. The guiding image is a vision of the future state of the watercourse and stream corridor, and should consider the condition of key natural system variables (hydrology, chemistry, geomorphology, physical habitat and biology). Once the guiding image, goals and objectives are defined then evaluation criteria can be developed to measure the success of the restoration.

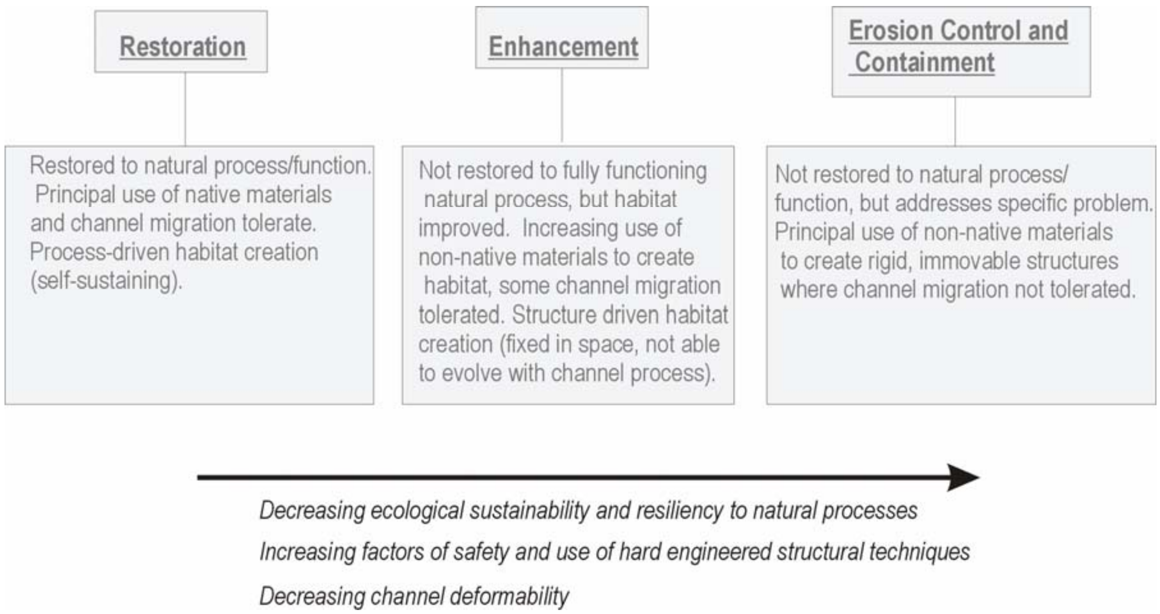

Figure 2.1: Geomorphic restoration project type continuum (*from* Gillilan *et al*. 2005).

2.1.1 Review of Monitoring Protocols Used by TRCA

Components of the Toronto and Region Conservation Authority (TRCA) Regional Monitoring Network (RMN – TRCA 2001) protocols and the Ontario Stream Assessment Protocol (OSAP – Stanfield 2005) were reviewed to assess their applicability for evaluating NCD projects. In general, the RMN and OSAP protocols are simple, systematic, and science-based with reproducible methods for assessing natural channels. However, the geomorphic components of the protocols outlined in the RMN and OSAP are not always the most appropriate procedures for assessing NCD's in easily accessible urban areas. The RMN and OSAP protocols were developed for alluvial channels where remoteness, forest cover, limited equipment or staff sophistication and limited budgets may be controlling factors.

Components of the RMN include aquatic habitat and species, fluvial geomorphology, terrestrial natural heritage, flow and precipitation, and surface water quality. The objective of the RMN is to provide indicators to measure environmental change at the broad watershed and subwatershed levels to be analyzed and used to guide environmental management decisions. The RMN is specifically designed to assess environmental indicators at broad levels to assess cumulative impacts (positive and negative) over time and is not intended for monitoring small-scale projects (TRCA 2001). Objectives for NCD are usually focused on features and functions specific to aquatic systems, therefore some components of the RMN were not applicable to monitoring NCD's, and not included as part of this literature review.

Although it is difficult to quantify NCD success, themes for measuring success can be defined. In all cases, some measures of dynamic stability and habitat value can be made. One potential measure of channel stability is pass-through of sediment. Assuming the channel is in equilibrium, sediment entering into the modified reach should equal sediment exiting out. This is a fundamental concept with regard to equilibrium channels. Although cross-sections, long-profiles, erosion pins and other geomorphic measures outlined in the RMN protocols provide an appreciation of channel sediment dynamics, they do not allow for quantification of total sediment deposition. In the end, an appreciation of sediment transport may be all that is required.

A geomorphologic monitoring program for NCD projects should quantify systematic adjustments and characterize the factors that impact future channel stability. These factors include channel geometry, composition of surficial and sub-pavement sediments, type and strength of bank materials, bank and floodplain vegetation and any prescribed detailed design elements. The RMN protocol fulfills most of these requirements.

Habitat assessment and biotic community sampling procedures outlined in the RMN are derived from the OSAP. These methods follow standard procedures for assessing habitats and collecting and analyzing benthic invertebrate and fish assemblages. Methods outlined in these protocols are adequate to characterize habitat of natural channels and evaluate the performance of NCD's in terms of habitat and community benefits. NCD project goals and objectives need to be reviewed to determine the degree of biological studies required. For projects that require authorization under the federal *Fisheries Act*, Department of Fisheries and Oceans (DFO) monitoring requirements often determine the spatial extent, sampling frequency and sampling locations for biological monitoring.

Additional OSAP methodologies are available for identifying sites, evaluating physical habitat and documenting water temperature in wadeable streams (Stanfield 2005). The methods presented are repeatable, scientifically defensible, and can be used for monitoring or impact assessment studies, dependent upon which modules are selected. The methodologies are categorized into three levels: screening surveys, assessment surveys and diagnostic surveys. The level of survey required is dependent upon the variables being measured and the level of detail required to evaluate project objectives. Quantitative and qualitative methods are provided for the assessment of channel structure, physical habitat, substrate quality, habitat homogeneity and stream width.

Watershed characteristics upstream from a project area generally have a greater influence on water quality than local NCD projects. Moreover, the dynamic characteristics of water quality parameters (e.g. diurnal fluctuations in stream temperature, dissolved oxygen, etc.) make it difficult to accurately evaluate the site-specific influences. Nevertheless, some evaluations of NCD's have shown a positive influence on water quality parameters (Harrington 1999). Basic water quality monitoring can be undertaken to assess in part, the NCD project and overall subwatershed characteristics as part of regional monitoring efforts. Water quality parameters outlined in the RMN can be used to characterize conditions at NCD sites where an objective of the design was to improve water quality, or the scale of the project is large enough to reasonably expect an improvement to water quality. These parameters are easily sampled and do not require extensive field or laboratory analyses compared with the more rigorous analyses for organic and metal compounds.

In summary, a number of components of the RMN and OSAP protocols were of direct value for use in development of a standardized NCD monitoring program. Fluvial geomorphological methods were adapted from the RMN, with modifications in areas of rapid assessments and sub-reach habitat mapping. Water chemistry and public opinion surveys methods were taken directly from the RMN. The OSAP was used for monitoring aquatic habitat, fish communities and benthic macroinvertebrates. Details of the monitoring methods are provided in a separate report in this series entitled *"Evaluating the Effectiveness of Natrual Design Projects: A Protocol for Monitoring New Projects"*.

2.2 General Monitoring Considerations

Several authors argue the need for integrated stream assessment protocols to understand, monitor and predict stream ecosystem behaviour and response (e.g. Clar *et al*. 2004). A review of the literature suggests that there are several established protocols for monitoring biological and chemical components, but there is no comprehensive protocol for monitoring all aspects of NCD's. Several authors advocate that NCD monitoring should include an assessment of fluvial geomorphology, engineering, hydrology, aquatic and terrestrial biology, water quality, and social and economic indicators (Kondolf and Micheli 1995; Downs and Kondolf 2002). This list is inclusive, but should be rationalized with the scale, goals, and targeted value of the NCD. Also, field measures need to target variables that are potentially modified by the NCD and eliminate regional or watershed scale variables that are independent from or unrelated to the NCD and project goals and objectives.

Most existing stream monitoring protocols have been designed for natural channels and are not well suited to assess the form and function of newly constructed channels. These diagnostic protocols typically do not have allowances for short-term construction impacts and delays in re-establishment of system function. Quality of aquatic habitat, riparian cover, and channel stability evolves over time after installation of a NCD, as new soil horizons develop, hydraulic sorting and compaction occurs and aquatic organisms re-colonize the area. Moreover, monitoring protocols for natural streams are not designed to evaluate constructed bioengineering and other channel design elements.

2.2.1 Timing of Monitoring

A review of stream restoration monitoring programs found that most did not exceeded two years of follow-up (Downs 2000; Downs and Kondolf 2002). However, it is generally agreed that monitoring should take place for at least five years and include monitoring after large flow events at or above the bankfull stage (Kondolf 1998; Slate *et al.* 2004). Kondolf and Micheli (1995) suggest ten years as the minimum period for evaluating project performance to assess the influence of major flood events and the long-term sustainability of the project; although this may not always be financially feasible. Concerns have also been documented regarding a lack of monitoring immediately following construction when vegetation has not yet become established (Slate *et al*. 2004). This is an essential monitoring period given that typical summer storm events in southern Ontario and resultant major channel adjustments are likely to occur shortly after NCD construction. It is recommended that monitoring be conducted before project construction, immediately after construction, and periodically afterwards for 5-10 years (Kondolf 1998). Monitoring does not need to be continuous during the 5-10 year period but should evaluate channel adjustments immediately after construction and after large flood events (Kondolf 1998).

The FISRWG (2001) suggests that minimum monitoring frequencies are dependent on the time since project construction. A single, annual monitoring effort is considered sufficient for established restoration projects, but intensive quantitative data should be collected during the first three years after construction. After this period, the objectives, scope and monitoring duration may change to reflect maintenance needs, rather than to monitor success criteria. Initially, a 3-year monitoring period is suitable for identifying design corrections to address any problems that may have arisen during construction. However, the overall monitoring timeframe must account for the life-span of the project.

2.2.2 Baseline Data

Baseline data are typically collected at the project site or from a reference reach that is considered to be reflective of pre-disturbance conditions, to establish targets for measuring the success of NCD projects (Downs 2000). Unfortunately, reference reaches are commonly influenced by upstream land uses and other watershed-scale impacts and generally do not often reflect pre-disturbance conditions (Kondolf 1998). To account for this, Downes *et al*. (2002) recommend sampling from both *Impact* and *Control* locations during both the *Before* and *After* periods (BACI design). The control site should be in close proximity to the study area and be influenced by similar land use, riparian vegetation, channel network and historical conditions but not project construction. The impact site is considered to be the location of the NCD project. Using this approach the effect of natural and anthropogenic activities on the measured variables can be determined. It is argued that this method allows for multiple or replicate control and impact sites to be used to deduce natural variability, variation among samples and the spatial extent of change or improvement from NCD projects (Downes *et al*. 2002).

Saldi-Caromile *et al*. (2004) recommend the following to be included in baseline and construction data collection:

- Establishment of permanent benchmarks
- As-built surveys to document design configuration relative to permanent benchmarks
- Summary of site hydrology
- Documentation of aerial photography, summary of erosion history and other geomorphic data pertinent to project design
- Documentation of pre-project site and reach data pertaining to fish and wildlife use, riparian corridor, floodplain function and overall habitat condition

2.2.3 Spatial Extent of the Study

The spatial extent of the study site can be determined with the use of reach delineation. It is suggested that delineation of a reach consider planform, gradient, hydrology, local surficial geology, physiography, and vegetative/land cover control (Montgomery and Buffington 1997; Richards *et al*. 1997). Ideally, the monitoring reach should encompass the NCD project, and include a non-impacted section of stream close to the project area. However, in some cases, the monitoring will have to incorporate control areas outside of the study site.

The reach delineation approach fits well with the BACI monitoring design described above (Downes *et al*. 2002). The goal of the BACI design is to limit variability between the control and impact sites so that the variables influencing the impact site can be identified. The control and impact sites are placed within the defined reach. Monitoring should be implemented at non-random sites targeting important or characteristic cross-sections, bioengineering design elements and habitat features of both the NCD and control sites.

2.2.4 Sample Size

Large numbers of samples increases sampling and processing time and associated costs. Therefore, increasing confidence in statistical analysis while reducing time and costs needs to be balanced. Davis *et al*. (2001) recommend that a minimum of 5 replicates be sampled when statistical analyses are to be performed.

2.3 Monitoring Methodologies

To monitor and evaluate the effectiveness of NCD projects, measurements of geomorphic characteristics are emphasized in the literature since channel and floodplain geomorphology provides for aquatic and riparian structures and functions (Kondolf and Micheli 1995; Downs and Kondolf 2002). Scholz and Booth (2001) suggest an emphasis on physical measurements because: I) physical effects such as high flows produce the most severe impacts to watercourses; II) monitoring techniques for biological studies are well established; and III) physical measurements are relatively simple and inexpensive compared to chemical and biological assessments. Chemical and biological monitoring protocols are well established (e.g. Plafkin *et al*. 1989, Kerans and Karr 1994) but less so for geomorphic assessments. This is due in part to the complexity of channel conditions and the wide array of channel assessments and monitoring techniques available (Montgomery and MacDonald 2002).

There are several stream monitoring protocols in existence that offer various methods for monitoring many attributes in natural streams. Many of these attributes are useful for monitoring NCD's, and have applicability for the southern Ontario context.

It has been suggested that geomorphic components of NCD monitoring should include a compliance audit, related to the design intentions, a performance audit of the short-term functioning of the system and a geomorphic evaluation of long-term processes (Downs 2000). Figure 2.2 outlines a framework for monitoring NCD's with a long-term goal of geomorphic evaluation. The compliance audit involves review of background information and drawings related to NCD design and construction to assess the installed NCD compared to the designed NCD. It is recommended that design alterations made during construction as part of field-fitting be noted, as they may not appear in the design drawings which could lead to an interpretation of poor installation. The performance audit evaluates the NCD after construction to determine NCD functioning over a period of time. Audits should include quantitative and qualitative monitoring assessments to compare to previous monitoring or pre-construction baseline data. Downs (2000) supports the use of long-term geomorphic evaluations to gather information on the long-term sustainability of the design. This involves examining geomorphology-hydrology relationships (as opposed to geomorphology-hydraulic relationships) by using principles of sediment transport continuity set against the long-term flow record. Although not currently available as a tool to monitor NCD's, sediment transport and flow depths can be predicted using empirical equations, provided these equations are calibrated to predict channel forms in NCD's.

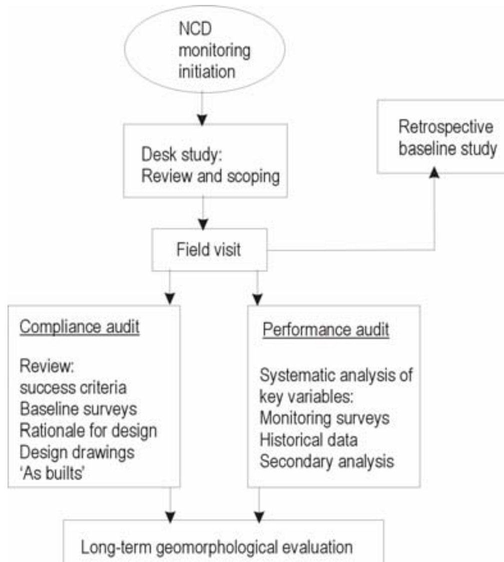

Figure 2.2: A framework for monitoring NCD (*from* Downs 2000).

The Ministry of Natural Resources and the Watershed Science Center of Ontario have jointed produced a document entitled *Adaptive Management of Stream Corridors in Ontario* (2002), containing a section on Monitoring, Evaluation, and Long-term Adaptive Management. In it, the adaptive management process is summarized as is relates to monitoring of streams and restoration projects.

A nine-step approach is put forward by the MNR and WSC, outlining the process from goal setting to re-evaluation of monitoring design (Figure 2.3). The approach is designed to facilitate effective monitoring, and provide a means by which the science and practice of stream management can be advanced. Essentially, stream restoration projects are to be considered as well-structured experiments, by which practitioners can learn more about common problems and hypothesize above future design improvements. In viewing stream restoration in this way, allowances are given for learning, improving, and ultimately better managing the stream resource.

The first step in the adaptive management approach is to define the goals of the monitoring program. In doing so, project goals and objectives are made clear, and the scope of monitoring interest is identified. Following that, specific monitoring questions are developed. These questions are intended to address the goals and objectives identified in step one, and aid in determining the spatial extent of monitoring required. The third step is to design the monitoring program and select appropriate methods to evaluate project performance. At this point, performance thresholds are determined, against which the monitoring data will be compared. The performance thresholds are related to the project-specific goals and objectives, and are part of an iterative review process themselves. Once monitoring methods are selected, the evaluation is carried out and the results are interpreted using the performance thresholds identified. A decision is made on whether or not the results are acceptable, and further refinements to the performance thresholds or overall monitoring design can be made as necessary. Lastly, the modifications to the monitoring program are implemented, and the process repeats itself again.

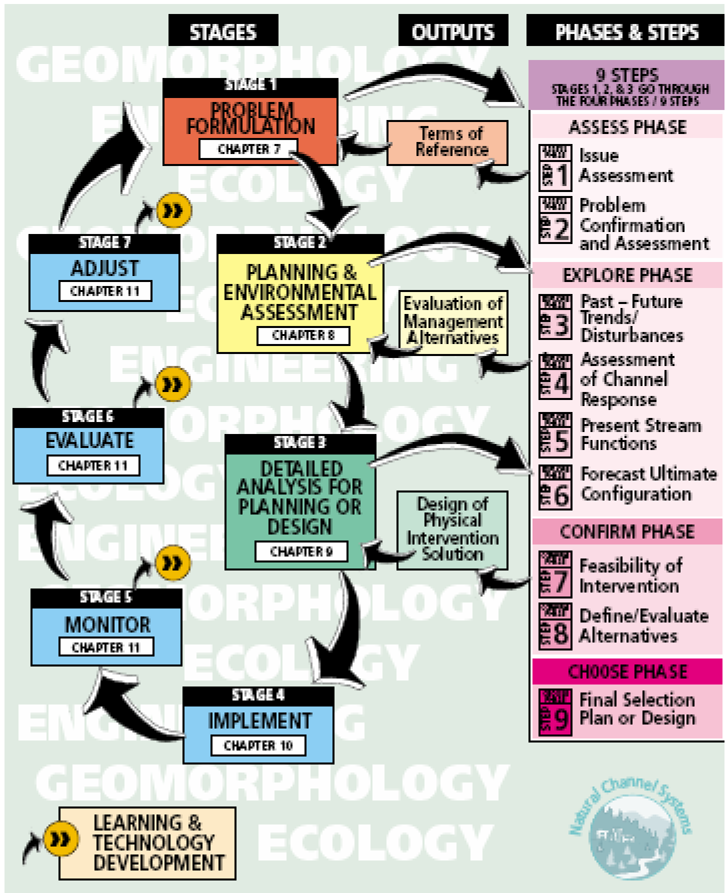

Figure 2.3: Nine-step adaptive management process (*from* MNR and WSC 2002).

The most important component of the monitoring process occurs when the results are evaluated and relative success of the project is determined. This information provides guidance on maintenance requirements, and informs the practitioner as to how the project functioned relative to the original plan. This component closes the loop in the adaptive management process and provides valuable information to move forward on the understanding of the science and practice of stream corridor management and restoration. Stream restoration projects are inherently experimental, in that it is acknowledged that they will likely require maintenance or modification at a later date, as the system moves towards dynamic equilibrium. Monitoring is the only means by which such adaptive projects can be implemented with confidence and accountability.

2.3.1 Geomorphic Assessments

2.3.1.1. Site Characterization

Reach sketch maps provide important site characterization information if repeat visits are to be made. Prominent features such as roads, trees and large boulders are included for future observers to locate the site, survey pins and benchmarks (Harrelson *et al*. 1994). An approximate scale, legend and coordinates should be included as well as cross-section and sampling locations (Stanfield 2005). A well-drawn sketch map can provide valuable information on the general characteristics of a site and can assist in evaluating change over time (Harrelson *et al*. 1994). Most importantly, the reach sketch map provides information on both geomorphic and habitat components in a way that highlights the functional integration of these features.

Geomorphologists and ecologists assess physical aquatic habitat using methods that have resulted in a research intersection between *bottom-up* and *top-down* approaches (Newson and Newson 2000). Simply stated, geomorphic studies generally evaluate channel form and stream hydraulics in an attempt to predict physical habitat (e.g. Statzner *et al*. 1988), whereas ecologists study physical characteristics to support functional habitat definitions (e.g. Kemp *et al*. 1999).

The bottom-up approach used by geomorphologists assumes that form dictates function and that habitat and organism diversity is a product of morphological variability. Statzner *et al.* (1988) coined the term hydraulic stream ecology to describe the interrelationships between stream velocity, depth and substrate in order to predict benthic invertebrate and fish assemblages. Ecologists typically view physical habitat from a top-down perspective where assessments of biota and qualitative measures of habitat are related to simple physical characteristics. Terms such as *functional habitats* have been used to define habitat types but are generally not related to hydraulic or geomorphic conditions (Kemp *et al.* 1999). They examined functional habitats with depth and velocity measurements and found that each habitat was generally associated with distinct depth-velocity conditions. However, there was no consideration of channel forming flows and their influence on habitat conditions.

Sub-reach habitat mapping has been advocated for assessing the quality of aquatic habitat. Formalized approaches such as mapping hydraulic units (Thomson *et al.* 2001) and biotopes (Newson and Newson 2000) can be incorporated into sub-reach maps. Hydraulic units are defined as patches of uniform flow and substrate, and biotopes are the equivalent of geomorphic units (i.e. pools, riffles, runs) at the sub-reach scale. Including such integrative measures of morphology and habitat provides adequate description of channel stability and physical habitat. Also, sufficient information is collected to allow monitoring over time. Sub-reach habitat mapping that includes hydraulic units, substrate and biotopes provides a comprehensive interpretation of channel form and function.

2.3.1.2. Surveying

Given that NCD's are in a period of adjustment immediately after construction, surveying is required to document channel form and as-built conditions. Typically, channel geometry is measured with monumented cross-sections and longitudinal profiles. An experienced field crew, reliable survey equipment and surveys tied to benchmarks are necessary for repeatable and consistent data. Harrelson *et al.* (1994) provide excellent descriptions of applied techniques applicable to monitoring NCD's. High resolution techniques may also be used, such as high-density topographic surveys for defining and monitoring natural stream channels (Lane and Chandler, 2003). Less established vegetation, convenient access and available survey benchmarks in urban settings provide an opportunity to utilize more sophisticated and detailed methods. These methods typically result in improved accuracy and precision of the data.

Kondolf and Micheli (1995) advocate the use of monumented cross sections to evaluate channel form, and allow for sample replication. Monumented cross sections can also incorporate measures of aquatic habitat and riparian vegetation (Kondolf and Micheli 1995) although additional cross sections may be necessary to appropriately evaluate these indicators. 10-15 cross-sections are recommended, located two to five channel widths apart (e.g. Sear and Newson 2004). Replicates of similar morphological units (e.g. riffle, pool, run, transition, glide) should be used to represent the morphology of the study reach (Kondolf and Micheli 1995). A minimum of twenty sample points are recommended for each cross-section, including the deepest point of the channel, bottom of bank, top of bank and bankfull stage (Annable 1999).

Bankfull width and depth measurements are primary variables for relating channel size to watershed parameters such as area, flood frequency or level of development (Harrelson *et al.* 1994). The bankfull width is a measure of the width of the stream at the point where it tops its banks and spills onto the floodplain. In urban environments, streams are often disconnected from the floodplain or entrenched. In these situations breaks in slope, change in bank vegetation or bank erosion can indicate where the high flow mark.

Longitudinal profile surveys provides accurate information on pool depth, riffle gradient and overall channel gradient and can document the type and rates of change occurring. Surveying equipment is used to measure bankfull elevations, maximum pool depths, riffle elevations, and any obstructions to flow. The length of survey is recommended to be 10-20 times the bankfull width of the stream (Annable 1999).

2.3.1.3. Photographs from Fixed Vantage Points

Photographs from fixed vantage points are an ideal method to qualitatively document and monitor channel adjustments, bank erosion, success of riparian vegetation and the effectiveness of in-stream structures and erosion-control measure (Doll *et al.*, 2003). Ideally, photographs should be taken from the same vantage at the same time of year to provide the most accurate comparison. It is also important to document bioengineering and restoration plantings at an appropriate season. Harrelson *et al.* (1994) provides a methodology for tying site photographs into a benchmarked survey.

2.3.1.4. Erosion Assessment

Erosion pins can be installed along meander bends as well as along straight sections of channel to provide comparison of change over time and erosion rates (Harrelson *et al.* 1994). Generally, a 1-m length of rebar is driven horizontally into the bank leaving approximately 10 cm exposed (Harrelson *et al.* 1994). Use of erosion pins provides accurate point measurements, while surveys provide less detail but an overall view of the design.

Scour chains and depth of disturbance rods can be used to measure scour in coarse and fine sediment environments, respectively (Harrelson *et al.* 1994). A chain is attached to a pin at a buried depth where scour is not anticipated. The length of chain found on return field visits indicates the depth of sour over the time period (Harrelson *et al.* 1994). The wiffle ball technique is a modification of the scour chain method. Multiple scour events can be monitored without having to replace monitoring devices. Numerous wiffle balls are attached to a rod at equal increments and the rod is installed into the streambed. During scour events, material is removed and wiffle balls float to the water surface allowing determination of scour depth. Both scour chains and wiffle balls are used in scientific studies where short-term or storm-event data are collected. They are not suitable techniques for long-term monitoring.

2.3.1.5. Bed Material Size Distribution

Surficial sediments can be sampled using pebble counts to characterize bed conditions and particle size distributions (Wolman 1954). Pebble counts can be used to estimate grain roughness, predict bed mobilization thresholds, assess framework size of spawning gravels, and track changes in surficial sediment. The OSAP prescribes pebble counts at equal intervals based on channel dimensions whereas the RMN protocol prescribes counts at equal distanced cross-sections within geomorphic units (pools, rifles, runs) to ensure measurement of multiple habitat types. Another pebble count technique is the zigzag method that mixes sample points from a number of habitats. This technique has not been found to provide an adequate sample size or a repeatable procedure (Kondolf 2000). A thorough review of numerous methods for sampling particle size distributions in gravel and cobble-bed streams are summarized in Bunte and Abt (2001).

Visual estimates of grain size have been well documented in numerous studies of physical habitat (e.g. Plafkin *et al.* 1989). They are simple and cost-effective but do not allow for quantifiable or repeatable measures. No literature was found to indicate that such subjective measurements could be reproducible between observers (Kondolf and Piegay 2003).

Kondolf and Piegay (2003) suggest that combining facies maps with pebble counts provides an overall context of sedimentary units with specific grain size distribution data. A facies map categorizes sedimentary deposits that have similar grain size and/or sedimentary structure that represents a distinct local depositional environment. It provides an accurate description of current conditions, baseline data for measuring future change, and a basis for comparing sediment characteristics among channels, but less detail than pebble counts over a wide area (Kondolf and Piegay 2003). It is useful for integrating measures of geomorphology and aquatic habitat.

Bulk sampling for fine sediments is not necessary when examining gross features and facies. This technique is more appropriate for sediment transport modeling projects.

2.3.1.6. Rapid Assessments

Numerous rapid assessment methods exist to evaluate stream health and the form or function of physical, chemical or biological components. All rapid assessment methods assume that an established riparian zone is a measure of stream stability. The MOE (1999) Rapid Geomorphic Assessment (RGA) documents indicators of channel instability, and types of systematic adjustments occurring in the system (e.g. widening, planform adjustment). This provides insight into stresses from alterations in sediment and flow regime). The Galli (1996) Rapid Stream Assessment Technique (RSAT) ranks in-stream habitat, water quality, riparian conditions, and biological indicators. Along with these assessments, rapid measurements of bankfull channel dimensions, type of substrate, vegetative cover, channel disturbance, areas of erosion and other observations are included. With NCDs, rapid assessment of stability is problematic with regard to newly planted riparian vegetation not functioning as an established community.

The Adopt-A-Buffer Toolkit provided by the Delaware Riverkeeper Network (2003) is a potentially useful tool for performing rapid assessments of newly constructed projects. The methods outlined for the plant survey are suited to recently installed restoration plantings; however the implementation details may not be appropriate for the southern Ontario context, and may require calibration for local use.

2.3.2 Bioengineering Elements

Generally, bioengineering is used in NCD to increase bank stability, provide aquatic habitat and limit hazards associated with channel migration. An evaluation of these elements for habitat provision can be done by comparing the distribution and quantity of in-stream habitat before construction with after-construction data. The OSAP describes methodologies to quantify and classify in-stream habitat by quality and type (Stanfield 2005). Changes in amount, distribution and quality of habitat can be determined spatially and temporally.

Measurements of vegetation survival associated with bioengineered structures can be made using plots or direct counts (Doll *et al*. 2003). Stem-counts and photographs can document existing vegetation and be compared with upstream reference conditions. It is recommended that 10% of the bioengineering elements be surveyed, using sampling plots that are repeatable and tied into a benchmarked survey. Sampling should be conducted during the growing season and monitoring of vegetation survivorship at meander bends is critical (Doll *et al.* 2003).

Wilson *et al.* (2002) describe a method for evaluating in-stream, off-channel and fish access restoration using a four-point ranking scale contrasting present conditions relative to project objectives. Rating intervals are: 1 – failure to meet objectives; 2 – poorly meeting objectives; 3 – adequately meeting objectives; and 4 –beyond expectations of meeting objectives. Rankings are made for both physical and biological components of in-stream and channel rehabilitation projects, similar to methods by Koning (1999). Most ranking schemes have been developed for mountain environments, therefore using a semi-qualitative assessment approach may be the best alternative until success criteria are developed for local conditions.

2.3.3 Riparian Conditions

Linkages between riparian and aquatic habitats are important characteristics of stream corridors, and are often considered as design elements of NCD's in floodplain areas. To assess the function and effectiveness of stream corridors several parameters need to be measured, including habitat type, width, length continuity and character of surrounding lands (Stephenson 1999).

Winward (2000) describes sampling methods for monitoring riparian vegetation that measure vegetation cross-section, greenline composition and woody species regeneration. A minimum of five cross-sections are randomly positioned perpendicular to the stream flow and the dominant vegetation types are recorded. The data are compiled to determine percent composition for each community type. The greenline is defined as the first perennial vegetation that forms at the water's edge. Winward (2000) argues that evaluating this vegetation composition can provide indication of the general health of the riparian area, as well as the current strength of the stream banks. The dominant vegetative community type is recorded along the greenline, and woody species are recorded based on age class and height of the plant. Riparian assessment procedures by Koning (1999) provide indicators for monitoring vegetation, including measurements of tree and shrub survival, growth in target trees, tree height, stem diameter at specific height, leader growth and bud size, canopy cover and evidence of disease, animal damage and windthrow. A monitoring assessment of riparian conditions can also be used to determine what maintenance repairs are necessary for a NCD project.

The Adopt-A-Buffer Toolkit provided by the Delaware Riverkeeper Network (2003) is a potentially useful tool for performing surveys of recently installed restoration plantings. This method documents percentage of plantings that are alive/healthy, status of live stakes, damage to plants, and documents invasive plant species. Implementation may require calibration for local use.

Riparian conditions are also assessed as part of the OSAP point-transect sampling methodology. Dominant vegetation community types are recorded at each transect, and a bank grid is used to assess the extent of rooted vegetation within 1 m of the banks (Stanfield 2005). These measures are used to evaluate riparian vegetation type and density. The OSAP also provides methods for evaluating stream temperature in the context of thermal suitability for varying fish communities. Pre- and post-construction monitoring of stream temperature upstream and downstream of the project site can be used as an indicator of riparian vegetation shading effects, and success of the NCD design in providing conditions suitable for target fish communities.

Ecological Land Classification (ELC) is a vegetation community description tool to systematically categorize vegetation communities of southern Ontario (Lee *et al*. 1998). It is a province-wide ecological classification scheme that describes and inventories plant communities at various scales. The ELC would be useful for classifying the vegetation within riparian zones and developing plant lists for areas of interest. The ELC has limited value for assessing riparian vegetation in newly planted restoration areas, as it is designed for classification of established vegetation communities that change over long periods of time. ELC may be useful for documenting pre-construction conditions and reference reach conditions as part of developing restoration targets.

2.3.4 Aquatic Conditions

2.3.4.1. In-Stream Habitat

There are several stream monitoring protocols in existence that assess aquatic habitat in varying ways. Of these protocols, the Ontario Stream Assessment Protocol (OSAP – Stanfield 2005) is the most relevant to the southern Ontario context, and is used as part of the TRCA Regional Monitoring Network. Therefore, measures of in-stream habitat from the OSAP are practical for incorporation into a NCD monitoring protocol.

The OSAP contains a series of standardized methodologies for identifying sampling sites, evaluating benthic macroinvertebrate communities, evaluating fish communities, measuring physical habitat in wadeable streams. Multiple methods are presented for each section, varying in amount of effort required and interpretations that can be made of the data. The sections pertaining to physical in-stream habitat focus on measurements of channel structure, channel processes, and habitat suitability for biota. As many of these variables are typically measured during fluvial geomorphic studies, there may be significant overlap in data if the OSAP methods are adopted wholesale in a NCD monitoring protocol. Therefore, it may be more appropriate to include only portions of the OSAP methods for physical habitat, to integrate with geomorphological measurements.

2.3.4.2. Water Quality

Benthic invertebrates are a widely used bio-indicator of water quality and aquatic ecosystem health because sampling and identification is inexpensive and simple (Resh *et al.* 1995; Whiles *et al.* 2000). Benthic invertebrates are less mobile than fish and may be more responsive to watershed-scale influences than diatoms (Chessman *et al.* 1999). The U.S. Environmental Protection Agency's Rapid Bioassessment Protocol (RBP) (Plafkin *et al.* 1989) and the Benthic Index of Biotic Integrity (B-IBI) (Kerans and Karr 1994) are examples of bioassessment approaches that use biological measures of benthic invertebrate communities. The most common usage of the RBP is below point sources, such as sewage treatment plants (Watzin and McIntosh 1999).

The OSAP describes a method for measuring the composition of benthic macroinvertebrate communities that is consistent with the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones *et al.* 2004). Based upon the varying sensitivities of the organisms collected an evaluation of biotic health is determined and inferences of upstream water quality can be made.

Chemical water quality monitoring can often be used in conjunction with biological monitoring. Water chemistry is often conducted after biological studies to determine the causal factors influencing the structure and function of benthic invertebrate communities. Laboratory analyses of water chemistry are expensive, and detailed assessments are often required to provide evidence of impact. As example, heavy metals may be influencing benthic invertebrate community structure and function, but they cannot be identified without water chemistry analysis. *In situ* water chemistry tests are often more practical compared with laboratory analyses and may include: water temperature, pH level; dissolved oxygen, conductivity, turbidity/opacity; suspended/floating matter; trash loading, odour, colour.

Provincial Water Quality Objectives (PWQO's) for Ontario are provided by the Ministry of Environment and Energy (MOEE) as a guideline for the protection of aquatic life and recreational uses (MOEE 1994). If chemical analyses are performed, the results can be compared with the PWQO numerical and narrative criteria, which are chemical and physical indicators of satisfactory conditions in surface waters (MOEE 1994).

2.3.4.3. Fish Community

A common anticipated response to NCD projects is an increase in habitat usage by fish. Measures of habitat usage by fish can be obtained by conducting a fish inventory within the NCD project area. The OSAP describes suitable methods for fish inventories employing electrofishing techniques to document fish community composition and relative abundance. Metrics such as Catch Per Unit Effort (CPUE) and species richness and diversity can be derived from the data to evaluate the NCD.

A fish community Index of Biotic Integrity (IBI) was adapted for southern Ontario by Steedman (1988). The IBI integrates 10 fish community metrics that result in a score of stream habitat quality. A change in score implies a change in the fish community and can indicate that a shift has occurred in fish habitat condition or characteristics. The IBI can be used to compare fish community metrics over time as NCD sites become established.

2.3.5 Social and Cultural Elements

Natural environments are important in both rural and urban landscapes for human recreation and enjoyment. Recreation may be as simple as visually stimulating experiences or more intensive such as swimming, canoeing, hiking, fishing and hunting (Harrington 1999). Aesthetic benefit of a NCD and recreational use by humans can be evaluated to monitoring public perception of project success.

The RMN describes a survey methodology implemented by volunteers to determine the overall aesthetics of watercourses with the TRCA jurisdiction. Sites are ranked with categories for water colour, water clarity, water odour and the presence of visible debris and litter. Data are converted to numerical index values and scored for the study area. The results provide information about public opinion that can be used to refine the design and monitoring processes. A more detailed survey of public viewpoints and expectations of a channel restoration project is described in Planck *et al.* (1999). A questionnaire was designed to determine the level of understanding and viewpoints of local residents with regard to a channel restoration project. Data were collected on demographics, education, and respondent use of the restored channel area. The authors found that the responses varied but the information gathered was useful in evaluating the NCD project.

2.4 Data Analysis and Evaluation of Project Success

Palmer *et al.* (2005) suggest that the most effective restoration projects lie at the intersection of ecological, learning and stakeholder success (Figure 2.4). Downs and Kondolf (2002) suggest that using an adaptive management approach allows for success to be defined in two ways. First, project success can be realized if a project achieves its goals or if the project provides a learning experience and/or improves the science of NCD projects. Also, NCD techniques can be improved upon and the relative costs and benefits of projects can be compared (Opperman and Merenlender 2004).

Figure 2.4: Effective restoration using ecological, stakeholder and learning successes.

Although Figure 2.4 provides a conceptual definition of success, criteria are required to evaluate restoration projects. Measures of success should be derived from pre-defined project targets. For existing projects where these targets are not available, general thresholds can be used (i.e. increase to overall channel length, increased variability in substrate, increased variability in channel morphology, etc.). Palmer *et al.* (2005) list five criteria for measuring success and Jansson *et al.* (2005) supply a 6th criterion (Table 2.1). From these criteria, a list of monitoring measures can be developed to assess the effectiveness of the restoration project at attaining the original goals.

Table 2.1: Criteria for evaluating NCDs (*from* Palmer *et al.* 2005; Jansson *et al.* 2005).

Criteria	Evaluation Guidelines	Indicators
Guiding Project Image	Consideration of key system variables (hydrology, chemistry, geomorphology, physical habitat and biology).	Project goals and objectives.
Conceptual Model	Details how the system works, how it is affected by environmental conditions, how it has been impaired, and how it may respond to restoration techniques.	Change in the system or causes of impairment, and mechanisms responsible for the change.
Ecosystem Improvement	Selection of indicators of ecological integrity specific to local and watershed conditions, and identification of stressors.	Channel stability, biotic integrity, biotic diversity, water quality, and aquatic/terrestrial habitat.
Increased Resilience	Documentation of maintenance requirements and capacity to recover from natural and anthropogenic disturbances.	Amount of maintenance required after channel construction and comparison with range of reference conditions values.
Impact Reduction	Assessment of impacts from channel construction.	Downstream deposition of fines, percent riparian vegetation damaged, degree of bank erosion, planting survival.
Ecological Assessment	Documentation of post-restoration monitoring with appropriate indicators.	Pre- and post-construction monitoring assessments.

Analyzing monitoring data is essential for evaluating a project’s success at achieving its goals and objectives, determining how key ecological indicators are responding, and providing information to improve future designs (Gaboury and Wong 1999). Kondolf and Micheli (1995) provide a conceptual process for evaluating a stream restoration project (Figure 2.5).

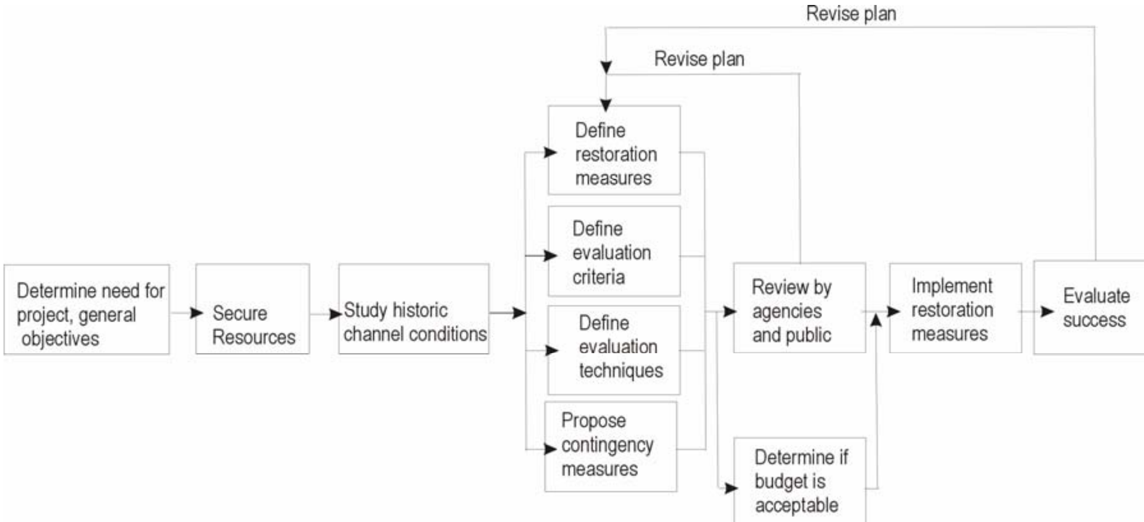

Figure 2.5: Conceptual diagram of stream restoration evaluation (*from* Kondolf and Micheli 1995).

2.5 Storage and Management of Data

Storage and management of data is an important component in any monitoring process. It provides an inventory of monitored projects and allows for comparisons to be made between projects quickly and efficiently. If storage and management of data are overlooked, important information may be lost and project evaluation may be affected. Hard copies should have duplicates that are stored in a separate location from the originals, and computer files should have backup copies (Harrelson *et al.* 1994). Photographs also require timely management and organization. It is recommended that both hard and digital copies be kept for storage and retrieval purposes (Yetman 2001). Results from the monitoring program must also be summarized in a concise fashion and presented to resource managers to provide evidence of project success, failures and future needs for NCD's.

2.6 Training

NCD monitoring requires field personnel to be well trained in the procedures they are to follow (Gaboury and Wong 1999). No outline of the skill base needed to monitor and evaluate NCD's was found in the literature. Although not implicitly stated in most protocols, a multi-disciplinary approach should be taken with teams representing the disciplines of geomorphology, biology and engineering. Training in other monitoring protocols (e.g. OSAP) may help to implement the monitoring of NCD projects.

2.7 Gaps in the Literature

In general, although there are many protocols in the general literature that outline a conceptual framework for monitoring NCDs, there have been no comprehensive protocols developed specifically for the southern Ontario context where substantial channel alteration work has occurred. Existing methodologies focus on field measures and lack guidance in developing criteria or measures of performance, establishing reference reaches, collecting baseline information and analyzing monitoring data.

The literature notes a need for NCD monitoring to move beyond simply assessing the low flow or bankfull channel design, to evaluating floodplain features and functions. Stream corridors and connectivity between the floodplain and low flow channel are features and functions that should be assessed as part of NCD.

Currently, there are limited baseline data for existing NCDs, and lack of associated criteria for evaluating success, which is likely a product of applying varying monitoring efforts and the complexity inherent in natural watercourses. Excellent conceptual frameworks exist for monitoring designs, but there are limited applied science methodologies available. The importance of cultural and social elements are also discussed in the conceptual literature, but few detailed methods are found.

With regard to performance criteria and success thresholds, generic concepts are provided, but limited guidance is available on pre-defined restoration targets. Moreover, there is very limited work documenting failure and mechanisms of failure of NCD elements. It is important to identify mechanisms of failure as part of a monitoring initiative, as numerous examples exist from which important data can be gleaned.

3.0 PRELIMINARY ASSESSMENT OF TRCA NCD PROJECTS

3.1 Introduction and Purpose

A preliminary assessment of 29 NCDs within the Toronto and Region Conservation Authority (TRCA) jurisdiction was conducted to document existing conditions, identify design themes, and qualitatively identify practical issues that needed to be considered in development of a standardized monitoring protocol. The assessment included a review of available background information and design materials provided by the TRCA. Site visits included rapid assessments, photographs, several quantitative measurements and visual assessments of geomorphology, aquatic habitat, water quality, bioengineering, restoration plantings, in-stream structures and aesthetic value. The preliminary assessment provided insight on common design issues and assisted with refining and identifying key techniques used to monitor NCD's. Fulfilling the adaptive management approach, qualitative observations of thematic or common design deficiencies are described and generic prescriptions to improve design success are outlined.

3.2 Methodology

Initially, 23 NCD project sites within the TRCA jurisdiction were selected for a preliminary assessment in the fall of 2005. The assessments were comprised of a desktop summary of existing pre-construction conditions (as available), a review of design materials (drawings, design briefs, EA documents, and other supporting materials as available) and a field component including rapid assessments of the sites to examine existing conditions. In the RFP there were 32 sites identified for assessment, but due to the limited extent of some of the projects and the lack of background information this list was reduced to 23 sites. Several NCD sites contained multiple reaches with significantly different design characteristics and site conditions. These sites were subdivided into separate reaches and treated as separate sites; this increased the number of assessment sites to 29.

As part of the desktop assessment all available drawings and documentation were reviewed, and the following information was summarized, as available:

- Project objectives
- Design method
- Scale of works
- Design constraints
- Construction / permit date
- Bankfull design parameters
- Planform design parameters
- Instream structures and substrates
- Bank treatments, bioengineering, habitat structures prescribed

An excel spreadsheet was created to summarize the materials outlined above (Appendix B).

As part of the field assessment each site was visited by at minimum a two-person team. During each site visit, the entire NCD was walked as well as portions of channel upstream and downstream of the NCD, where accessible. Photographs documenting sites conditions were also collected.

The preliminary assessment for each NCD project area included:

- Sub-reach sketch map following methodologies outlined in the literature review and monitoring sections
- Rapid Geomorphic Assessment (MOE, 1999)
- Rapid Stream Assessment Technique (Galli, 1996) and a modified protocol which included separate evaluations of riffle form and function and bioengineering function
- Visual assessment of reach characteristics
- Approximate measurements of bankfull dimensions and wetted width and depth
- Qualitative observations of geomorphic and aquatic habitat characteristics
- Comments on channel hardening, disturbances or barriers
- Photographic record of site conditions
- Visual assessment of restoration plantings, in-stream structures and bioengineering elements
- Visual assessment of aesthetics, maintenance, resilience, riffle success/failure
- General comments with respect to observed conditions

Assessments were completed on standardized field sheets to allow comparability between sites. Photographs were organized and labeled and field data were condensed into 2-page summary sheets for each NCD.

3.3 Discussion and Results

Observations from the preliminary assessment provide insight on the level or detail of designs, methodologies and techniques currently being applied, overall condition of existing NCD sites within the TRCA jurisdiction and an initial qualitative evaluation of 'successful' design elements and projects. Background information on pre-existing conditions as well as design related materials were reviewed where possible as part of the preliminary assessment. Permitting dates for NCD's ranged from less than one year to eight years with an average age of 3 years. This means that most of the channels are likely still in adjustment. The project scales varied from 27 m to over 1800 m in extent, although most were greater than 100 m. Several projects covered multiple reaches. The extent of corridor modification ranged from works limited to those necessary to install the low flow channel and limited re-vegetation to construction of 60 to 90 m wide floodplains (channel corridors) including substantial earthworks, corridor stabilization and restoration planting. The range in project scales needs to be recognized as a difficulty in standardizing monitoring protocols. Monitoring requirements need to reflect the level of alteration and potential impact of the NCD.

With regard to documentation of designs, limited baseline information exists for the majority of NCD sites within the TRCA jurisdiction, as well as a lack of monitoring documents, which makes assessing overall 'success' of individual NCD's difficult. Fewer than 20% of NCD projects within the TRCA jurisdiction included design briefs, pre-construction information or monitoring programs. This apparent lack of documentation is likely both a product of the discontinuity in paper accounting from conceptual design to detailed submissions, and less rigorous previous permitting requirements with regard to documenting pre-design conditions, conceptual design objectives, and performance criteria.

It is anticipated that this proportion has and will continue to increase in the future as NCD practices mature. Design briefs in particular are important, as they are intuitively the document in which to incorporate per-construction conditions, conceptual design objectives, and performance criteria.

A review of available design materials provided insight on what types of designs and restoration practices are being implemented and when they were constructed. With regards to design approaches, many of the projects did not specifically outline a design methodology. Through a review of the drawings in absence of a documented design approach, a large number appeared to use a simple modification of existing conditions or limited reference reach approaches (design geometry generally conforms to existing conditions with addition of ‘enhancements’ or ‘stabilization elements’). A more limited proportion applied either a Rosgen-like approach or a more formal reference reach approach. With regards to common design elements, more than 90% of projects included constructed riffles and restoration plantings, and almost 80% included bioengineering elements. Only 40% of projects included habitat structures.

Bank treatments tended to consist of brush layering, brush mattresses, fascines, crib walls, and vegetated rip rap. Habitat structures were limited to features such as root wads and anchored logs, and occasional application of lunkers. Floodplain wetlands, wet meadows and off-line ponds were also prescribed as habitat/corridor enhancement features.

There was a general lack of post-construction monitoring documentation submitted to the TRCA. This is likely, in part, due to the permitting process which usually only requires monitoring documentation to be submitted to DFO. From those projects where monitoring documents were available, the documents usually examined geomorphic, habitat and planting success to some level. Most summarized potential issues and discussed at least qualitatively successful elements of the design. In all cases there was a lack of pre-defined success criteria.

The timing of the preliminary assessment should be noted as this may greatly influence observations and measurements recorded. NCD projects were visited after a very large storm event affecting the GTA (August 19, 2005). Also, site reconnaissance occurred in the late fall. During this period flows were variable due to seasonal storm events. In most cases sites were visited during periods of relatively low flow. In many instances, observations were collected outside of true low flow conditions, which are preferable for assessing fish passage. Also erosion and depositional evidence is best observed before leaf out, which was another limitation. It should also be noted that 13 of the NCD projects were visited three months earlier and documented with photographs and provide a comparison of flow conditions and riparian vegetation.

A number of overall design elements were generally successful. A qualitative comparison of design drawings with present site conditions shows that the majority of NCD’s have similar planform compared to the design. Qualitatively, it was observed that most riparian plantings were establishing as prescribed. The majority of the crib walls observed were generally undamaged with established vegetation and functioning as per design. It is assumed that brush mattressing was successful, where applied, as the outsides of most of the prescribed meander bends were well vegetated.

Overall project success was evaluated in a qualitative manner by examining the function of design elements. The design elements were categorized into; constructed riffles, bioengineering elements, and habitat structures. Riffle failure or success is described in more detail in the following paragraphs. For riffles to be considered functional as an overall design element, greater than 50 percent of the individual riffles within the design needed to be functioning. Similarly, for bioengineering to be considered successful, greater than 50 percent of the bioengineered structures needed to be stable (limited evidence of imminent failure). Habitat structures were evaluated based upon their survival and function. An example, a LUNKER being in place and providing the habitat envisioned, would be regarded as successful. Whether fish were utilizing these features was not assessed. Appendix D summarizes this qualitative assessment. In general the channel designs were functioning as intended. The only repeating issue was the occurrence of obstructions to fish migration. The majority of these obstructions were caused by vegetation encroachment or the construction of riffle structures at an elevation higher than the low flow channel. An examination of failure of individual design follows.

It should be noted that the failure of an individual bioengineering element or grade control structure in a substantive design should not be interpreted as failure of the design. In many cases individual design elements may not have performed as anticipated within a given design. Within each NCD a number of individual design elements were generally not functioning as intended. The most commonly observed themes included, partial failure of riffle structures, low survival rates of live staking, extensive areas of exposed parent material and excessive bank erosion (greater than 50% of the channel length). Given the lack of baseline data or reference reach data it is difficult to establish if this should simply be considered natural adjustment or systematic issues with these NCD’s.

An almost ubiquitous design element was construction of riffle pool sequences, and therefore special attention was taken to qualitatively examine the condition of these features. With regard to prescription and installation of bed control structures such as riffles, vortex weirs and other similar design elements, there appeared to be limited appreciation of the semi-alluvial nature of many of the channels within the GTA. In many cases bed materials were either not prescribed in adequate quantities or installed in a way which limited their potential success, such as being installed directly on till or other similar materials to a limited depth and or without keying materials into the bed.

Individual riffle ‘failures’ can be separated into those with compromised function and those with structural failure. From comparison between designs and the failed features, in many cases these issues can be attributed to limited design detail, or appreciation of the existing conditions, and/or poor construction practices. In several cases over-sized materials or poor gradation have resulted in substantial through flow of installed riffles, which given the lack of structural failure is treated as compromised function. These features likely do not provide good spawning grounds, oxygenation of flows or in the most extreme cases result in complete subsurface flow during low flow conditions causing barriers to fish passage. These features are often accompanied by encroachment of in-stream vegetation due to the lack of concentrated flow; these channels also tend to have issues with regard to water quality. Installation of less sorted gradations and/or with a native fine component, along with thorough compaction would likely correct these issues.

The most prevalent structural failure was outflanking. This was particularly true of hard structural features such as rock vortex weirs. There are two reasons for these failures. First, limited lateral extent of treatments did not account for potential channel migration. Second, and likely more important, lack of integrated bed and bank treatments. Given that in many cases bank materials are more susceptible to erosion than the prescribed bed materials, designs should at minimum include adequate bank treatment to temporarily stabilize banks until vegetation has established. Outflanking in most cases was not contributing to complete failure of the design element.

Winnowing of riffles leading to functional failure was also observed. There was limited evidence of active headcutting of riffles, but given that in many designs the riffle materials were not keyed into the bed and were only in layers 2-3 grain diameters thick, headcutting would likely rapidly lead to total failure. As such, it is possible that the process may have initiated the failure of elements that were 'blown out'. The extent and location of parent material may have not been included in design considerations because exposure of parent materials was fairly common, contributing to riffle failure and limiting pool development.

In most cases restoration plantings were healthy. However, on several occasions live staking was observed to be functioning poorly. This in many cases was due to improper installation, timing of installation or lack of watering during critical stages.

Overall, approximately 83% of the channels were in transition or adjustment and will continue to undergo minor adjustments. The remainder were either heavily vegetated with wetland vegetation or were low gradient streams showing few signs of geomorphic adjustments.

3.4 NCD Project Site Summaries

A summary of each site is provided as part of the preliminary assessment of NCD sites. Detailed site summaries are included in Appendix C for each of the NCD monitoring sites. Also, functioning of design elements is provided in Appendix D.

3.5 NCD Project Site Monitoring Plans

Based upon a review of the preliminary monitoring data collected at the sample sites, a monitoring plan was developed for each of the NCD sites based upon the methods presented in this protocol. The detailed monitoring plans for each site can be found in Appendix E.

3.6 Costing/Utilization

From review of existing identified NCD's in this project, the scale of projects is highly variable. Therefore, staff time required to fulfill monitoring requirements will also be highly variable. With regards to costing, realistic costs will be dependent on hourly rates. These will be dramatically different if the work is completed as internally or alternatively outsourced. Therefore Table 3.1 provides opinions of probable staff requirements broken down on the basis of individual activities conducted during the 3 years for each monitoring component. In several cases, activities require multiple staff; therefore probable staff numbers are also included. The detailed estimate of utilization is based on conducting a full monitoring program at one NCD site over the recommended monitoring time period assuming a 100 to 300 m length of channel. This would include field, laboratory (where necessary) and desktop summary of data. It does not include meetings, or a master report preparation. This format allows simple rationalization of costs once per diem rates are identified. It is also noted that there is a significant level of rationalization available through completion of complementary components of monitoring. The geomorphic, habitat and bioengineering components can be completed as one unit with a limited increase in the staff requirements outlined for the geomorphic component. Fisheries surveys and water quality due to the specific field and laboratory components need to be treated as individual components. The social and cultural elements assume site observations and compilation of mail out survey.

Table 3.1: Complete monitoring program staffing requirements for one NCD project over 3 years.

MONITORING COMPONENT	No. of Staff Required	Total Person Days
Fluvial Geomorphology	**2**	**14***
Aquatic Habitat	**2**	**10***
Fish Community	**2**	**8**
Water Quality	**2**	**14**
Riparian Conditions	**1**	**8***
Engineered / Bioengineering Elements	**1**	**2.5***
Social and Cultural Elements	**1**	**4.5**
	Total	61

* can be combined with other components involving complimentary activities

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APPENDIX A:

Glossary

Table A1: Glossary of terms

Aggradation	The geological process by which a streambed is raised in elevation by the deposition of additional material transported from upstream (opposite of degradation).
Alluvial Stream	Streams that have erodible boundaries and are free to adjust dimensions, shape, pattern and gradient in response to change in slope, sediment supply or discharge.
Bankfull	This stage is delineated by the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in stream bank slope, perennial vegetation limit, rock discoloration, and root exposure.
Bankfull Discharge	A flow of water large enough to fill the width and depth of a stable, alluvial stream. Water fills the channel up to the first flat depositional surface (active floodplain) in the stream. Such a discharge occurs approximately every 1.5 years.
Baseflow	Flow in a channel generated by moisture in the soil or groundwater.
Bed Erosion	The process by which water loosens and wears away soil and rock from the bottom of a body of water, usually resulting in a deepening of the body of water.
Bedload	The part of a channel's sediment transport that is not in suspension, consisting of coarse material that is moving on or near the channel bed.
Benthic Macroinvertebrates	An organism lacking a backbone, large enough to be seen with the naked eye, that inhabits the bottom of a stream.
Bioengineering	An engineering technique that applies biological knowledge when designing and constructing earth and water constructions and when dealing with unstable slopes and stream banks.
Cross-Section	A transect taken at right angles to the stream flow direction.
Deposition	The settlement of material onto the channel bed.
Diatoms	Microscopic unicellular algae. Most are aquatic.
Discharge	The rate of flow expressed in volume per unit of time (usually expressed in m3s-1). Discharge is the product of the mean velocity and the cross-sectional area of flow.
Erosion	A process or group of processes whereby surface soil and rock is loosened, dissolved, or removed from one place to another by natural means.
Facies	The sum total of features that reflect a particular sedimentological / depositional unit.
Floodplain	Any lowland that borders a stream and is inundated periodically by water.
Fluvial	The science of or pertaining to river processes. Also, the distinctive

Geomorphology	channel features produced by the action of a stream or river.
Geomorphic	Pertaining to the geology, origin and nature of landforms.
Hydrology	An earth science that studies the occurrence, distribution, and movement of water.
Macrophytes	A plant large enough to be visible to the naked eye, especially in reference to aquatic plants.
Physiography	The study of landforms and soil forming materials.
Planform	Channel pattern.
Reach	A channel type unit length with the same channel type existing for a length over twenty bankfull channel widths (Rosgen). The length of channel uniform with respect to discharge, depth, area, and slope. The length of a channel for which a single gage affords a satisfactory measure of the stage and discharge. The length of a river between two gaging stations. More generally, any length of a river.
Riffle	A reach of stream in which the water flow is shallower and more rapid than the reaches above and below.
Riparian	The area adjacent to flowing water (e.g. rivers, perennial or intermittent, streams, seeps or springs) that contains elements of both aquatic and terrestrial ecosystems.
Scour	The process of removing material from the bed or banks of a channel through the erosive action of flowing water.
Sediment Load	The sum total of sediment available for movement in a stream, whether in suspension (suspended load) or at the bottom (bedload).
Surficial Geology	The study of surface materials, their formation and distribution.
Watershed	The land drained by a river or creek and its tributaries.

APPENDIX B:

NCD Desktop Project Summary

Table B1: Project Descriptions

Project Description											
Project ID	Project Name	Watershed	Municipality	Location	Project Objectives	Project Reach Length (m)	Project Valley Width (m)	Design Approach/ Method	Design Assumptions	Design Constraints	Construction Date
2	Little Etobicoke Creek Restoration - Applewood Park	Etobicoke	Mississauga	No File Provided							
3	Fonthill Channel Restoration	Rouge	Markham	Highway 7 and Main Street in Markham	Not identified.	500	12	Not identified.	Not identified.	Not identified.	1996
4	Highland Creek Malvern Branch Bank Restoration	Highland	Toronto	No File Provided							
5	Highland Creek Rehabilitation Study - Natural Channel Design	Highland	Toronto	Markham Road and Ellesmere Road in Toronto	Creation of a natural valley system with meandering channel, connection to floodplain, and appropriate terrestrial habitat.	1800	60	Model after a local characteristic reach.	Not identified.	Not identified.	1997
6	Little Rouge River Restoration Project	Rouge	Markham	5726 19th Avenue in Markham	New bypass channel to take ponds off line.	200	20	Not identified.	Not identified.	Not identified.	1998 / 1999
8	Berczy Village Burdenet Creek Channel Lowering	Rouge	Markham	McCowan Road and Major Mackenzie Drive in Markham	Not identified.	900	60	Design to be Rosgen Type E Channel	Not identified.	Not identified.	1999
9	New Westminster Creek Natural Channel Design	Don	Vaughan	Dufferin Street and Rutherford Road in Vaughan	Not identified.	420	40	Not identified.	Not identified.	Not identified.	1998
10	Wismer Commons Robinson Creek Lowering	Rouge	Markham	16th Avenue and Major Mackenzie Drive in Markham	Creation of a new stream valley using NCD to provide insteram diversity, riparian habitat diversity and corridor function.	760	20	Design to be Rosgen Type E Channel	Not identified.	Not identified.	2000
11A	Miller Creek Realignment and Natural Channel Design (Reach 6)	Duffins	Ajax	Taunton Road and Westney Road in Ajax.	Re-creation of a meandering stream form with riffle-pool sequences. Reconnect the floodplain. Mitigation of a barrier to fish passage. Valley corridor improvement through plantings.	1055	40-60	Modelled after a local characteristic reach.	Not identified.	Beaver activity in the project area will affect channel processes. Channel design must meet existing elevations at reach boundaries.	2003

Project Description											
Project ID	Project Name	Watershed	Municipality	Location	Project Objectives	Project Reach Length (m)	Project Valley Width (m)	Design Approach/ Method	Design Assumptions	Design Constraints	Construction Date
11B	Miller Creek Realignment and Natural Channel Design (Reach 1-2)	Duffins	Ajax	Taunton Road and Westney Road in Ajax.	Re-creation of a meandering stream form with riffle-pool sequences. Reconnect the floodplain. Mitigation of a barrier to fish passage. Valley corridor improvement through plantings.	812	40-60	Modelled after a local characteristic reach.	Not identified.	Beaver activity in the project area will affect channel processes. Channel design must meet existing elevations at reach boundaries.	2003
12A	Block 32 Don River Tributary Channel Realignment (Upstream from Highway 400)	Don	Vaughan	Highway 400 and Major Mackenzie Drive in Vaughan.	Naturalized valley corridor with low-flow meandering channel.	1400	45	Design to be Rosgen Type E5 Channel	Not identified.	Not identified.	1999
12B	Block 32 Don River Tributary Channel Realignment (Downstream from Highway 400)	Don	Vaughan	Highway 400 and Major Mackenzie Drive in Vaughan.	Naturalized valley corridor with low-flow meandering channel.	770	40 to 90	Design to be Rosgen Type E5 Channel	Not identified.	Not identified.	1999
13	Robinson Creek Naturalization	Rouge	Markham	Highway 7 and Markham Road in Markham	Not identified.	238	UNK	Not identified.	Not identified.	Not identified.	2000/2001
14	German Mills Creek Realignment	Don	Richmond Hill	Yonge Street and Brookside Road in Richmond Hill	Not identified.	70	UNK	Not identified.	Not identified.	Not identified.	2000
15	Carruthers at Bayly and Shoal Point Road	Carruthers	Ajax	No File Provided							
16	Amberlea Creek Realignment	Frenchman's Bay	Pickering	Bayly Street and Vistula Drive in Pickering	Not identified.	85	UNK	Not identified.	Not identified.	Not identified.	2001
17	Holy Trinity School Stream Realignment	Rouge	Richmond Hill	No File Provided							

Project Description												
Project ID	Project Name	Watershed	Municipality	Location	Project Objectives	Project Reach Length (m)	Project Valley Width (m)	Design Approach/ Method	Design Assumptions	Design Constraints	Construction Date
18A	Morningside Tributary (Upstream Reach)	Rouge	Toronto	Staines Road and Morningside Avenue Extension in Toronto	Channel realignment to restore form and function of stream corridor and aquatic habitat.	550	60	Model after a local characteristic reach.	fluvial geomorphology principles, detailed geomorphic investigations, accommodate proposed post development flow regime while creating a dynamically stable form and diverse aquatic habitat.	Significant lengths of valley are linear, limiting planform configuration. Confluence of Morningside and Neilson tributaries must be properly constructed. Hydro towers are located within the valley corridor.	2003
18B	Morningside Tributary (Middle Reach)	Rouge	Toronto	Staines Road and Morningside Avenue Extension in Toronto	Channel realignment to restore form and function of stream corridor and aquatic habitat.	600	60	Model after a local characteristic reach.	Not identified.	Significant lengths of valley are linear, limiting planform configuration. Confluence of Morningside and Neilson tributaries must be properly constructed. Hydro towers are located within the valley corridor.	2003
18C	Morningside Tributary (Downstream Reach)	Rouge	Toronto	Staines Road and Morningside Avenue Extension in Toronto	Channel realignment to restore form and function of stream corridor and aquatic habitat.	500	60	Model after a local characteristic reach.	Not identified.	Significant lengths of valley are linear, limiting planform configuration. Confluence of Morningside and Neilson tributaries must be properly constructed. Hydro towers are located within the valley corridor.	2003
18D	Morningside Tributary (Neilson Reach)	Rouge	Toronto	Staines Road and Morningside Avenue Extension in Toronto	Channel realignment to restore form and function of stream corridor and aquatic habitat.	100	8	Model after a local characteristic reach.	Not identified.	Significant lengths of valley are linear, limiting planform configuration. Confluence of Morningside and Neilson tributaries must be properly constructed. Hydro towers are located within the valley corridor.	2003
19	Exhibition Creek Relocation	Rouge	Markham	No File Provided							
20	Lower Milne Creek Restoration	Rouge	Markham	McCowan Road and Highway 7 in Markham	To improve the health of the river and valley system, while addressing flood and erosion control issues. Enhancement of fish habitat also desired, including removal of barriers within the reach.	340	15	Design the channel to be a Rosgen "C" form.	Not identified.	Not identified.	2003

Project Description											
Project ID	Project Name	Watershed	Municipality	Location	Project Objectives	Project Reach Length (m)	Project Valley Width (m)	Design Approach/ Method	Design Assumptions	Design Constraints	Construction Date
21	Mimico Creek Realignment	Mimico	Mississauga	Airport Road and Slough Road in Mississauga	Reconstruct an existing stream, narrow the valley, remove fish barrier.	350	45	Model after a local characteristic reach.	Not identified.	Sanitary sewer parallels watercourse; concrete grade control structures.	2003
23	Carruthers North of Rossland Road - Ajax	Carruthers	Ajax	Rossland Road west of Audley Road in Ajax.	Realignment of 26.5 m of creek, incorporating riffle pool sequences into design to enhance fish habitat. Installation of ripairan plantings.	27	UNK	Not identified.	Not identified.	Not identified.	2003/2004
24	Neilson Tributary	Rouge	Toronto	Neilson Road and McNichol Avenue Extension in Toronto	Realignment of the tributary to accommodate development; restoration of channel form and function; target redside dace and central stoneroller habitat.	525	30	Not identified.	Not identified.	Not identified.	2004
25	Tennis Canada Black Creek Tributary Realignment	Humber	Toronto	York University Campus	Compensation plan for removal of 80 m of channel upstream.	150	UNK	Design to be a Rosgen Type B Channel	Not identified.	Not identified.	2003
26	Fanshore Watercourse Alteration	Humber	Brampton	Rosegarden Drive and Goreway Drive in Brampton	Realignment of tributary to accommodate development. Enhancement of channel form and function.	89	UNK	Not identified.	Not identified.	Not identified.	2003
27	Mimico Creek Tributary Realignment	Mimico	Brampton	Highway 407 and Airport Road in Brampton	Realignment of the watercourse to accommodate development; diversification of aquatic habitat; prevention of stream bank erosion.	140	30	Not identified.	Not identified.	Not identified.	2003
28	Rouge River Tributary 1 Channel Lowering and Naturalization	Rouge	Markham	16th Avenue and 19th Line in Markham	Not identified.	105	UNK	Not identified.	Not identified.	Not identified.	2005
29	Tranquility Stream Relocation	Humber	Richmond Hill	Yonge Street and Bloomington Road in Richmond Hill	Realignment of an intermittent tributary to accommodate development.	800	35	Not identified.	Not identified.	Not identified.	2003
30A	Upper Milne Creek Restoration (South of Bullock Drive)	Rouge	Markham	McCowan Road and Bullock Drive in Markham	To restore the natural channel and mitigate existing downstream flooding and erosion problems. Stabilization of banks through bioengineering and plantings.	320	15	Not identified.	Not identified.	Not identified.	2005
30B	Upper Milne Creek Restoration (North of Bullock Drive)	Rouge	Markham	McCowan Road and Bullock Drive in Markham	To restore the natural channel and mitigate existing downstream flooding and erosion problems. Stabilization of banks through bioengineering and plantings.	200	25	Not identified.	Not identified.	Not identified.	2005

Table B2: Project Bankfull, Riffle/Pool and Planform Design Parameters

		Bankfull Design Parameters			Riffle / Pool Design Parameters						Planform Design Parameters		
Project ID	Project Name	Bf Discharge (cms)	Avg. Bf Width (m)	Avg. Bf Depth (m)	Avg. Riffle Width (m)	Avg. Riffle Depth (m)	Riffle Substrate Size	Avg. Pool Width (m)	Avg. Pool Depth (m)	Pool Substrate Size	Meander Wavelength Range (m)	Amplitude (m)	Meander Belt Width (m)
2	Little Etobicoke Creek Restoration - Applewood Park	No File Provided											
3	Fonthill Channel Restoration	UNK	2.50	0.70	3.00	0.34	UNK	2.00	0.95	native materials	straight channel		
4	Highland Creek Malvern Branch Bank Restoration	No File Provided											
5	Highland Creek Rehabilitation Study - Natural Channel Design	2.50	8.00	0.80	8.00	0.80	UNK	UNK	UNK	UNK	80	UNK	20 to 30
6	Little Rouge River Restoration Project	UNK	1.20	UNK	UNK	UNK	UNK	UNK	UNK	UNK	34	2.0	6
8	Berczy Village Burdenet Creek Channel Lowering	3.30	2.80	0.30	2.20	UNK	pea gravel to 200 mm	UNK	0.40	UNK	30	8.0	20
9	New Westminster Creek Natural Channel Design	0.60	3.50	0.29	2.50	0.50	native materials	3.00	0.80	native materials	35 to 49	22.0	30
10	Wismer Commons Robinson Creek Lowering	UNK	1.00	0.35	1.00	0.35	UNK	5.00	0.70	50 to 150 mm	23	9.0	10
11A	Miller Creek Realignment and Natural Channel Design (Reach 6)	2.40	5.50	0.30	5.70	0.24	2 to 20 mm	5.48	0.41	Natural	36 to 62	18.0	41 to 63
11B	Miller Creek Realignment and Natural Channel Design (Reach 1-2)	3.25	6.00	0.40	7.11	0.27	3 to 30 mm	6.53	0.44	Native materials	44 to 76	22.0	50 to 59
12A	Block 32 Don River Tributary Channel Realignment (Upstream from Highway 400)	0.46	1.80	0.35	1.00	UNK	10% 450-600 mm; 20% 100-200 mm; 30% 50-75 mm; 30% 10-20 mm; 10% 5-10 mm	1.00	0.55	Native materials	35	13.0	15
12B	Block 32 Don River Tributary Channel Realignment (Downstream from Highway 400)	0.86	2.00	0.50	UNK	UNK	10% 450-600 mm; 20% 100-200 mm; 30% 50-75 mm; 30% 10-20 mm; 10% 5-10 mm	1.00	0.55	Native materials	35	14.2	15
13	Robinson Creek Naturalization	UNK	3.50	0.60	3.50	0.30	50% 50-200 mm; 50% coarse sand to 50 mm	4.00	1.15	native materials	70	25.0	35
14	German Mills Creek Realignment	UNK	3.00	0.50	3.00	0.45	River Run Stone D50 = 150 mm	3.00	0.3-0.5	Native materials	20	1.5	3
15	Carruthers at Bayly and Shoal Point Road	No File Provided											
16	Amberlea Creek Realignment	UNK	3.50	0.50	4.00	UNK	400-600 diameter fieldstone	4.00	0.57-0.64	25-225 mm	N/A not sufficient length		
17	Holy Trinity School Stream Realignment	No File Provided											

		Bankfull Design Parameters			Riffle / Pool Design Parameters						Planform Design Parameters		
Project ID	Project Name	Bf Discharge (cms)	Avg. Bf Width (m)	Avg. Bf Depth (m)	Avg. Riffle Width (m)	Avg. Riffle Depth (m)	Riffle Substrate Size	Avg. Pool Width (m)	Avg. Pool Depth (m)	Pool Substrate Size	Meander Wavelength Range (m)	Amplitude (m)	Meander Belt Width (m)
18A	Morningside Tributary (Upstream Reach)	2.32	1.80	0.30	5.20	0.37	0.025-0.10; 0.05-0.20; 0.01-0.05	5.80	0.50	Native materials	25	4.9	20
18B	Morningside Tributary (Middle Reach)	3.32	1.80	0.30	5.20	0.45	0.025-0.10; 0.01-0.05	5.50	0.50	Native materials	20	6.0	15
18C	Morningside Tributary (Downstream Reach)	2.32	1.80	0.30	5.30	0.30	0.025-0.10; 0.05-0.20; 0.01-0.05	6.00	0.40	Native materials	11	2.0	15
18D	Morningside Tributary (Neilson Reach)	0.15	UNK	UNK	1.60	0.10	250-350 mm	1.90	0.14	Native materials	15	3.0	6
19	Exhibition Creek Relocation	No File Provided											
20	Lower Milne Creek Restoration	5.90	4.00	1.00	4.00	0.70	50% coarse sand to 50 mm; 50% 50 mm to 200 mm	5.00	1.00	UNK	105	50.0	60
21	Mimico Creek Realignment	2.00	4.00	0.54	4.00	UNK	UNK	4.00	UNK	UNK	straight channel		
23	Carruthers North of Rossland Road - Ajax	UNK	5.00	1.20	4.00	0.20	50 mm to 150 mm	5.00	1.20	50 mm to 150 mm	30	5.0	15
24	Neilson Tributary	2.73	2.00	0.50	1.50	0.20	Gravel; median diameter 0.01-0.03 m	1.95	0.30	Native material	25	11.0	15
25	Tennis Canada Black Creek Tributary Realignment	9.60	9.00	0.25	9.00	0.25	sand to 200 mm	9.00	0.85	sand to 200 mm	45	15.0	35
26	Fanshore Watercourse Alteration	0.41-0.5	3.10	0.40	3.35	0.30	0.5 to 3 mm	3.25	0.37	Native material	40	13.0	15
27	Mimico Creek Tributary Realignment	UNK	4.50	0.40	4.50	0.50	50 to 100 mm	2.00	0.60	4-10mm	30	5.0	10
28	Rouge River Tributary 1 Channel Lowering and Naturalization	0.40	2.70	UNK	1.90	0.30	25 to 100 mm	2.70	0.40	Native material	35	7.0	10
29	Tranquility Stream Relocation	UNK	1.70	0.20	No pool/riffle sequence		native materials	1.70	0.20	native material	60	7.0	9
30A	Upper Milne Creek Restoration (South of Bullock Drive)	4.23	4.20	0.50	5.00	0.30	50% 100 mm; 30% 50 mm; 10% 25 mm; 20% <10 mm	1.70	0.20	native material	straight channel		
30B	Upper Milne Creek Restoration (North of Bullock Drive)	4.23	3.00	0.60	1.50	0.30	50% 100 mm; 30% 50 mm; 10% 25 mm; 20% <10 mm	3.00	0.60	native material	35	5.0	10

Table B3: Project Gradient, Substrate and Other Design Parameters

		Gradient Design Parameters				Substrate Design Parameters		Other Design Components			
Project ID	Project Name	Channel Gradient (%)	Avg. Riffle Gradient (%)	Avg. Inter-Pool Gradient	Vertical Amplitude (m)	Substrate Size	Substrate Gradation	Bank Treatments / Bioengineering	Riparian Plantings	Habitat Structures	In-stream Structures
2	Little Etobicoke Creek Restoration - Applewood Park							No File Provided			
3	Fonthill Channel Restoration	3.00	UNK	UNK	0.3	300 mm (weir), 25-150 mm (vortex weir)	UNK	Armourstone and bioengineering, vegetated rip rap.	5 m both banks; 50% channel length (10% deciduous tree cover; 20% coniferous tree cover; 30% shrub cover; 40% herbaceous cover) - remainder of riparian area already vegetated.	Unknown	Vortex weirs.
4	Highland Creek Malvern Branch Bank Restoration							No File Provided			
5	Highland Creek Rehabilitation Study - Natural Channel Design	UNK	UNK	UNK	UNK	UNK	UNK	Armourstone, brush mattresses, live fascines, live stakes.	30 m both banks; 90% channel length (80% shrub cover - livestakes; 10% deciduous tree cover; 10% coniferous tree cover).	Removal of gabions and weirs; plunge pools; aquatic plantings in floodplain.	Rock vortex cascades; vortex weirs.
6	Little Rouge River Restoration Project	UNK	UNK	UNK	UNK	300-1000 mm field stone boulders (boulder crossing)	UNK	Fascines.	70% of channel length being reforested on both banks.	Unknown	Unknown
8	Berczy Village Burdenet Creek Channel Lowering	0.25	UNK	UNK	UNK	UNK	UNK	Fascines.	10 m both banks; 100% channel length (40% deciduous tree cover; 40% coniferous tree cover; 20 % shrub cover) - with herbaceous seed mic throughout.	Wet meadows along creek channel.	None
9	New Westminster Creek Natural Channel Design	0.18	0.18	low flow channel no pool riffle sequence		native materials	UNK	UNK	UNK	Unknown	Unknown
10	Wismer Commons Robinson Creek Lowering	0.04	0.45	UNK	0.35	Sand to 100 mm	UNK	Coir biologs; fascines; brush layers.	10 m both banks; 100% channel length (40% deciduous tree cover; 20% coniferous tree cover; 40% shrub cover).	Wetland side channels; root wads; anchored logs.	Unknown
11A	Miller Creek Realignment and Natural Channel Design (Reach 6)	0.29	2.50	0.29	UNK	2-20 mm; native materials	UNK	UNK	UNK	Unknown	Unknown
11B	Miller Creek Realignment and Natural Channel Design (Reach 1-2)	0.31	3.70	0.29	UNK	3-30 mm; native materials	UNK	UNK	UNK	Unknown	Unknown

		Gradient Design Parameters				Substrate Design Parameters		Other Design Components			
Project ID	Project Name	Channel Gradient (%)	Avg. Riffle Gradient (%)	Avg. Inter-Pool Gradient	Vertical Amplitude (m)	Substrate Size	Substrate Gradation	Bank Treatments / Bioengineering	Riparian Plantings	Habitat Structures	In-stream Structures
12A	Block 32 Don River Tributary Channel Realignment (Upstream from Highway 400)	0.25	0.09	0.04	0.45	400-600 diameter fieldstone	10% 450-600 mm; 20% 100-200 mm; 30% 50-75 mm; 30% 10-20 mm; 10% 5-10 mm	None	15 m both banks; 100% channel length (20% deciduous tree cover; 10% coniferous tree cover; 10% shrub cover; 60% herbaceous lowland and upland seed mixes).	Pools and offline ponds; lunge pool downstream from gabion drop structure; plunge pool below future culvert; skid lunkers; cable stayed trees; gravel beds.	Grade controls.
12B	Block 32 Don River Tributary Channel Realignment (Downstream from Highway 400)	0.22	UNK	0.06	UNK	UNK	10% 450-600 mm; 20% 100-200 mm; 30% 50-75 mm; 30% 10-20 mm; 10% 5-10 mm	Coir biologs	Lowland and upland woody species with pockets of meadow marsh.	Pools and offline ponds; plunge pool at future water quantity control berm; skid lunkers; cable stayed trees.	Grade controls.
13	Robinson Creek Naturalization	1.44	2.75	UNK	0.67	riffle: 50% (50-200 mm round stone) 50% (coarse sand to 50 mm sandstone)	point bar: 50% 25-60 mm roundstone 50% 60 - 150 mm round stone	Armourstone, live fascines and brush mattresses.	20+ m both banks; 50% of channel length (existing vegetation present elsewhere) - 50% deciduous tree cover; 50% shrub cover.	Habitat ponds in floodplain; anchored logs.	Vortex weirs.
14	German Mills Creek Realignment	2.50	UNK	0.30	0.5	river run stone D50 = 150 mm	UNK	Bioengineering with rock toe protection, brush layering.	10 m both banks; 100% channel length (40% coniferous tree cover; 10% deciduous tree cover; 40% shrub cover).	None	None
15	Carruthers at Bayly and Shoal Point Road							No File Provided			
16	Amberlea Creek Realignment	1.68	UNK	UNK	0.9	UNK	UNK	Armourstone and plantings.	3 m both banks; 100% of channel length (70% shrub cover; 30% deciduous tree cover).	None	Vortex weirs and rocky ramps.
17	Holy Trinity School Stream Realignment							No File Provided			
18A	Morningside Tributary (Upstream Reach)	0.67	3.00	0.10	0.21	UNK	UNK	Planting of deep rooting native grasses; high root density plants on outside meander bends, erosion control blankets.	Grasses.	None	None
18B	Morningside Tributary (Middle Reach)	0.18	1.00	0.33	UNK	UNK	UNK	Planting of deep rooting native grasses; high root density plants on outside meander bends, erosion control blankets.	Grasses.	None	None

		Gradient Design Parameters				Substrate Design Parameters		Other Design Components			
Project ID	Project Name	Channel Gradient (%)	Avg. Riffle Gradient (%)	Avg. Inter-Pool Gradient	Vertical Amplitude (m)	Substrate Size	Substrate Gradation	Bank Treatments / Bioengineering	Riparian Plantings	Habitat Structures	In-stream Structures
18C	Morningside Tributary (Downstream Reach)	0.08	0.50	UNK	UNK	UNK	UNK	Planting of deep rooting native grasses; high root density plants on outside meander bends, erosion control blankets.	Grasses.	None	None
18D	Morningside Tributary (Neilson Reach)	0.90	2.00	UNK	0.2	250-350 mm; native materials	UNK	Planting of deep rooting native grasses; high root density plants on outside meander bends, erosion control blankets.	Grasses.	None	None
19	Exhibition Creek Relocation							No File Provided			
20	Lower Milne Creek Restoration	1.00	0.02	0.01	0.4-0.5	64 mm for 2-year event	Point bars: 50% 100-200 mm round, 50% 50-100 mm round. B channel section 50% 50-200 mm, 50% coarse sand.	Armourstone, brush layers; brush mattresses; fascines; live stakes; crib walls.	5 m both banks; 100% channel length (10% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover; 40% seed mixture).	Unknown	Vortex weirs.
21	Mimico Creek Realignment	1.00	UNK	0.00	0.46	25 mm to 400 mm	Riffle: 35% 400 mm, 25% 150-300 mm, 15% 75-200 mm, 20% 50-125 mm, 5% 25-75 mm	Live stakes.	15 m both banks; 100% channel length (10% deciduous tree cover; 10% coniferous tree cover; 30% shrub cover; 50% herbaceous seed mix).	None	Rocky ramps.
23	Carruthers North of Rossland Road - Ajax	1.00	0.30	UNK	0.08	pool/riffle: 50 mm to 150 mm river stone/ pea gravel mix	UNK	Vegetated 600 mm rock protection.	3 m both banks; 100% channel length (50% shrub cover; 25% deciduous tree cover; 25% coniferous tree cover)	None	None
24	Neilson Tributary	0.94	1.50	UNK	UNK	Gravel; median diameter 0.01-0.03 m; native materials	pools: 5% less than 5 mm. Riffle crest: 300 mm, 150 mm, 100 mm, 5 mm.	Live stakes.	10 m both banks; 100% channel length (50% deciduous tree cover; 20% coniferous tree cover; 30% shrub cover).	None	None
25	Tennis Canada Black Creek Tributary Realignment	0.30	4.50	1.40	0.02	0.1 to 300 mm	pools 5%; riffle crest 300 mm, 150 mm, 100 mm, 5 mm	Vegetated rip rap	None	Rootwads	None
26	Fanshore Watercourse Alteration	0.20	0.25	0.20	0.1	Riffle: 0.03-0.05 m	riffle: 0-1" (50%), 1-2" (50%)	None	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	None	None
27	Mimico Creek Tributary Realignment	0.75	1.00	UNK	0.20	cobble/gravel	UNK	Living revetments.	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover) - grass seed mix throughout riparian area.	None	Vortex weirs.

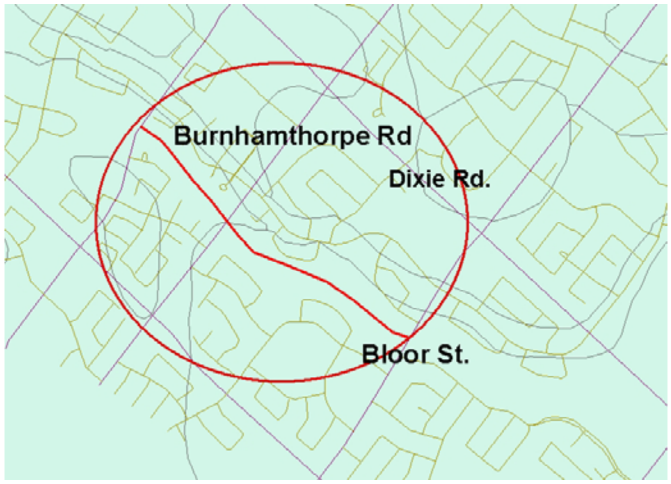
		Gradient Design Parameters				Substrate Design Parameters		Other Design Components			
Project ID	Project Name	Channel Gradient (%)	Avg. Riffle Gradient (%)	Avg. Inter-Pool Gradient	Vertical Amplitude (m)	Substrate Size	Substrate Gradation	Bank Treatments / Bioengineering	Riparian Plantings	Habitat Structures	In-stream Structures
28	Rouge River Tributary 1 Channel Lowering and Naturalization	0.50	1.00	0.05	0.185	riverstone 300 mm diameter at confluence, riverstone 25-100 diameter d/s of vortec weirs	UNK	Brush mattresses; vegetated riverstone; live stakes and erosion mats.	2 m both banks; 100% channel length (10% deciduous tree cover; 10% coniferous tree cover; 80% shrub cover) - also scattered plantings within 10 m of channel, among MTO seed mixture.	None	Vortex weirs.
29	Tranquility Stream Relocation	0.26	No riffle/pool sequence			native material	N/A	Willow bundles; fascines.	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	Live shade tripods; half logs; floodplain pools.	Unknown
30A	Upper Milne Creek Restoration (South of Bullock Drive)	1.00	4.50	UNK	0.2	50-600 mm stone.	50% <300 mm; 50% 300-600 mm (rocky ramps = 80% >300 mm; 20% <50 mm)	Armourstone, brush layering; live stakes; brush mattresses, live fascines.	10 m both banks; 100% channel length (50% deciduous cover; 10% coniferous tree cover; 25% shrub cover; 15% wetland plants).	None	Vortex weirs; rocky ramp cascades.
30B	Upper Milne Creek Restoration (North of Bullock Drive)	1.00	1.00	UNK	0.3	50-600 mm stone.	50% <300 mm; 50% 300-600 mm (rocky ramps = 80% >300 mm; 20% <50 mm)	Brush layering; live stakes; brush mattresses, live fascines.	5 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	Aquatic plantings; wetland cells.	None

APPENDIX C:

NCD Project Site Summaries

02. Little Etobicoke Creek

Location and Access
Near Burnhamthorpe Rd. and Dixie Rd. in Mississauga



Site Location

Channel Design Rationale
No file provided.

Pre-construction Site Conditions
No file provided.

Existing Site Conditions
The channel flows through a residential area and park setting with a generally narrow floodplain. Riparian vegetation consists of grasses, shrubs and trees. The channel is sinuous with a low gradient.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	n/a	5.0	n/a	0.5	N/a
Riffle	n/a	3.0-5.0	n/a	0.02-0.30	n/a
Pool	n/a	4.0-5.0	n/a	0.4-0.9	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs	Vortex weirs are in good condition; some outflanking observed; two vortex weirs are set below low flow surface elevation
Bank Treatment	Vegetated rip rap, root wads	Appear to be functioning as intended. Some banks show evidence of erosion including areas with root wad treatments
Riparian Zone	Unknown	Established and growing

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	12.0	Good	Minor structural failure to root wads and riffles
Bioengineering and Habitat	7.6	Good	Riparian plantings in good condition
RGA	0.25	In Transition	Degradation; widening

Photographs

View of channel looking upstream. Note: vegetated rip rap (right bank) and root wad placement.

Available Documentation

No available documentation

03. Fonthill Channel

Location and Access
Highway 7 and Main Street in Markham

Site Location

Channel Design Rationale
Not identified.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a residential area and the riparian area is vegetated with short grasses, shrubs and both deciduous and coniferous trees.
The channel is generally straight.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	2.5	2.5	0.7	0.5	0.3
Riffle	3.0	2.0-2.5	0.34	0.05-0.15	n/a
Pool	2.0	2.5	0.95	0.4-0.7	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle-pool sequences	Riffle-pool sequences observed in field; some outflanking observed, materials appear to be too small
Bank Treatment	Armourstone and bioengineering, vegetated rip rap.	All observed and appear to be functioning as intended.
Riparian Zone	5 m both banks; 50% channel length (10% deciduous tree cover; 20% coniferous tree cover; 30% shrub cover; 40% herbaceous cover) - remainder of riparian area already vegetated.	Established and growing

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	7.0	Good	Narrow planted buffer width
RGA	0.33	In Transition	Degradation; widening

Photographs

View of channel looking downstream. Note: vegetated rip rap (left bank) and rip rap and residential lawn (right bank).

Available Documentation

Culvert replacement Channel Profile, The Corporation of the Town of Markham Engineering Department – Drawing No. C1. Prepared by Madongsong – Atkari Engineering Limited., October 1996.

Culvert replacement Channel Profile, The Corporation of the Town of Markham Engineering Department – Drawing No. C3. Prepared by Madongsong – Atkari Engineering Limited., October 1996.

Culvert replacement Channel Profile, The Corporation of the Town of Markham Engineering Department – Drawing No. C4. Prepared by Madongsong – Atkari Engineering Limited., October 1996.

Culvert replacement Channel Profile, The Corporation of the Town of Markham Engineering Department – Drawing No. C5. Prepared by Madongsong – Atkari Engineering Limited., October 1996.

Culvert replacement Channel Profile, The Corporation of the Town of Markham Engineering Department – Drawing No. C6. Prepared by Madongsong – Atkari Engineering Limited., October 1996.

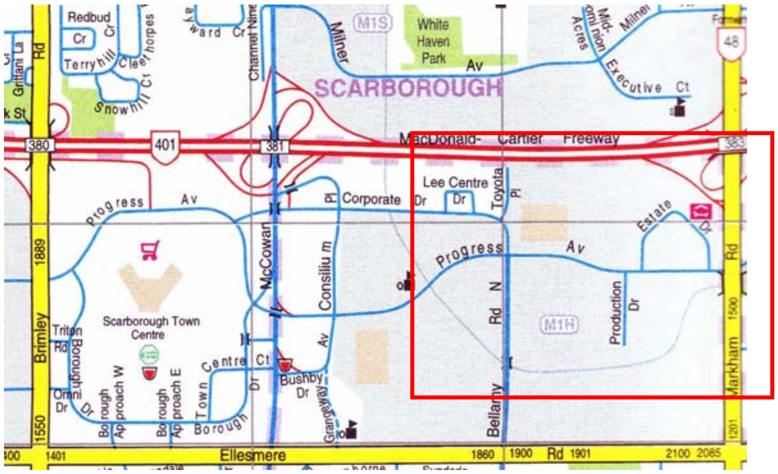
Culvert replacement, Fred Valley Dr., Markham, Ont, Landscape Planting Plan: The Corporation of the Town of Markham Engineering Department – Drawing No. L1. Prepared by Madongsong – Atkari Engineering Limited., July 30 1996.

Culvert replacement, Fonthill Blvd, Markham, Ont, Landscape Planting Plan: The Corporation of the Town of Markham Engineering Department – Drawing No. L2. Prepared by Madongsong – Atkari Engineering Limited., July 30 1996.

Culvert replacement, Rycroft Drive & Stream, Markham, Ont, Landscape Planting Plan: The Corporation of the Town of Markham Engineering Department – Drawing No. L3. Prepared by Madongsong – Atkari Engineering Limited., July 30 1996.

05. Highland Creek

Location and Access
The upstream and downstream limits of the channel design are Highway 401 and Markham Road, respectively. The channel may be accessed from any of the crossings – Corporate Drive, Progress Avenue, Bellamy Road N.



Site Location

Channel Design Rationale
The project was initiated in order to renaturalize the corridor thus improving the natural integrity of the channel and enhancing its recreational and aesthetic values.

Pre-construction Site Conditions
Highland Creek was channelized during the 1960s, producing a straight channel with manicured valley slopes and a mix of hard bank treatments such as gabion baskets and armour stone. The resulting increase in channel gradient, in combination with the increase in runoff associated with development, encouraged bed and bank erosion.

Existing Site Conditions
With the exception of the reach between Highway 401 and Corporate Drive the channel is moderately sinuous. The channel design contains vortex weirs and flow deflectors. Most vortex weirs are functioning as intended; however, a few are submerged below the water surface, buried by transported material, or have been removed during high flows. With regard to direct bank protection, cribwalls have been installed downstream of Bellamy Road.

The reach between Highway 401 and Corporate Drive is generally straight with limited floodplain access. Downstream between Progress Avenue and Bellamy Road, the channel exhibits evidence of adjustment as a meander cutoff has created an island. The reach upstream of Markham Road with armour stone protection along the banks was not part of the channel design. Channel instability tends to increase in the downstream direction as the extent of bank erosion and till exposure increase.

The riparian area is vegetated with short grasses, shrubs and both deciduous and coniferous trees.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	n/a	n/a	n/a	n/a	0.54
Riffle	9.5	4-6	0.8	0.1-0.2 (max)	n/a
Pool	12.0	5-7	2.4	0.4-1.0 (max)	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Rock vortex weirs	Most are functioning as intended; few are below water surface, buried by transported substrate or have failed
	Flow deflectors	Generally performing as intended and reducing localized erosion
Bank Treatment	Cribwalls	Generally performing as intended; all are intact; limited erosion behind cribwall structure
	Live Fascine	Not observed in field; vegetation likely established
	Brush mattress	Not observed in field; vegetation likely established
Riparian Zone	Ponds	Generally in good condition and providing water retention function
	Tree and shrub plantings	Established and growing
	Seed mix	Established

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	18.5	Fair	Channel instability, scouring; riparian habitat
Bioengineering and Habitat	11.5	Good	None
RGA	0.37	In Transition	Degradation; widening

Photographs

Highland Creek viewed upstream toward Bellamy Road.

One of several cribwalls installed between Bellamy Road and Markham Road.

Available Documentation

Highland Creek Rehabilitation Study, Markham Branch. Prepared by Cumming Cockburn Limited, November 1995.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 1, Drawing No. L1.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 2, Drawing No. L2.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 3, Drawing No. L3.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 4, Drawing No. L4.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 5, Drawing No. L5.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 6, Drawing No. L6.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Existing Condition and Demolition – Reach 7, Drawing No. L7.

Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 1, Drawing No. L8. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 2, Drawing No. L9. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 3, Drawing No. L10. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 4, Drawing No. L11. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 5, Drawing No. L12. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 6, Drawing No. L13. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Grading and Layout Plan – Reach 7, Drawing No. L14. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 1, Drawing No. L15. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 2, Drawing No. L16. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 3, Drawing No. L17. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 4, Drawing No. L18. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 5, Drawing No. L19. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 6, Drawing No. L20. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Planting, Bioengineering & Features Plan – Reach 7, Drawing No. L21. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Details, Drawing No. L22. Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

Proposed Creek Rehabilitation, Highland Creek, From Markham Rd. (at Progress) to Hwy. 401 (at Progress Avenue): Details, Drawing No. L23 Prepared by Harrington and Hoyle Ltd., Totten Sims Hubicki Associates, and Water Regime Investigations and Simulations Ltd., February 28, 1997.

06. Little Rouge Restoration Project

Location and Access
5726 19th Avenue in Markham

Site Location

Channel Design Rationale
A 'natural' channel design was constructed in order to take an online pond off-line.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a residential property along a fairly large pond. The channel banks are relatively steep and consist primarily of shrubs and grasses. The channel is generally straight.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	1.2	1.5-2.0	n/a	0.3	n/a
Riffle	n/a	1.0-1.5	n/a	0.05-0.20	n/a
Pool	n/a	1.0-1.5	n/a	0.2-0.4	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	none	N/A
Bank Treatment	Fascines	Appear to be functioning as intended.
Riparian Zone	70% of channel length being reforested on both banks.	Established and growing

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	7.3	Good	Narrow planted buffer width
RGA	0.29	In Transition	Widening

Photographs

View of channel looking upstream. Note: vegetation encroachment and steep banks.

View of riparian plantings.

Available Documentation

Letter Correspondence, to Mary Asselstine, From Nigel, regarding 5726 19th Avenue, Markham. August 8, 1996

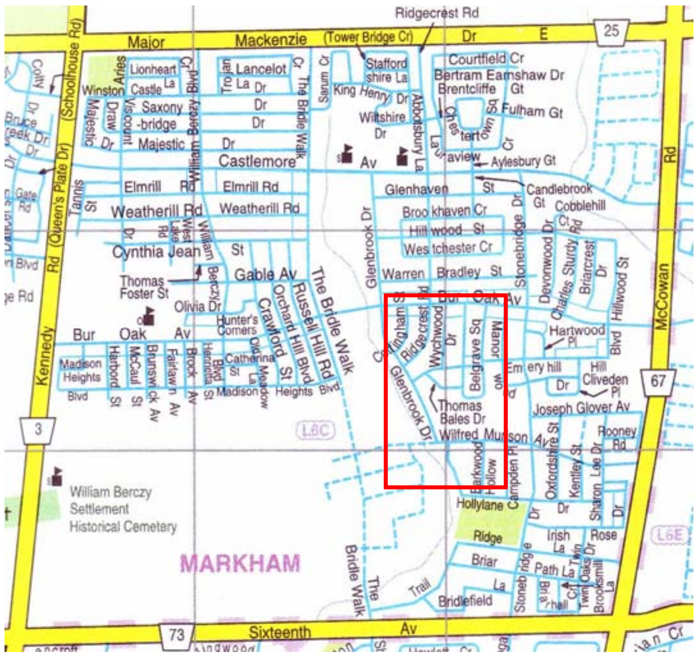
Proposed Bypass Channel, 5726 19th Avenue: Curcio Property – Drawing No. L1 (2 Copies). Prepared by Totten Sims Hubicki Associates., August 6, 1998

Proposed Bypass Channel, 5726 19th Avenue: Curcio Property – Drawing No. L2 (2 Copies). Prepared by Totten Sims Hubicki Associates., August 6, 1998

Subsurface Investigation Pond Berm, 5726 19th Avenue: Part of Lot 31, Concession VII Markham Prepared by Terraprobe, June 3, 1998.

08. Burndenet Creek

Location and Access
The channel design extends in a southerly direction from Bur Oak Avenue to south of Murison Avenue in the Town of Markham. The channel may be accessed from these two streets as well as along any portion of the channel via Glenbrook Drive or Holly Lane.



Site Location

Channel Design Rationale
The channel was lowered to provide an outlet for the upstream stormwater management pond. The channel design was based on an E6 type channel from Rosgen's classification system, in addition to channel geometry equations by Leopold and Wolman.

Pre-construction Site Conditions
Based on photographs of the channel prior to construction, Burndenet Creek was situated in a grass and wetland vegetation dominated area. Flow appeared to be unconfined to a defined channel in many areas. The channel also appeared to have a low width-to-depth ratio and had encroachment by grasses and wetland species.

Existing Site Conditions
The riparian area is vegetated with short grasses, shrubs and both deciduous and coniferous trees. Areas adjacent to the channel are well vegetated with shrubs and trees.

The channel is moderately sinuous with three online wet meadow features. Both the channel and ponds are largely vegetated with cattails, which reduce flow velocities and contribute to the smooth surface flow. The channel bed was designed to be comprised of silt, which has been maintained. Furthermore, the bed morphology was designed to be variable about the average geometry without specifications for riffle or pool geometries. There was, however, little bed variability between riffle and pool sections. Bank erosion was frequently observed, particularly along the outside bank at bends.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	2.8	n/a	0.3	n/a	0.25
Riffle	n/a	2.0	n/a	0.1	n/a
Pool	n/a	2.0-2.2	n/a	0.2-0.3	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle-pool sequences	Riffle-pool sequences observed in field; limited variability with regard to substrate; vegetation establishment in channel
Bank Treatment	Live fascine along outer banks of bends	Not observed in field; frequent outer bank erosion and slumping
	100-200 mm rocks along outer banks with larger stones at base	Not observed in field; frequent outer bank erosion and slumping
Riparian Zone	Tree and shrub plantings	Established and growing
	Seed mix	Mainly short grasses established

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	15.5	Fair	Sediment deposition; bank erosion; instream habitat
Bioengineering and Habitat	5	Fair	Limited variability between riffles and pools
RGA	0.31	In Transition	Widening

Photographs

Meandering channel viewed upstream. Note the vegetation in the channel.

Typical stream section.

Available Documentation

Burndenet Creek Channel Design Brief. Prepared by Cosburn Patterson Mather, February 1999.

Burndenet Creek Channel Lowering, From Station 0+100 to 0+400, Drawing No. 401. Prepared by Cosburn Patterson Mather, February 1999.

Burndenet Creek Channel Lowering, From Station 0+400 to 0+700, Drawing No. 402. Prepared by Cosburn Patterson Mather, February 1999.

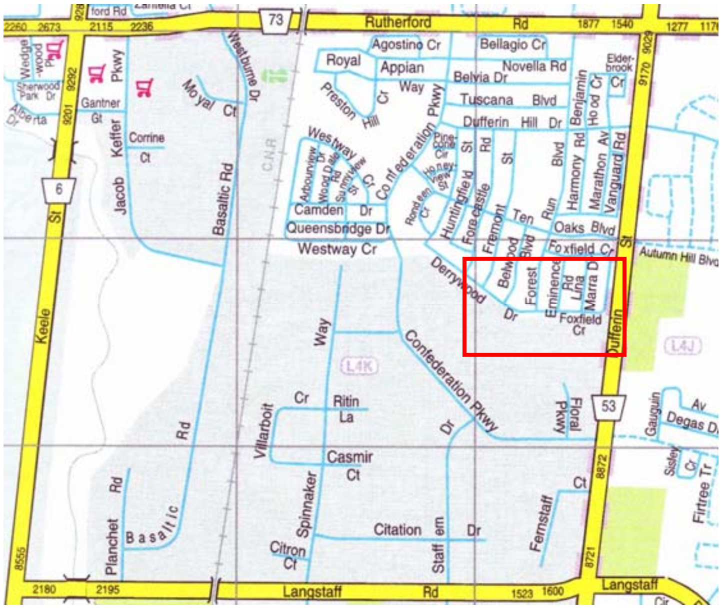
Burndenet Creek Channel Lowering, From Station 0+700 to 0+900, Drawing No. 403. Prepared by Cosburn Patterson Mather, February 1999.

Burndenet Creek Channel Lowering, Details, Drawing No. 404. Prepared by Cosburn Patterson Mather, February 1999.

Burndenet Creek Rehabilitation Planting Plan, Drawing No. RP1. Prepared by Cosburn Giberson Landscape Architects, October 13, 1998.

09. New Westminster Creek

Location and Access
The channel design extends in a southeasterly direction along Derrywood Road, from which the site may be accessed.



Site Location

Channel Design Rationale
Westminster Creek was designed as part of the construction of a stormwater management facility. The channel was generally modelled using a C-type channel as defined under the Rosgen classification system. Further, the channel is located immediately upstream of a stormwater management facility and is designed with consideration of regular flooding.

Pre-construction Site Conditions
Not available.

Existing Site Conditions
At the upstream end of the channel design is a ~4 m drop structure constructed of armour stone. The channel below is situated at the bottom of a basin to accommodate flooding. The riparian zone is well vegetated with grasses, shrubs and both deciduous and coniferous trees.

The channel itself is moderately sinuous and has a low gradient. The entire length of channel is vegetated with cattails. This, in part, reduces flow velocities and promotes sedimentation. As such, the channel bed is comprised of unconsolidated silt and exhibits limited morphological variability.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.5	2.0-3.0	0.29	0.2-0.3	0.176
Riffle	2.7	n/a	0.26 (average)	n/a	n/a
Pool	4.3	n/a	0.33 (average)	n/a	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	None*	Channel colonized by cattails
Bank Treatment	None*	Generally stable banks; likely due to retarded flow velocities
Riparian Zone	Trees and shrubs	Established and growing
	Seeding	Extensive coverage with short grasses

* Design components with respect to the creek and its banks were not observed in the field and not documented in the available package.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	24.5	Good	Sediment deposition, instream habitat
Bioengineering and Habitat	n/a	n/a	No bioengineering or riffle-pool sequences observed
RGA	0.179	In Regime	Aggradation

Photographs

Meandering channel viewed downstream. Note the establishment of vegetation within the channel.

Typical instream section with vegetation.

Available Documentation

Stormwater Management Facilities Implementation Design Report: Dufferin Hill, Block 17 – OPA 400, City of Vaughn, Regional Municipality of York. Prepared by Rand Engineering Corporation, April 1999.

Dufferin Hill – Block 17, External Servicing Works, Block 17 Properties: General Plan, Sheet No. 1. Prepared by Rand Engineering Corporation, September 1998.

Dufferin Hill – Block 17, External Servicing Works, Block 17 Properties: Grading Plan, Stormwater Management Facilities, Sheet No. 2. Prepared by Rand Engineering Corporation, September 1998.

Dufferin Hill – Block 17, External Servicing Works, Block 17 Properties: Grading Plan, Stormwater Management Facilities, Sheet No. 3. Prepared by Rand Engineering Corporation, September 1998.

Dufferin Hill – Block 17, External Servicing Works, Block 17 Properties: Sections, Stormwater Management Facilities, Sheet No. 18. Prepared by Rand Engineering Corporation, September 1998.

Dufferin Hill – Block 17, External Servicing Works, Block 17 Properties: Details, Armour Stone Drop Structure, Sheet No. 22. Prepared by Rand Engineering Corporation, September 1998.

Note: Additional drawings with regard to the stormwater management facility are available as part of the package.

10. East Robinson Creek (Wismer Commons)

Location and Access

The designed channel of Robinson Creek flows in southerly direction from Bur Oak Drive to Edward Jeffreys Avenue in Markham. The site can be accessed from either street, or from any point along Golden Meadow Drive or Raspberry Ridge Drive.

Site Location

Channel Design Rationale

The channel was lowered to enhance stormwater servicing and maximize valleylands within the area.

Pre-construction Site Conditions

The corridor was primarily vegetated with shrub willows and deciduous trees. The channel was widening into the banks and valley slope causing trees to fall. Furthermore, it was downcutting into till or surficial material (sand and gravel). Bankfull width and depth were “indeterminate”, while wetted width was 2.25 m and water depth was 0.2 m. Bankfull gradient was 1.14%.

Existing Site Conditions

The channel can be divided into two reaches based on channel morphology. The channel in the upstream reach (upstream of walkway/culvert) has well formed riffle-pool sequences, and is generally stable due to bioengineering. Most riffle sections are vegetated with cattails. The corridor is well vegetated primarily with dense, tall grasses, which provide channel cover. Wetland features were installed and have maintained their form.

Downstream of the walkway, the channel morphology changes as all riffles are exposed and thus present fish passage issues. The first three upstream riffles are particularly significant as they are constructed with small boulders above bankfull level. As with the upstream reach, the riparian area is well vegetated.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	n/a	n/a	n/a	n/a	0.75
Riffle	1.0	1.5	0.35 (max)	0.2 (max)	n/a
Pool	5.0	2.5	0.70 (max)	0.5 (max)	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle-pool sequences	Riffles and pools in place as designed; vegetation growth in riffle sections; riffles downstream of walkway exposed (in contrast to upstream) during low flow conditions
Bank Treatment	Coir logs (outside banks at bends)	All are intact and providing protection as intended
	Brush mattresses (outside banks at bends)	Shrubs growing on most outside bends
Riparian Zone	Seed mixes	Well established with dense grasses
	Tree plantings	Established and growing

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	30.5	Good	Instream habitat
Bioengineering and Habitat	10	Good	Channel morphology (emergent riffles in downstream reach)
RGA	0.097	In regime	Minor aggradation; minor planform adjustment in downstream reach

Photographs

Pool with coir log along outside bank for stabilization. Note the dense grass in the riparian area.

Riffle section with vegetation encroachment.

Available Documentation

Fish Habitat Evaluation: East Robinson Creek, Wismer Commons. Prepared by Michael Michalski Associates, January 1997.

Wismer Commons, Town of Markham: Stormwater Management, East Robinson Creek, Bio-engineering Plan, Drawing No. C1-B. Prepared by NAK Design Group, June 1999.

Wismer Commons, Town of Markham: Stormwater Management, East Robinson Creek, Planting Plan, Drawing No. C1-A. Prepared by NAK Design Group, June 1999.

Wismer Commons, Town of Markham: Stormwater Management, East Robinson Creek, Staging Plan, Drawing No. C1-C. Prepared by NAK Design Group, June 1999.

Wismer Commons, Town of Markham: Construction Details, Drawing No. D2. Prepared by NAK Design Group, June 1999.

Wismer Commons: S.W.M. Pond #1, Outfall at Channel, Drawing No. TSWM-14. Prepared by Schaeffers Consulting Engineers, April 21, 1999.

Wismer Commons: Plan and Profile, Stream Channel Layout, Sta. 0+000 to Sta. 0+225.770, Drawing No. TSWM-17. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: Plan and Profile, Stream Channel Layout, Sta. 0+225.770 to Sta. 0+513.451, Drawing No. TSWM-18. Prepared by Schaeffers Consulting Engineers, December 1999.

Wismer Commons: Plan and Profile, Stream Channel Layout, Sta. 0+513.451 to Sta. 0+625.000, Drawing No. TSWM-19. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: East Stream Channel, Cross-sections 1 to 4, Drawing No. TSWM-20. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: East Stream Channel, Cross-sections 5 to 8, Drawing No. TSWM-21. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: East Stream Channel, Cross-sections 9 to 11 and Typical Pool & Riffle Detail, Drawing No. TSWM-22. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: East Stream Channel, Cross-sections 12 to 14, Drawing No. TSWM-23. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: East Stream Channel, Cross-sections 15 to 18, Drawing No. TSWM-24. Prepared by Schaeffers Consulting Engineers, April 1999.

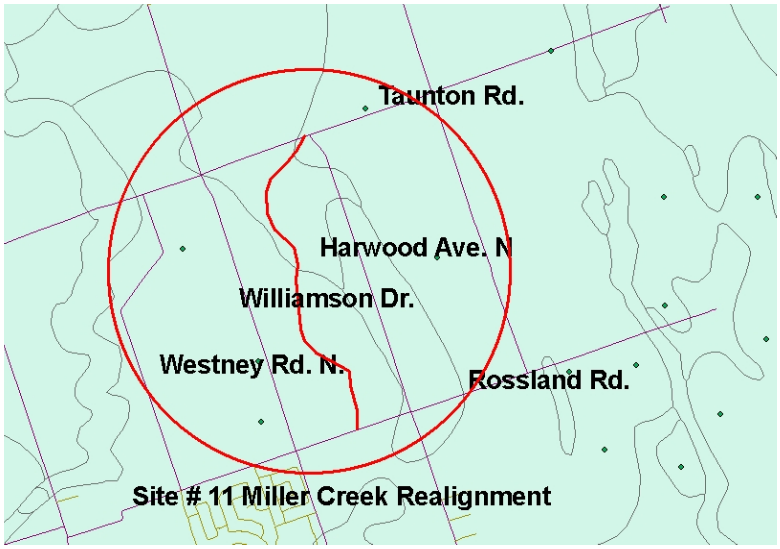
Wismer Commons: East Stream Channel, Cross-sections 19 to 21, Drawing No. TSWM-25. Prepared by Schaeffers Consulting Engineers, April 1999.

Wismer Commons: Detail of 4.88mx1.52m Con-Span Culvert Crossing Edward Jeffreys Avenue (East Channel), Drawing No. TSWM-26. Prepared by Schaeffers Consulting Engineers, May 1999.

Note: Additional documentation with regard to S.W.M. facility pond and West Robinson Creek available with package.

11. Miller Creek

Location and Access
Taunton Road and Westney Road in Ajax.



Site Location

Channel Design Rationale
Re-creation of a meandering stream form with riffle-pool sequences. Reconnect the floodplain. Mitigation of a barrier to fish passage. Valley corridor improvement through plantings.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a wide floodplain bordered by residential property. The channel is sinuous with a generally low gradient. Riparian vegetation is predominantly grasses.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	5.5-6.0	3.5-4.0	0.3-0.4	0.4	n/a
Riffle	5.70-7.11	2.0-2.5	0.24-0.27	0.05-0.15	n/a
Pool	5.48-6.53	5.0-6.0	0.41-0.44	0.2-0.6	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffles	Vegetation encroachment into riffles
Bank Treatment	Cribwalls	Only one instance of some degree of failure
Riparian Zone	Grass seed mix	Riparian vegetation in good condition

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	11.0	Good	Vegetation encroachment
Bioengineering and Habitat	8.8	Good	Type of vegetation
RGA	0.26	In Transition	Widening; planimetric adjustment

Photographs

View of channel looking upstream. Note: vegetation encroachment and exposed riffle materials.

Available Documentation

Miller Creek Realignment and Natural Channel Design Brief, Development Area A6, Neighbourhood 2 Lands, Town of Ajax, Prepared by Cosburn Patterson Mather Limited, February 2000.

Flood Plain Map, Prepared for Runnymede Development Corp., Town of Ajax, Prepared by Sabourn Kimble & Associates Ltd., June 2004, HEC 2

Lot Grading Plan Area 1 Millward Crescent, Prepared for Rennymede Westney Ltd., Town of Ajax – Drawing No. 412. Prepared by Sabourn Kimble & Associates Ltd., July 2002

Lot Grading Plan Area 2 Enclave 2B, Prepared for Rennymede Westney Ltd., Town of Ajax, - Drawing No. 214. Prepared by Sabourn Kimble & Associates Ltd., April 2000

Lot Grading Plan Area 3 Central South, Prepared for Starstoke Developments Inc., Town of Ajax – Drawing No. 507. Prepared by Sabourn Kimble & Associates Ltd., May 2003

Lot Grading Plan Area 3 Central, Prepared for Starstoke Developments Inc., Town of Ajax – Drawing No. 508. Prepared by Sabourn Kimble & Associates Ltd., May 2003

Lot Grading Plan Area 3 Central North, Prepared for Starstoke Developments Inc., Town of Ajax – Drawing No. 509. Prepared by Sabourn Kimble & Associates Ltd., May 2003

Lot Grading Plan Area 3 North, Prepared for Starstoke Developments Inc., Town of Ajax – Drawing No. 510. Prepared by Sabourn Kimble & Associates Ltd., May 2003

Fax Correspondence: Fisheries Act Authorization, Miller Creek Realignment, Fish Habitat Management, Fisheries and Oceans Canada; CFN 31250

12. Don River Tributary

Location and Access
Highway 400 and Major Mackenzie Drive in Vaughan.

Site Location

Channel Design Rationale
.Naturalized valley corridor with low-flow meandering channel.

Pre-construction Site Conditions
Not available.

Existing Site Conditions
The channel flows through a wide floodplain bordered by residential land. The channel is sinuous with a low gradient. Riparian vegetation is predominantly grasses with some grasses and trees.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	1.8	3.0	0.35	0.35	0.25
Riffle	1.0	2.0	N/A	0.05	0.09
Pool	1.0	2.5	0.55	0.45	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Pools and offline ponds; plunge pool at future water quantity control berm; skid lunkers; cable stayed trees.	Appear to be functioning as intended
Bank Treatment	None	N/A
Riparian Zone	15 m both banks; 100% channel length (20% deciduous tree cover; 10% coniferous tree cover; 10% shrub cover; 60% herbaceous lowland and upland seed mixes).	Riparian vegetation in good condition

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	6	Fair	All riffles emergent and vegetated (upstream section)
Bioengineering and Habitat	6.4	Good	Minor patches of erosion associated with bioengineering components
RGA	0.29	In Transition	Widening

Photographs

View looking upstream from Highway 400. Note: well established riparian vegetation

View looking upstream from most downstream extent of NCD. Note: wide floodplain, offline pond features, sinuous channel.

Available Documentation

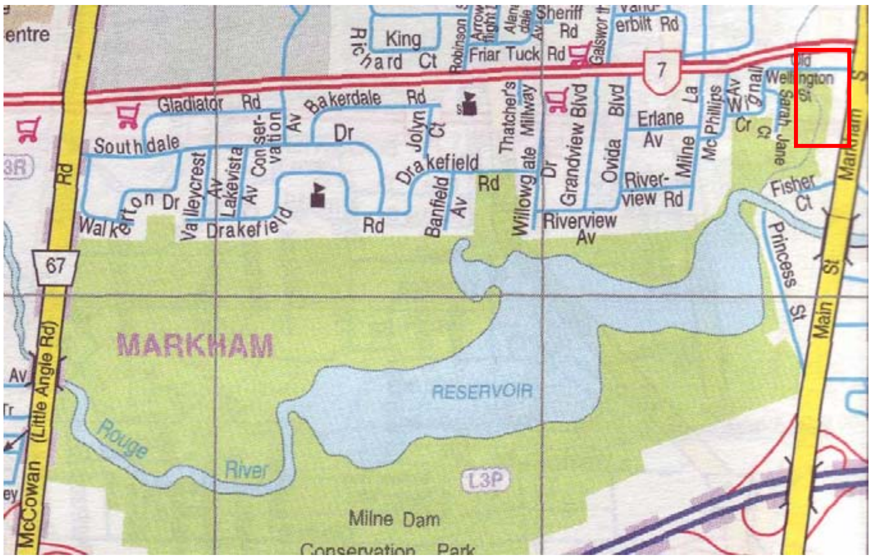
Dillon Consulting. OPA 400 – Block 32 (Wes) and Vaughn Centre. Fisheries Compensation Plan – Overview. Submitted to TRCA – April 13, 1999

Schaeffers Consulting Engineers. Addendum to the Stormwater Management Design Report. SWM Facilities and Valley Works- Vellore Woods Community (Block 32-West), City of Vaughn. April 1999.

13. Robinson Creek

Location and Access

The channel design portion of Robinson Creek is located immediately south of the culvert under Highway 7 and Old Wellington Road to the west of Markham Road. The site is accessed from the north end of the channel off of Old Wellington Street, which in a westerly direction from Markham Road.



Site Location

Channel Design Rationale

Not available.

Pre-construction Site Conditions

The drawing of the channel prior to construction shows that the channel alignment has not changed significantly. The pre-existing channel was slightly less sinuous and the second bend was relatively sharp.

Existing Site Conditions

The construction of 238 m of channel took place in 2000 and 2001. Compared to pre-construction conditions, the channel corridor exhibits greater variability with respect to channel alignment and riparian habitat. Vortex weirs were installed to provide grade control in this steep reach.

Erosion along the outer banks is evident and the material used to harden the bank at the first bend has been exposed. Till is exposed on the bed from the second bend to the downstream limit of the channel design. It is also exposed along the base of the bank at the second increasing to above bankfull level at the third bend. The southeast bank of the generally straight section of channel between the second and third bends has been eroded and a steep bank largely comprised of till remains.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.50	n/a	n/a	n/a	1.44
Riffle	3.50	3.0	0.30 (max)	0.2 (max)	2.75
Pool	4.00	3.5	1.15 (max)	0.5 (max)	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Rock vortex weirs comprised of a single row of ~1 m diameter stones	Maintaining form; generally functioning as designed although the bed has scoured and till is exposed downstream of the second bend; third weir outflanked on outside of bend; second last weir outflanked on both sides
Bank Treatment	Brush mattresses along outside banks of bends	No evidence of brush mattresses
	Outer bank of first bend comprised of a mix of large stones, broken concrete blocks, cinder blocks and other miscellaneous materials	Bank is eroded and materials have been deposited in the channel
Riparian Zone	Tree plantings	Immature with protective shield
	Seeding	Very dense, especially 150 m upstream reach
	Pond (x2) installation	One offline pond located on the inside of meander bend; the other pond located on outside of same bend but connected to pool below a stormwater outfall, which drains into another stormwater outfall pool and finally into Robinson Creek at the 4th bend

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
MRSAT Bioengineering and Habitat	19	Fair	Channel stability
RGA	0.45	In Adjustment	Widening and degradation

Photographs

Downstream view of channel at first bend. Note the erosion of the right bank.

One of ten rock vortex weirs used for grade control.

Available Documentation

Robinson Creek Natural Channel Design: Existing Conditions and Phasing Plans, Drawing No. L1. Prepared by Harrington and Hoyle Ltd., July 2000.

Robinson Creek Natural Channel Design: Grading and Layout Plans, Drawing No. L2. Prepared by Harrington and Hoyle Ltd., July 2000.

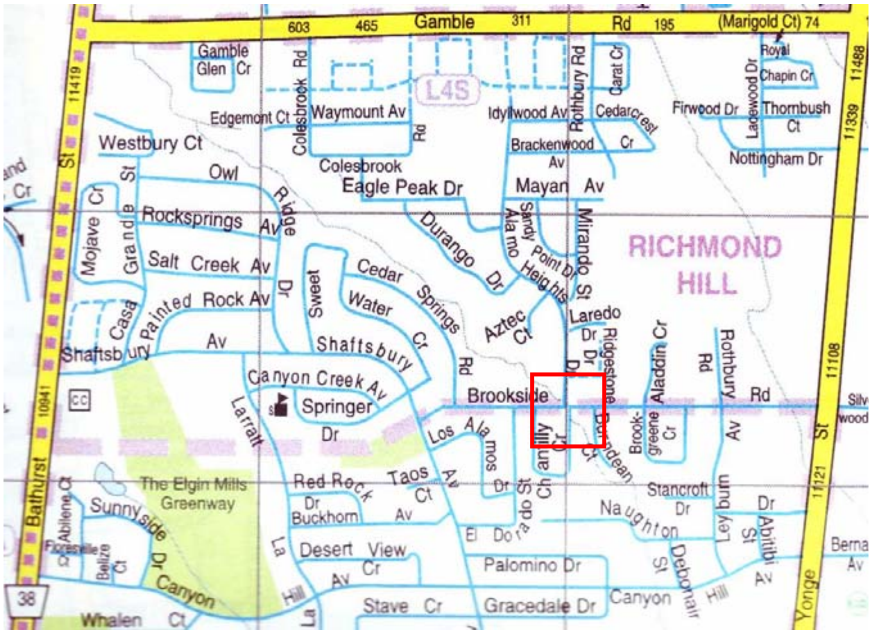
Robinson Creek Natural Channel Design: Plan Enlargements and Details, Drawing No. L3. Prepared by Harrington and Hoyle Ltd., July 2000.

Robinson Creek Natural Channel Design: Planting Plan, Drawing No. L4. Prepared by Harrington and Hoyle Ltd., July 2000.

Hydraulic Report: Robinson Creek, Markham, Ontario. Prepared by Totten Sims Hubicki Associates, March 14, 2000.

14. German Mills Creek

Location and Access
The channel design portion of German Mills is located immediately upstream of Brookside Road, between Chantily Crescent and Burndean Court, in Richmond Hill.



Site Location

Channel Design Rationale
Not available.

Pre-construction Site Conditions
Documentation of the channel prior to construction is unavailable. The channel reach upstream of the design may, however, provide a picture of past channel conditions. The channel here exhibits evidence of instability. Trees have fallen or are leaning into the channel and roots are exposed. The overbank area is generally flat and vegetated primarily with mature trees.

Existing Site Conditions
The channel corridor is comprised of a low sinuosity channel bounded by valley slopes, which are graded upwards from the edge of the channel. The valley slopes are vegetated with shrubs and trees.

The bed is lined with macrophytes along much of the design channel. The water therefore flows over vegetation. Pool substrate is mainly silt and sand, and exposed riffles are generally made up of small cobbles.

There is no erosion along the design channel as energy is largely dissipated by in-channel vegetation and due to the high width-to-depth ratio of the channel cross-section.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.00	n/a	n/a	n/a	3.00
Riffle	3.00	1.5	n/a	0.15 (max)	n/a
Pool	3.00	2.0	0.40 (max)	0.3 (max)	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle and pool sequences, the former comprised of 150 mm (D_{50}) stones	Macrophytes have grown over most riffles and pools, in part or in entirety; exposed riffle materials are small cobbles and pools are generally silt and sand
Bank Treatment	Brush mattresses along outside banks of bends	Shrubs have established along the sections of the bank although not strictly along outside bends
Riparian Zone	Tree and shrub plantings	Immature trees and shrubs have established
	Seeding	Short grasses and herbaceous species growing

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	25	Good	Channel stability
Bioengineering and Habitat	7	Fair	Bed morphology variability
RGA	0.21	In Transition	Planform adjustment

Photographs

Channel corridor viewed upstream from Brookside Road.

Channel with abundant macrophyte.

Available Documentation

Brookside Road, German Mills Creek Approach Channel Plan View, Drawing No. 1605PP16. Prepared by Mitchell, Pound & Braddock, July 2000.

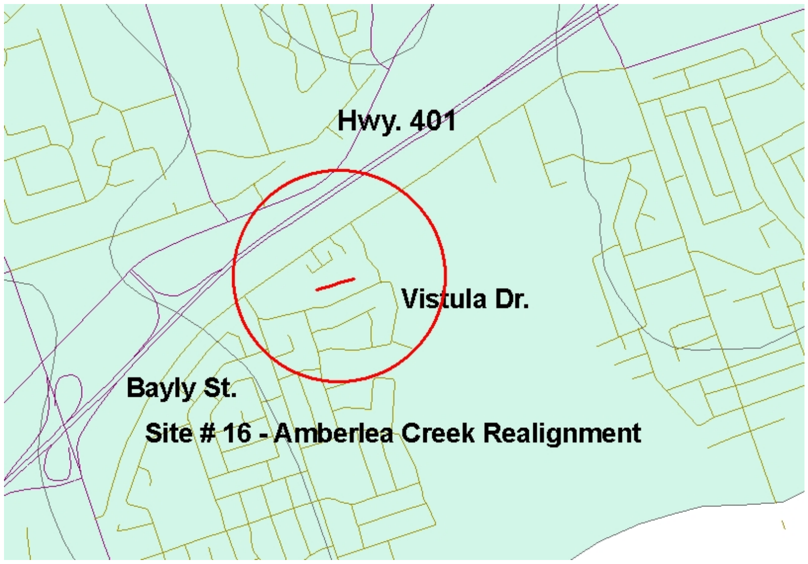
Brookside Road, German Mills Creek Approach Channel Details, Drawing No. 1605PP17. Prepared by Mitchell, Pound & Braddock, July 2000.

Brookside Road, German Mills Creek Approach Channel Details, Drawing No. 160SLA01. Prepared by Mitchell, Pound & Braddock, August 2000.

German Mills Creek Culvert Crossing & Details, Drawing No. 1605CD03. Prepared by Mitchell, Pound & Braddock, February 2000.

16. Amberlea Creek

Location and Access
Bayly Street and Vistula Drive in Pickering.



Site Location

Channel Design Rationale
Not identified.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a narrow floodplain bordered by residential property. The channel is sinuous with a generally low gradient. Riparian vegetation is predominantly trees and shrubs. There is extensive bank erosion and till exposure immediately upstream of the 'natural' channel design.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.5	3.0-4.0	0.5	0.4	1.68
Riffle	4.0	1.0-2.0	N/A	0.1-0.25	n/a
Pool	4.0	1.5-2.0	0.57-0.64	0.2-0.4	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs and rocky ramps.	Minor outflanking of riffles; pools poorly formed
Bank Treatment	Armourstone and plantings	Appear to be functioning as intended
Riparian Zone	3 m both banks; 100% of channel length (70% shrub cover; 30% deciduous tree cover).	Riparian vegetation in good condition

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	7.0	Good	Narrow riparian planting corridor
RGA	0.33	In Transition	Degradation; widening

Photographs

View of channel looking downstream. Note: well developed point bar and minor erosion behind rock treatment. Vortex weir (foreground) appears to be functioning as intended.

View of channel looking upstream. Note: well developed pool riffle sequences. Vortex weirs appear to be functioning as intended.

Available Documentation

Construction Staging and Sediment Control Plan, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L1. Prepared by Schollen and Company., July 2001

Layout and Grading Plan, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L2. Prepared by Schollen and Company., July 2001

Planting Plan 1, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L3. Prepared by Schollen and Company., July 2001

Landscape Details, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L4. Prepared by Schollen and Company., July 2001

Planting Plan 2, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L5. Prepared by Schollen and Company., July 2001

Landscape Sections, Bayly Street & Vistula Drive, Pickering: Amberlea Creek Stabilization Ph II – Drawing No. L6. Prepared by Schollen and Company., July 2001

18. Morningside Tributary

Location and Access
Staines Road and Morningside Avenue Extension.

Site Location

Channel Design Rationale
Channel realignment to restore form and function of stream corridor and aquatic habitat. Fluvial geomorphology principles, detailed geomorphic investigations, accommodate proposed post development flow regime while creating a dynamically stable form and diverse aquatic habitat.

Pre-construction Site Conditions
Significant lengths of valley are linear, limiting planform configuration. Confluence of Morningside and Neilson tributaries must be properly constructed. Hydro towers are located within the valley corridor.

Existing Site Conditions
The channel flows through a wide floodplain bordered by residential property. The channel is sinuous with a generally low gradient. Riparian vegetation is predominantly grasses and shrubs.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	1.8	4.0	0.3	0.4	0.18
Riffle	5.2	1.5-2.0	0.45	0.05-0.15	1.0
Pool	5.5	2.0-2.5	0.5	0.3-0.5	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs and rocky ramps.	Minor outflanking of riffles
Bank Treatment	Planting of deep rooting native grasses; high root density plants on outside meander bends, erosion control blankets.	Appear to be functioning as intended
Riparian Zone	Unknown	Riparian vegetation in good condition

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	8.0	Good	Sparse riparian plantings
RGA	0.18	In regime	Degradation; widening

Photographs

View of channel looking downstream. Note: riffle section appears to be functioning as intended. Some bank erosion and outflanking seen along left bank.

View of channel looking upstream. Note: sinuous channel and well vegetated banks.

Available Documentation

Monitoring Report: Morningside Tributary at Morningside Heights Development Natural Channel Design. Prepared by Parish Geomorphic, January 15, 2004 (2 Copies)

Monitoring Report Draft: Morningside Creek and Neilson Tributary within the Morningside Heights Community Area. Prepared by Ecoplans Limited, June 2004

Letter of Intent to Implement Compensation, Mitigation and Monitoring Measures for the Harmful Alteration, Disruption or Destruction of Fish Habitat for Channel Reconfiguration of the Morningside and Neilson Tributaries in the City of Toronto. Prepared by Ecoplans Limited, April 2001

Devastation of the Morningside Tributary of the Rouge Park: Presentation to TRCA Board. October 19 2001

Monitoring Report (Year 1, 2003): Morningside Creek and Neilson Tributary within the Morningside Heights Community Area. Prepared by Ecoplans Limited, June 2004

Drawing Legend: List of Drawings prepared by LEA Consulting Ltd.

Grading Plan, City of Toronto, Works and Emergency Department: Brookside Subdivision Ph I. – Drawing No. GR-4. Prepared by Schaeffers Consulting Engineers, February 2002

Siltation Control Plan, City of Toronto, Works and Emergency Department: Morningside Heights – Core Services – Drawing No. SC-2BB. Prepared by Schaeffers Consulting Engineers, February 22, 2002 (3 Copies)

Morningside Heights Subdivision Prop. Con-Span Culvert Crossing Street 'B', Toronto: Culvert Details – Drawing No. SWM-20. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Prop. Con-Span Culvert Crossing Street 'B', Toronto: Culvert Details – Drawing No. SWM-21. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Prop. Con-Span Culvert Crossing Street 'B', Toronto: Culvert Details – Drawing No. SWM-22. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Prop. Con-Span Culvert Crossing Street 'B', Toronto: Culvert Details – Drawing No. SWM-23. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Staines Road. Toronto: Culvert Details – Drawing No. SWM-23A. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Staines Road. Toronto: Culvert Details – Drawing No. SWM-23B. Prepared By Schaeffers Consulting Engineers, January 2001

Morningside Heights Subdivision Precast Wingwall Details of Culvert Crossing Street F & B, Toronto: Drawing No. SWM 24. Prepared by Schaeffers consulting Engineers, January 2001 (2 Copies)

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 25. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 26. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 27. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 28. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 29. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 30. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 31. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel: Drawing No. SWM 32. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 10, 11 & 12: Drawing No. SWM 33. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 13, 14 & 17: Drawing No. SWM 34. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 18, 18.1 & 18.2: Drawing No. SWM 35. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 19, 19.1 &19.9: Drawing No. SWM 36. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 20, 20.1 & 21.2: Drawing No. SWM 37. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 22, 23 & 25: Drawing No. SWM 38. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 26, 26.1, 27 & 27.05: Drawing No. SWM 39. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 27.1, 27.2 & 28: Drawing No. SWM 40. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Morningside Tributary Channel, Sections 28.1, 29 & 29.2: Drawing No. SWM 41. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Typical Low Flow Cross Sections, Pool 1, 2, 3 & 5: Drawing No. SWM 42. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Typical Low Flow Cross Sections, Pool 4, Riffle 1, 2 & 3: Drawing No. SWM 43. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Typical Low Flow Cross Sections Riffle A, B & C: Drawing No. SWM 44. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Typical Low Flow Cross Sections TR 1-3 & Riffle 4: Drawing No. SWM 45. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Typical Low Flow Cross Sections Riffle A, B & C: Drawing No. SWM 44. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Neilson Tributary Channel: Drawing No. SWM 46. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Neilson Tributary Channel: Drawing No. SWM 47. Prepared by Schaeffers consulting Engineers, January 2001 (2 Copies)

Morningside Heights Subdivision, Neilson Tributary Channel, Typical Low Flow Sections: Drawing No. SWM 48. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision, Creek Improvement South of CPR: Drawing No. SWM 49. Prepared by Schaeffers consulting Engineers, January 2001

Morningside Heights Subdivision Subdivision Creek Improvement South of CPR Sections 5 to 6, Toronto: Drawing No. SWM 50. Prepared by Schaeffers consulting Engineers, January 2001

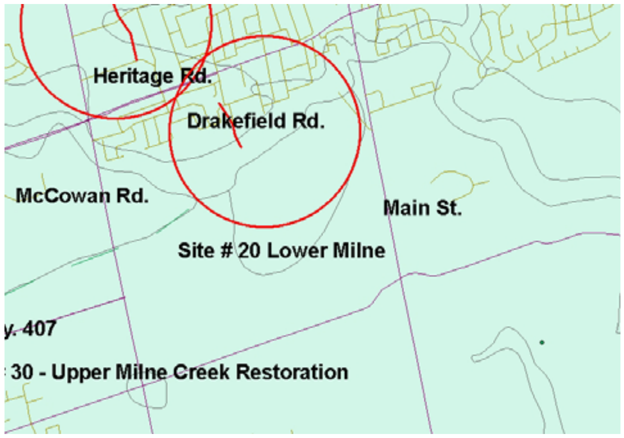
Morningside Heights Subdivision Subdivision Creek Improvement South of CPR Sections 6.5 and A to B, Toronto: Drawing No. SWM 51. Prepared by Schaeffers consulting Engineers, January 2001 (2 Copies)

Morningside Heights Subdivision Subdivision Creek Improvement South of CPR Sections C to F, Toronto: Drawing No. SWM 52. Prepared by Schaeffers consulting Engineers, January 2001 (2 Copies)

Valley Design Report, Morningside and Neilson Tributaries: Morningside Heights, Toronto. Prepared by Schaeffers Consulting Engineers, February 2001

20. Lower Milne

Location and Access
McCowan Road and Highway 7 in Markham.



Site Location

Channel Design Rationale
To improve the health of the river and valley system, while addressing flood and erosion control issues. Enhancement of fish habitat also desired, including removal of barriers within the reach.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a narrow floodplain bordered by residential property. The channel is generally straight with a generally moderate to high gradient. Riparian vegetation is predominantly grasses and shrubs.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	4.0	3.0	1.0	0.4	1.0
Riffle	4.0	1.5-2.0	0.7	0.05-0.15	0.02
Pool	5.0	2.0-2.5	1.0	0.2-0.4	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs.	Outflanking, winnowing and complete failure of majority of riffles
Bank Treatment	Armourstone, brush layers; brush mattresses; fascines; live stakes; crib walls.	Minor patches of erosion around bioengineering components, crib walls in excellent condition, fascines generally in excellent condition
Riparian Zone	5 m both banks; 100% channel length (10% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover; 40% seed mixture).	Riparian vegetation in good condition

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	8.5	Fair	Outflanking, winnowing and complete failure of majority of riffles
Bioengineering and Habitat	5.2	Fair	Minor patches of erosion around bioengineering components; Narrow riparian planting corridor
RGA	0.37	In Transition	Degradation; widening

Photographs

View of channel looking downstream. Note: fascines doing well along right bank.

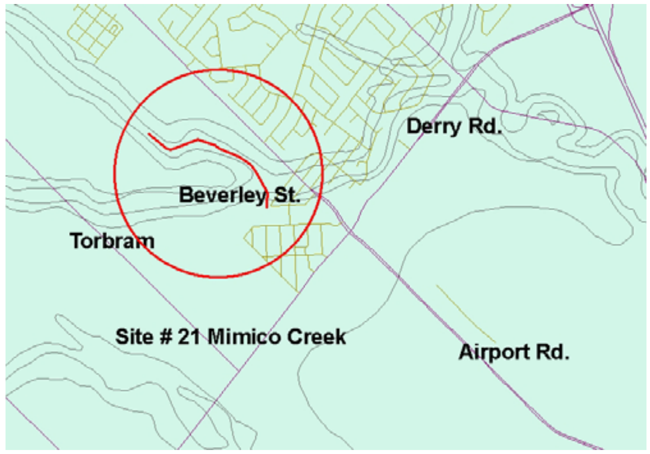
View of channel looking downstream. Note: good point bar development, high survival rate of crib wall plantings and crib wall providing good pool development.

Available Documentation

Class Environmental Assessment, Markham Ontario: Milne Creek Restoration Project. Prepared by Totten Sims Hubicki associates., March 31, 2000

21. Mimico Creek

Location and Access
Airport Road and Slough Road in Mississauga.



Site Location

Channel Design Rationale
Reconstruct an existing stream, narrow the valley, remove fish barrier.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a wide floodplain bordered by fallow agricultural land. The channel is generally straight with a low gradient. Riparian vegetation is predominantly grasses.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	4.0	2.5	0.54	0.5	1.0
Riffle	4.0	2.0-2.5	N/A	0.05-0.15	N/A
Pool	4.0	2.5-3.5	N/A	0.3-0.7	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs.	Outflanking common
Bank Treatment	Live stakes.	Minor patches of erosion around bioengineering components, crib walls in excellent condition, fascines generally in excellent condition
Riparian Zone	15 m both banks; 100% channel length (10% deciduous tree cover; 10% coniferous tree cover; 30% shrub cover; 50% herbaceous seed mix).	Riparian vegetation in good condition.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	6.6	Good	Narrow riparian planting corridor
RGA	0.25	In Transition	Widening

Photographs

View of channel looking downstream. Note: riparian vegetation appears to be functioning well.

View of channel looking upstream. Note: riffle structures generally functioning as intended.

Available Documentation

Assessment and Design Report, Orfus Realty Lands: Valley Corridor Assessment and Design, Second Submission report, City of Mississauga, Prepared by Dillon Consulting Limited, November 11, 2002.

Proposed Regional Flood Line: Orfus Realty Industrial Subdivision – Drawing No. CH-2A. Prepared by Dillon Consulting, May 13, 2002.

Proposed Regional Flood Line: Orfus Realty Industrial Subdivision – Drawing No. CH-2B. Prepared by Dillon Consulting, May 13, 2002.

Bioengineering Plan and Profile: Orfus Realty Industrial Subdivision – Drawing No. CH-4. Prepared by Dillon Consulting, April 30, 2002 (3 Copies)

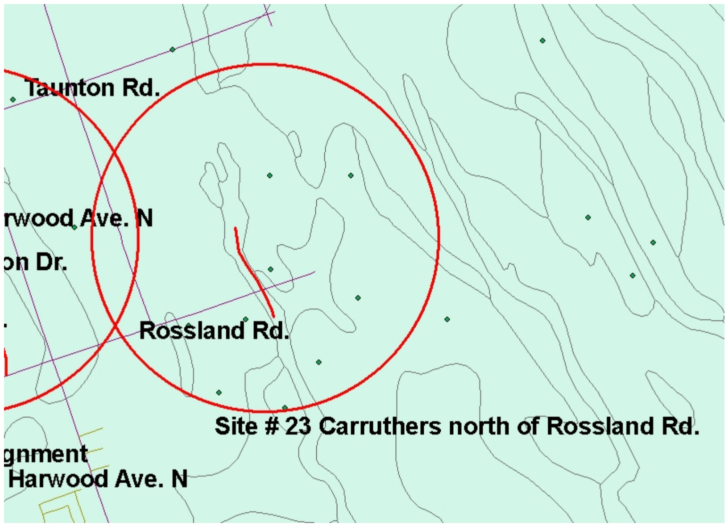
Planting Plan: Orfus Realty Industrial Subdivision – Drawing No. CH-5. Prepared by Dillon Consulting, April 30, 2002. (2 Copies)

Bioengineering and Planting Details: Orfus Realty Industrial Subdivision – Drawing No. CH-6. Prepared by Dillon Consulting, April 30, 2002. (2 Copies)

Erosion Control Details: Orfus Realty Industrial Subdivision – Drawing No. ER 2. Prepared by Dillon Consulting, May 13, 2002.

23. Carruthers Creek

Location and Access
Rossland Road west of Audley Road in Ajax.



Site Location

Channel Design Rationale
Realignment of 26.5 m of creek, incorporating riffle pool sequences into design to enhance fish habitat. Installation of riparian plantings.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a fairly wide forested floodplain. The channel is sinuous with a low gradient. Riparian vegetation is grasses, shrubs and trees.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	5.0	3.0	1.2	0.5	1.0
Riffle	4.0	2.0	0.2	0.1-0.2	0.3
Pool	5.0	2.0	1.2	0.4-0.5	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Boulder placement	Minor pool formation immediately downstream
Bank Treatment	Vegetated 600 mm rock protection.	Appears to be functioning as intended
Riparian Zone	3 m both banks; 100% channel length (50% shrub cover; 25% deciduous tree cover; 25% coniferous tree cover)	Riparian vegetation in good condition. However, plantings tend to be sparse.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	6.0	Fair	Narrow riparian planting corridor
RGA	0.14	In Regime	None

Photographs

View of channel looking upstream. Note: vegetated rip rap lining both banks.

View of channel looking upstream. Note: riffle structure and boulder placement generally functioning as intended.

Available Documentation

Rossland Road Bridge, Over Carruthers Creek; General Arrangement, Prepared for The Corporation of the Town of Ajax Planning and Development Department, Town of Ajax – Drawing No. S1, June 20, 2003

Rossland Road Bridge, Over Carruthers Creek; Fish and Habitat Improvement and Erosion & Sediment Control Plan, Prepared for The Corporation of the Town of Ajax – Drawing No. E1 Planning and Development Department, Town of Ajax, July 31, 2003

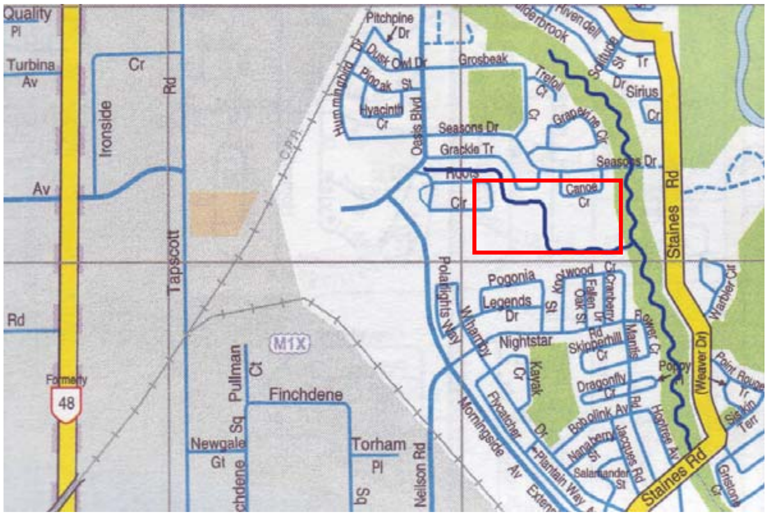
Fax Correspondence: Overdue Monitoring Report, Fish Habitat Management, Fisheries and Oceans Canada; CFN 34259

Report on Geotechnical Investigation Proposed Rossland Road Reconstruction and Carruthers Creek Water Crossing Structure, Ajax, Prepared by Golder Associates Ltd. March 2003

Letter Correspondence to Briar Young, Rossland Road Bridge Replacement over Carruthers Creek, Town of Ajax, Prepared by Warm Engineering and Biological Services, January 2005

24. Neilson East Tributary

Location and Access
The 520 m channel design extends in a westerly direction from the corner of Oasis Blvd. and Raponi Circle in Scarborough. It is most easily accessed from this upstream end.



Site Location

Channel Design Rationale
The channel was realigned to convey post-development flows and accommodate the development of surrounding lands.

Pre-construction Site Conditions
The first 150 m of channel from Oasis Blvd. was not part of the channel design. The corridor, however, was densely vegetated and grasses have encroached into the channel, a condition that may not have existed prior to planting. The condition of the downstream pre-design channel is unknown as documentation was not available. It is likely that the channel was similar to the upstream reach. Again, the impact of vegetation is unknown.

Existing Site Conditions
The corridor is well vegetated with grasses, particularly in the upstream reach where a channel design was not applied. Grasses here have encroached into the channel such that the channel is not well defined for much of its length. The channel is generally straight.

The designed channel reach exhibits a relatively sinuous planform and has riffle-pool sequences. Quantity of tree plantings is greater. Density and height of grasses in the riparian zone are reduced and grass encroachment into the channel is negligible.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	n/a	n/a	n/a	n/a	0.94
Riffle	n/a	1.5	n/a	0.15 (max)	n/a
Pool	n/a	2.5	n/a	0.4 (max)	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle-pool sequences	Maintaining form; functioning as designed
Bank Treatment	Coir cloth along entire length of channel design	Intact and operating as intended
	Coir logs along outside banks of bends	Unnoticeable as they are under coir cloth
Riparian Zone	Tree plantings	Established and maturing
	Seeding	Very dense, especially 150 m upstream reach

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
MRSAT	25.5	Good	Fair instream & riparian habitats; moderate sedimentation
Bioengineering and Habitat	11	Good	No issues
RGA	0.17	In Regime	Widening and planform adjustment

Photographs

View of channel looking downstream. Note: riffle section appears to be functioning as intended.

View of channel looking downstream. Note: well vegetated banks and riparian zone.

Available Documentation

Email Correspondence to Nancy Dionne, regarding Neilson East Subdivision. October 22, 2003

Letter Correspondence to Russel White, from David Schaeffer Engineering Ltd., regarding Mattamy (Neilson East) Subdivision. October 27, 2003

Letter Correspondence to Aaron Wisson, from Fisheries and Oceans Canada, regarding Authorization for the harmful alteration, disruption or destruction of fish habitat pursuant to subsection 35(2) of the *Fisheries Act*. November 12, 2003

Cover Sheet, Neilson East Subdivision, City of Toronto: Neilson Tributary Channel – 6th submission, Drawing No. C-1. Prepared by The MBTW Group., May 2002

Channel Sections, Neilson Tributary, City of Toronto: Mattamy (Neilson East) Subdivision – Drawing No. 16. Prepared by David Schaeffer Engineering Ltd., May 2002

Riparian Planting Plan, Neilson Tributary Channel, City of Toronto: Neilson East Subdivision, Neilson Tributary Channel – 6th submission Drawing No. PL-3. Prepared by The MBTW Group., May 2002

Details, Neilson East Subdivision, City of Toronto: Neilson Tributary Channel – 6th submission, Drawing No. D-2. Prepared by The MBTW Group., May 2002

General Plan, Mattamy Neilson Subdivision, City of Toronto – Drawing No. 1. Prepared by David Schaeffer Engineering Ltd., June 2002

Plan Lists, Neilson Tributary Channel, City of Toronto: Neilson East Subdivision – Drawing No. D-1. Prepared by The MBTW Group., May 2002

Riparian Planting Plan, Neilson Tributary Channel, City of Toronto: Neilson East Subdivision – Drawing No. PL-1. Prepared by The MBTW Group., May 2002

Riparian Planting Plan, Neilson Tributary Channel, City of Toronto: Neilson East Subdivision – Drawing No. PL-2. Prepared by The MBTW Group., May 2002
Hydraulic and Riparian Storage Analysis, City of Scarborough: Morningside Heights Neilson Tributary Improvements.

Prepared by David Schaeffer Engineering Ltd., October 2003

25. Hoover Creek (Black Creek Tributary)

Location and Access
The 150 m channel design extends in a southerly direction from The Pond Road, from which the site may be accessed.

Site Location

Channel Design Rationale
The channel was rehabilitated in part to improve fish habitat as compensation for the construction of the National Tennis Centre and the associated removal of a small intermittent channel locate in the uppermost reaches of Hoover Creek.

Pre-construction Site Conditions
The corridor was primarily vegetated with shrub willows and deciduous trees. The channel was widening into the banks and valley slope causing trees to fall. Furthermore, it was downcutting into till or surficial material (sand and gravel). Bankfull width and depth were "indeterminate", while wetted width was 2.25 m and water depth was 0.2 m. Bankfull gradient was 1.14%.

Existing Site Conditions
The channel flows through a narrow floodplain bordered by a narrow strip of forested land. The channel is fairly straight with a generally high gradient. Riparian vegetation is predominantly trees and shrubs.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	9	n/a	0.3	n/a	2.6
Riffle	n/a	1.6	n/a	0.1 (max)	4.5
Pool	n/a	2.2	n/a	0.4 (max)	1.4

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Riffle-pool sequences	Maintaining form; functioning as designed
Bank Treatment	Coir cloth along entire length of channel design	Intact and operating as intended
	Coir logs along outside banks of bends	Unnoticeable as they are under coir cloth
Riparian Zone	Tree plantings	Established and maturing
	Seeding	Very dense, especially 150 m upstream reach

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	19	Fair	Stability, downcutting
Bioengineering and Habitat			
RGA	0.33	In Transition	Downcutting, widening

Photographs

A former riffle-pool sequence viewed upstream. Note the degradation and bank erosion.

Downstream view of channel bend. Note the degradation and bank erosion.

Available Documentation

Hoover Creek Fish Habitat Compensation Plan. Prepared by SNC-Lavalin for Canadian Tennis Association, May 2003.

Hoover Creek Fish Habitat Monitoring Program: Year 1 (2004) Report. Prepared by SNC-Lavalin for Tennis Canada, Rexall Centre, December 2004.

National Tennis Centre, Tennis Canada: Fish Habitat Compensation Plan, Hoover Creek Stabilization, Plan and Profile, Drawing No. FHCP-1. Prepared by SNC-Lavalin, May 29, 2003.

National Tennis Centre, Tennis Canada: Fish Habitat Compensation Plan, Hoover Creek Stabilization, Cross-sections and Details, Drawing No. FHCP-2. Prepared by SNC-Lavalin, May 29, 2003.

National Tennis Centre, Tennis Canada: Fish Habitat Compensation Plan, Hoover Creek Stabilization, Details, Drawing No. FHCP-3. Prepared by SNC-Lavalin, May 29, 2003.

National Tennis Centre, Tennis Canada: General Notes and Details, Drawing No. 1.0A. Prepared by R.V. Anderson Associates, June 17, 2003.

National Tennis Centre, Tennis Canada: Site Grading, Drawing No. 1.2A. Prepared by R.V. Anderson Associates, June 17, 2003.

National Tennis Centre, Tennis Canada: Site Servicing, Drawing No. 1.3A. Prepared by R.V. Anderson Associates, June 17, 2003.

National Tennis Centre, Tennis Canada: Temporary Sediment and Erosion Controls, Drawing No. 1.4A. Prepared by R.V. Anderson Associates, June 17, 2003.

National Tennis Centre, Tennis Canada: Details, Drawing No. 1.5A. Prepared by R.V. Anderson Associates, June 17, 2003.

National Tennis Centre, Tennis Canada: Site Plan, Drawing No. A1.01. Prepared by Robbie/Young + Wright Architects, June 27, 2003.

National Tennis Centre: Details, Drawing No. D1. Prepared by Robbie/Young + Wright Architects, December 19, 2002.

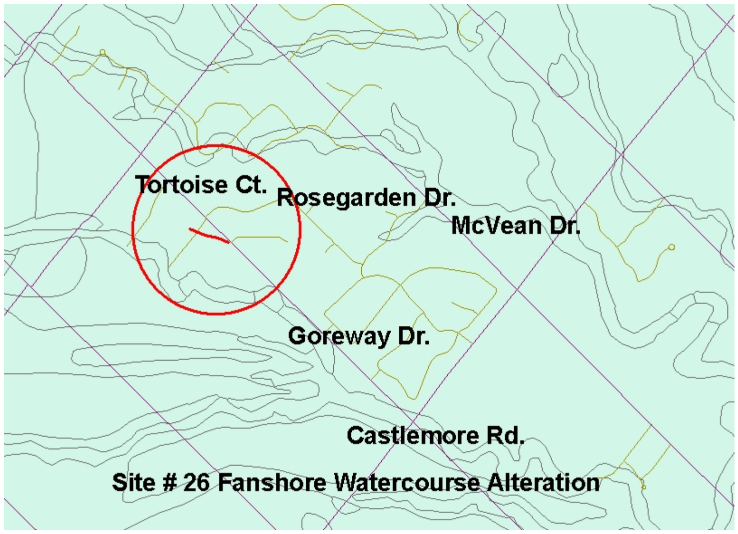
National Tennis Centre: Details, Drawing No. D2. Prepared by Robbie/Young + Wright Architects, June 18, 2003.

National Tennis Centre: Stormwater Management Facility, Rehabilitation Planting Plan, Drawing No. RP1. Prepared by Robbie/Young + Wright Architects, December 19, 2002.

National Tennis Centre, Tennis Canada: Site Periphery, Restoration Planting Plan, Drawing No. RP2. Prepared by Robbie/Young + Wright Architects, May 15, 2003.

26. Fanshore Watercourse Alteration

Location and Access
Rosegarden Drive and Goreway Drive in Brampton



Site Location

Channel Design Rationale
Realignment of tributary to accommodate development. Enhancement of channel form and function.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a narrow floodplain. The channel is sinuous with a low gradient. Riparian vegetation is predominantly grasses with some shrubs and trees.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.1	1.5	0.4	0.4	0.2
Riffle	3.35	1.5	0.3	0.05	0.25
Pool	3.25	1.5	0.37	0.2-0.35	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	None	N/A
Bank Treatment	None	N/A
Riparian Zone	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	Riparian vegetation in good condition.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	6.4	Good	Narrow riparian planting corridor
RGA	0.18	In Regime	None

Photographs

View of channel looking downstream. Note: low flow and vegetation encroachment into channel.

View of channel looking downstream. Note: riparian vegetation becoming well-established.

Available Documentation

Letter Correspondence Mr. Brain Casagrande, from EMC Group Limited, regarding Castlemore South Residential Subdivision, March 12, 2003

Community of Vales East Draft Plan, City of Brampton: Stormwater Management Report Castlemore South Residential Subdivision Fanshore Investments Inc., Prepared by EMC Group., April 28, 2003

Erosion and Sediment Control Plan, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-ES. Prepared by EMC Group Limited., August 2002

Stormwater Management Pond, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-CD1. Prepared by EMC Group Limited., October 2002

Stormwater Management Pond Details, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-CD2. Prepared by EMC Group Limited., October 2002

Stormwater Management Pond Cross-Sections, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-CD3. Prepared by EMC Group Limited., October 2002

Goreway Drive Box Culvert Extension, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-P19. Prepared by EMC Group Limited., January 2003

Storm Sewer Outlet, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-P16. Prepared by EMC Group Limited., October 2002

Storm Drainage Plan, Part 1, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-5. Prepared by EMC Group Limited., May 2002

Storm Drainage Plan, Part 2, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-6. Prepared by EMC Group Limited., May 2002

Grading Plan, Part 1, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-GR1. Prepared by EMC Group Limited., October 2002

Grading Plan, Part 2, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-GR2. Prepared by EMC Group Limited., October 2002

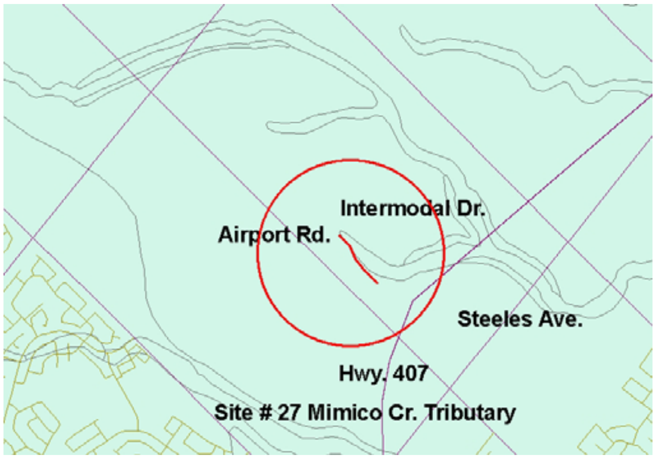
Grading Plan, Part 3, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-GR3. Prepared by EMC Group Limited., October 2002

Grading Plan, Part 4, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-GR4. Prepared by EMC Group Limited., October 2002

Grading Plan, Part 5, City of Brampton: Castlemore South Res. Subdivision – Drawing No. 94142-GR5. Prepared by EMC Group Limited., October 2002

27. Mimico Creek Tributary Realignment

Location and Access
Highway 407 and Airport Road in Brampton



Site Location

Channel Design Rationale
Realignment of the watercourse to accommodate development; diversification of aquatic habitat; prevention of stream bank erosion.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a narrow floodplain bordered by commercial/industrial land use. The channel is very sinuous with a low gradient. Riparian vegetation is predominantly grasses with some shrubs.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	4.5	3.0	0.4	0.5	0.75
Riffle	4.5	2.0	0.5	0.05-0.1	1.0
Pool	2.00	2.0	0.6	0.2-0.4	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex Weirs	Majority of riffles washed out
Bank Treatment	Living revetments.	80% of NCD with till exposure; undercut banks; extensive bank erosion; pools poorly developed
Riparian Zone	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover) - grass seed mix throughout riparian area.	Riparian vegetation in good condition.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	6.4	Good	50% of live staking did not take
RGA	0.49	In Adjustment	Degradation; widening; planimetric adjustment

Photographs

View of channel looking downstream. Note: extensive bank erosion and downcutting.

View of channel looking upstream. Note: riparian vegetation becoming well-established.

Available Documentation

Channelization Grading Plan: Merkins, Toronto: Menkes Developments Ltd. Intermodal Site – Drawing No. SP1. Prepared by Burnside., August 28, 2003

Channel Profile: Merkins, Toronto: Menkes Developments Ltd. Intermodal Site – Drawing No. SP2. Prepared by Burnside., August 28, 2003

Site Servicing Plan: Merkins, Toronto: Menkes Developments Ltd. Intermodal Site – Drawing No. S1. Prepared by Burnside., August 20, 2003

Channel Erosion Sedement Control Plan: Merkins, Toronto: Menkes Developments Ltd. Intermodal Site – Drawing No. ES1. Prepared by Burnside., August 14, 2003

Site Grading Plan: Merkins, Toronto: Menkes Developments Ltd. Intermodal Site – Drawing No. G1. Prepared by Burnside., July 23, 2003

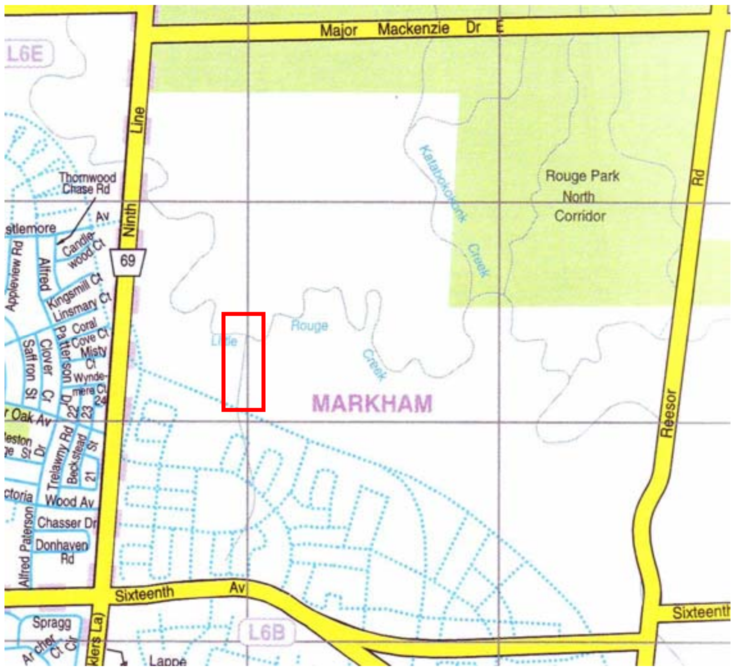
Landscape Plan, Channel Re-alignment, Airport Road & Intermodal Drive (Southeast Corner), Brampton: Menkes Development Ltd – Drawing No. L1. Prepared by STRYBOS Associates., April 10, 2003

Landscape Plan, Industrial Development, Airport Road & Intermodal Drive (Southeast Corner), Brampton: Menkes Development Ltd – Drawing No. L2. Prepared by STRYBOS Associates., April 10, 2003

Fax Correspondence: Authorization for the harmful alteration, disruption or distruction of fish habitat pursuant to subsection 35(2) of the *Fisheries Act*, Fisheries and Oceans Canada, CFN 34472, September 8, 2003

28. Little Rouge River Tributary 1

Location and Access
The site is located on the new Markham By-pass, east of Ninth Line and north of Sixteenth Avenue, in Markham. The channel flows in a northerly direction from the stormwater management facility at the Cornell development site to Little Rouge River. The site can be accessed from the new Markham By-pass.



Site Location

Channel Design Rationale
The channel was lowered to service the upstream stormwater management facility and to accommodate the new Markham By-Pass.

Pre-construction Site Conditions
Not available.

Existing Site Conditions
The 100 m channel is slightly sinuous with riffle and pool sequences. Installed at the upstream end of riffle sections are rock vortex weirs, which are either buried, partially exposed or largely emergent. The channel is aggrading at the upstream end of the channel design. In total, about half of the length of the channel, in both riffle and pool sections, is colonized by grasses and cattails. Algae are also found in riffle and pools. The downstream end of the channel design is composed of a relatively steep rocky ramp-type feature. Water flows mostly between and under the small boulder sized material.

On the day of the site visit, bioengineering had not been installed. The riparian are was, however, planted with trees, and grasses and herbaceous species were growing.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	n/a	n/a	n/a	n/a	0.51
Riffle	2.7	1.5	0.3 (max)	0.1-0.25	0.1
Pool	2.7	2.0	0.4 (max)	0.25-0.4	n/a

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Rock vortex weir	Weirs are completely buried, partially buried or largely emergent; completely buried weirs are located at the upstream end of the design and offer no function; largely emergent weirs are located towards the downstream end and are spaced such they do not provide grade control
	Vegetated riverstone	The channel margin area is vegetated as intended; water flows between the riverstone
Bank Treatment	Brush mattress	Newly installed
Riparian Zone	Tree plantings	Recently planted

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	17.5	Fair	Sediment deposition; instream habitat; water quality
Bioengineering and Habitat	n/a	n/a	Bioengineering incomplete on day of field visit
RGA	0.21	In Transition	Aggradation

Photographs

Channel viewed downstream from culvert.

Partially exposed vortex weir and riffle viewed upstream. Note the in-channel vegetation in the upstream pool.

Available Documentation

Natural Channel Design, Tributary One/Little Rouge River: Channel Rehabilitation Plan, Drawing No. L-1. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Channel Profile, Drawing No. L-2. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Landscape Details, Drawing No. L-3. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Landscape Details, Drawing No. L-4. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Landscape Details, Drawing No. L-5. Prepared by Marshall Macklin Monaghan, December 20, 2002.

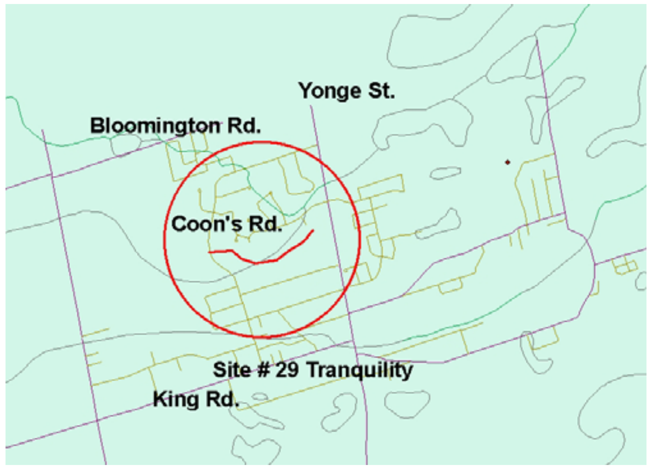
Natural Channel Design, Tributary One/Little Rouge River: Landscape Details, Drawing No. L-6. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Sedimentation and Erosion Control Plan – Phase 1 Excavation, Drawing No. SE-1. Prepared by Marshall Macklin Monaghan, December 20, 2002.

Natural Channel Design, Tributary One/Little Rouge River: Sedimentation and Erosion Control Plan – Phase 2 Staged Channel Construction, Drawing No. SE-2. Prepared by Marshall Macklin Monaghan, December 20, 2002.

29. Tranquility Stream

Location and Access
Yonge Street and Bloomington Road in Richmond Hill



Site Location

Channel Design Rationale
Realignment of an intermittent tributary to accommodate development.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a wide floodplain bordered by residential land use. The channel is very sinuous with a low gradient. Riparian vegetation is predominantly grasses with some shrubs.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	1.7	2.0	0.2	0.3	0.26
Riffle	No pool/riffle sequence	0.5-1.0	No pool/riffle sequence	0.05-0.20	No pool/riffle sequence
Pool	No pool/riffle sequence	2.0-2.5	No pool/riffle sequence	0.3-0.4	No pool/riffle sequence

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Live shade tripods; half logs; floodplain pools, riffles	Appear to be functioning as intended; Upstream riffles outflanked, two riffles emergent with through flow
Bank Treatment	Willow bundles; fascines.	Appear to be functioning as intended
Riparian Zone	10 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	Riparian vegetation in good condition.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	4	Poor	Structural failure of riffles; bioengineering not functioning as designed
Bioengineering and Habitat	6.3	Good	Bioengineering components not function as designed
RGA	0.46	In Adjustment	Aggradation; planimetric adjustment

Photographs

View of channel looking upstream. Note: low flow and vegetation encroachment into channel.

View of channel looking downstream. Note: riparian vegetation becoming well-established, rip rap placement and exposed riffle materials.

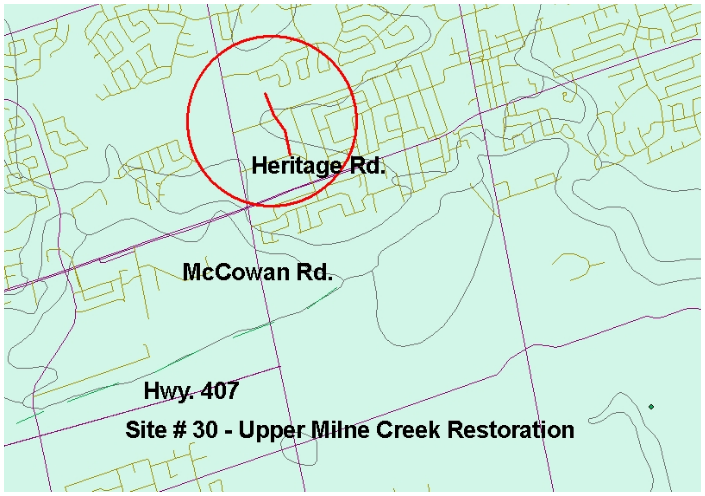
Available Documentation

Fax Correspondence: Tranquility, Fish Habitat Management, Fisheries and Oceans Canada; CFN 33710

Final Report, Assessment of Baseflow Contribution – Existing Creek Proposed Low Flow Channel, Tranquility Subdivision, Richmond Hill, Prepared by AMEC Earth & Environmental Limited, Submitted to Heathwood Homes (Tranquility) Limited, May 2003

30. Upper Milne

Location and Access
McCowan Road and Bullock Drive in Markham



Site Location

Channel Design Rationale
To restore the natural channel and mitigate existing downstream flooding and erosion problems. Stabilization of banks through bioengineering and plantings.

Pre-construction Site Conditions
Unknown.

Existing Site Conditions
The channel flows through a wide floodplain (upstream) and a narrow floodplain (downstream) bordered by industrial/commercial land use. Upon the site visit, riparian vegetation had not become established due to the recent construction of the channel.

Design Parameters

Design Feature	Bankfull Width (m)		Bankfull Depth (m)		Design Gradient (%)
	Design	Existing	Design	Existing	
Channel average	3.0	2.0-2.5	0.6	0.4	1.0
Riffle	1.5	1.5-2.0	0.3	0.05-0.15	1.0
Pool	3.0	2.0-2.5	0.6	0.2-0.8	N/A

Design Components

Design Component	Key Elements	Existing Condition
Instream Features	Vortex weirs	Appear to be functioning as intended;
Bank Treatment	Brush layering; live stakes; brush mattresses, live fascines.	Not installed when site visit conducted.
Riparian Zone	5 m both banks; 100% channel length (50% deciduous tree cover; 10% coniferous tree cover; 40% shrub cover).	Only seed when site visit conducted.

Rapid Assessment Results

Type of Assessment	Score	Condition	Type of Adjustment / Limiting Factors
RSAT (modified)	N/A	N/A	No bioengineering component
Bioengineering and Habitat	3.0	Poor	(Note: newly installed channel)
RGA	0.24	In Transition	Aggradation; planimetric adjustment

Photographs

View of channel looking downstream. Note: newly constructed channel with low gradient and high sinuosity.

View of channel looking upstream. Note: some channel adjustments occurring since construction (medial bars and sediment deposition).

Available Documentation

Upper Milne Creek Restoration, Between Heritage Road and C.N. Rail, Grading Plan., Markham, December 2004, Drawing No. L1

Upper Milne Creek Restoration, Between Heritage Road and C.N. Rail, Grading Plan., Markham, December 2004, Drawing No. L2

Upper Milne Creek Restoration, Between Heritage Road and C.N. Rail, Grading Plan., Markham, December 2004, Drawing No. L3

Upper Milne Creek Restoration, Between Heritage Road and C.N. Rail, Grading Plan., Markham, December 2004, Drawing No. L4

Application for Fill, Construction and Alteration to Waterways Permit, Toronto and Region Conservation Authority, Upper Milne Creek Restoration Project Corporation of the Town of Markham, Prepared by Harrington and Hoyle Ltd., March 2004

APPENDIX D:

Functioning of NCD Design Elements

Table D1: Functioning of NCD Design Elements

Project ID	Project Name	Constructed Riffles			Bioengineering			Habitat Structures			Riparian	Creation of
		In design	Functioning	Comments	In design	Type	Functioning	In design	Type	Functioning	Plantings	fish barriers
2	Little Etobicoke Creek	yes	yes	A couple riffles submerged	yes	Rootwads	yes	yes	Rootwads	yes	yes	no
3	Fonthill Channel Restoration	yes	yes	Riffles appear to be in good condition	yes	Vegetated rip rap	yes	no	N/A	N/A	yes	no
5	Highland Creek Rehabilitation	yes	yes	outflanking	yes	Brush mattresses, live fascines; live stakes	yes	yes	Wetland features	yes	yes	no
6	Little Rouge River Restoration Project	no	N/A	N/A	yes	Fascines	yes	no	N/A	N/A	yes	no*1
8	Berczy Village Burdenet Creek	yes	no	winnowing and vegetation encroachment	yes	Live fascines	yes	yes	Wet meadows along creek channel	yes	yes	yes
9	New Westminster Creek	yes	no	winnowing and vegetation encroachment	yes	Live fascines	yes	no	N/A	N/A	yes	no*2
10	Wismer Commons Robinson Creek	yes	no	winnowing and vegetation encroachment	yes	Coir biologs, fascines, brush layers	yes	yes	Wetland side channels, root wads, anchored logs	yes	yes	yes
11A	Miller Creek Realignment and Natural Channel Design (Reach 6)	yes	yes	winnowing and vegetation encroachment	yes	cribwalls, fascines	yes	no	N/A	N/A	yes	no
11B	Miller Creek Realignment and Natural Channel Design (Reach 1-2)	yes	yes	Good condition	yes	cribwalls, fascines	yes	no	N/A	N/A	yes	no
12A	Don River Tributary Realignment (Upstream from Highway 400)	yes	no	winnowing and vegetation encroachment	no	N/A	N/A	yes	Pools and offline ponds, skid lunkers, cable stayed trees, gravel beds	yes	yes	yes
12B	Don River Tributary Realignment (Downstream from Highway 400)	yes	yes	Good condition	yes	Coir biologs	yes	yes	Pools and offline ponds, skid lunkers, cable stayed trees	yes	yes	no
13	Robinson Creek Naturalization	yes	yes	outflanking	yes	Live fascines and brush mattresses	no	yes	Pond in floodplain, anchored logs	yes	yes	no
14	German Mills Creek Realignment	yes	yes	low flow	yes	Brush layering	yes	no	N/A	N/A	yes	no
16	Amberlea Creek Realignment	yes	yes	outflanking	no	N/A	N/A	no	N/A	N/A	yes	no
18A	Morningside Tributary (Upstream Reach)	yes	yes	outflanking	no	N/A	N/A	no	N/A	N/A	yes	no
18B	Morningside Tributary (Downstream Reach)	yes	yes	Good condition	no	N/A	N/A	no	N/A	N/A	yes	no
18C	Morningside Tributary (Neilson Reach)	yes	yes	winnowing	no	N/A	N/A	no	N/A	N/A	yes	no
20	Lower Milne Creek Restoration	yes	yes	outflanking	yes	Brush layers, brush mattresses, fascines	yes	no	N/A	N/A	yes	no

Project ID	Project Name	Constructed Riffles			Bioengineering			Habitat Structures			Riparian	Creation of
		In design	Functioning	Comments	In design	Type	Functioning	In design	Type	Functioning	Plantings	fish barriers
21	Mimico Creek Realignment	yes	yes	outflanking	yes	Live stakes	no	no	N/A	N/A	yes	yes*3
23	Carruthers North of Rossland Road - Ajax	yes	yes	Good condition	yes	Vegetated rip rap	yes	no	N/A	N/A	yes	no
24	Neilson Tributary (upstream of 18C)	yes	yes	Good condition	yes	Live stakes	yes	no	N/A	N/A	yes	no
25	Black Creek Tributary	yes	no	outflanking	yes	Vegetated rip rap	yes	yes	Rootwads	no	yes	yes
26	Fanshore Watercourse Alteration	yes	yes	low flow	no	N/A	N/A	no	N/A	N/A	yes	no
27	Mimico Creek Tributary Realignment	yes	no	outflanking	yes	Living revetments	no	no	N/A	N/A	no	no
28	Rouge River Tributary 1	yes	yes	winnowing	yes	Brush mattresses, live stakes	not installed	no	N/A	N/A	yes	yes
29A	Tranquility Stream (W. of Blackforest Dr.)	yes	yes	outflanking	yes	Willow bundles, fascines	yes	yes	Live shade tripods, half logs, floodplain pools	yes	yes	no
29B	Tranquility Stream (E. of Blackforest Dr.)	no	N/A	N/A	yes	Willow bundles, fascines	yes	yes	Live shade tripods, half logs, floodplain pools	yes	yes	yes
30A	Upper Milne Creek Restoration (S. of Bullock Dr.)	yes	yes	Good condition	yes	Brush layering, live stakes, live fascines	not installed	no	N/A	N/A	yes	no
30B	Upper Milne Creek Restoration (N of Bullock Dr.)	yes	yes	Good condition	yes	Brush layering, live stakes, live fascines	not installed	yes	Aquatic plantings, wetland cells	not installed	yes	no
PERCENT 'YES' TOTALS		93%	78%		79%		85%	40%		90%	97%	**32%**

*1 Channel had fish barrier prior to natural channel design (part of objectives)

*2 Fish barrier present regardless of natural channel design

*3 Objective of natural channel design was to remove fish barrier by constructing riffle immediately downstream of barrier

APPENDIX E:

NCD Project Site Monitoring Plans

NCD MONITORING PROGRAM
SITE 2 – LITTLE ETOBICOKE CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 2 – LITTLE ETOBICOKE CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of restoration plantings and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	Opinion surveys.	Entire project area.	Once during the monitoring period.	Summer (fair weather)

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 23/05	Weather: SUNNY	Recorder/Crew: LKT/BW
Location: MISSISSAUGA	Stream/Reach: LITTLE ETOBICOKE CREEK #2	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

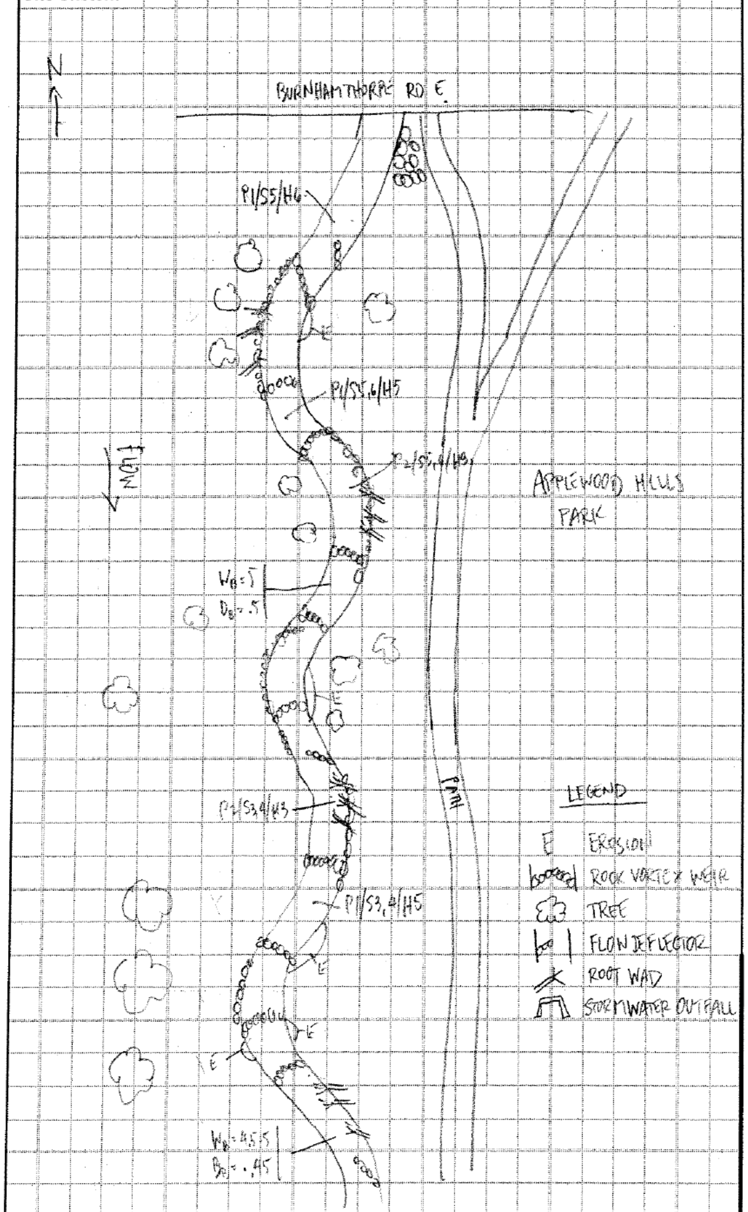
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Perceptible Flow
- H1 Standing Water

UTM Coordinates : ______

Notes:

RIPARIAN ZONE GENERALLY < 10 m
RIPARIAN VEG - TREES / SHRUBS
PRESENCE OF URBAN DEBRIS (TIRES, SHOPPING CARTS)

Site Sketch:



Drawn By: LK Checked By: ____

Channel length is 120m. Survey should include

PAGE 1 OF 3

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 23/05 Weather: SUNNY Recorder/Crew: KT/BW

Location: MISSISSAGA Stream/Reach: LITTLE ETOBICOKE CREEK Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

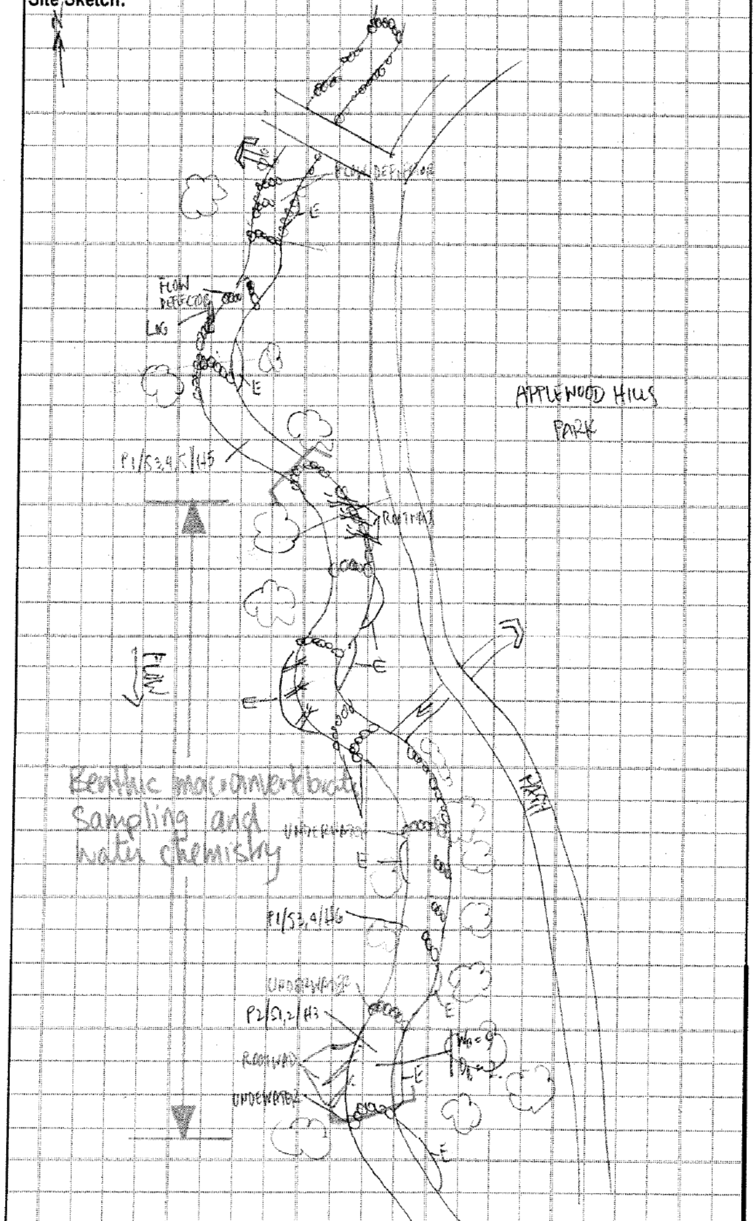
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2 OF 3

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 23/05	Weather: CLOUDY	Recorder/Crew: KT/BW
Location: MISSISSAUGA	Stream/Reach: LITTLE ETOBICOKE CREEK	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

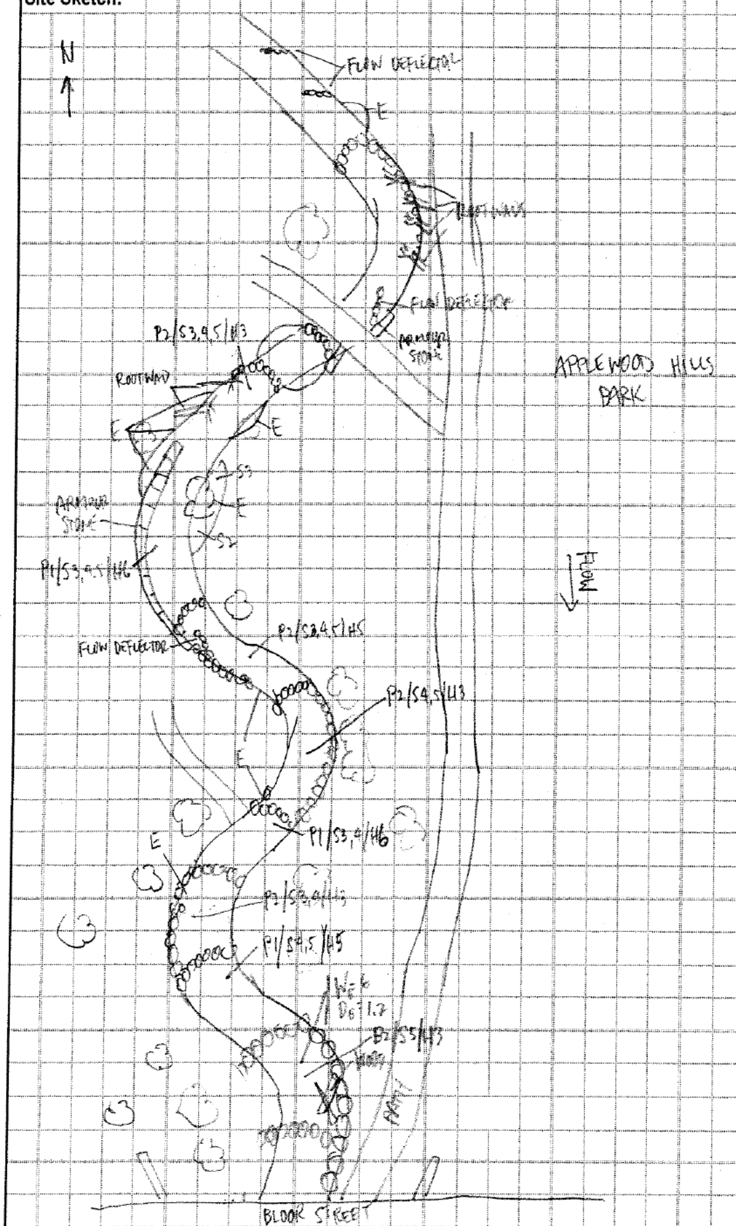
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates : ________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

NCD MONITORING PROGRAM
SITE 3 – FONTHILL CHANNEL RESTORATION

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 3 – FONTHILL CHANNEL RESTORATION

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY / **BENTHIC MACRO-INVERTEBRATES**	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT / BW
Location: MARKHAM	Stream/Reach: FOXHILL CHANNEL (#3) 1 of 3	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

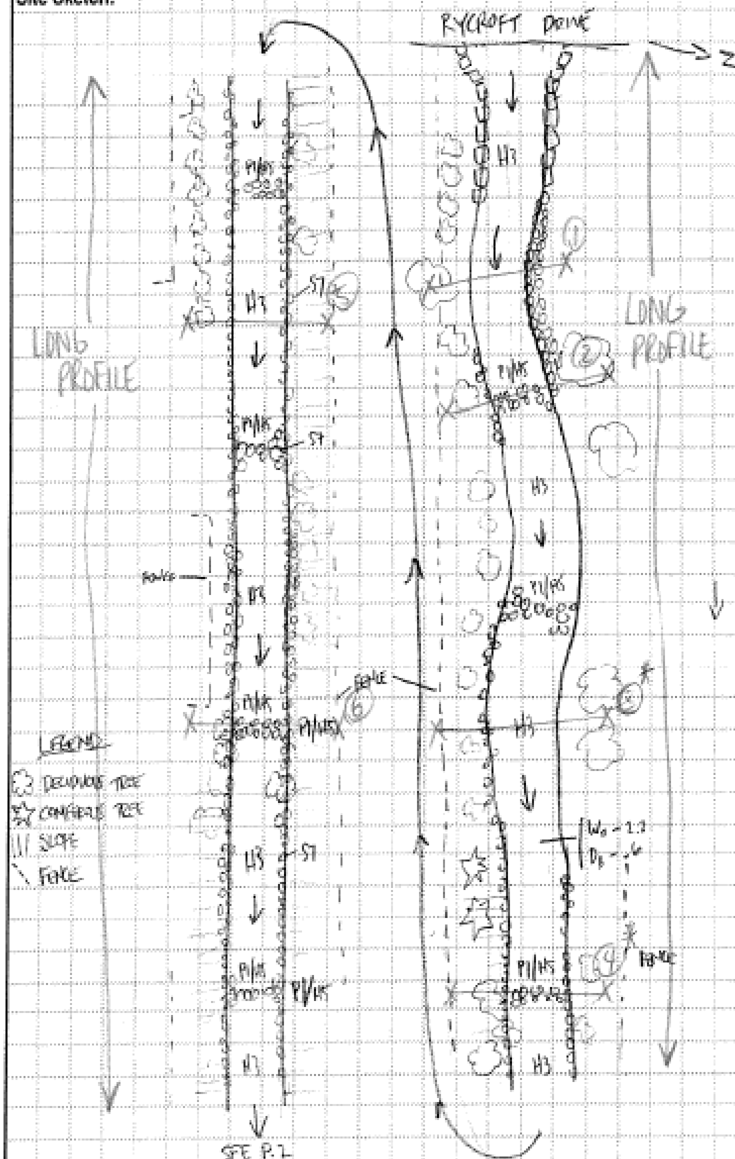
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

MOST VORTEX WEIRS AT UPSTREAM END
NEAR RYCROFT DRIVE WASHED D/S
LARGE BOULDERS FOR BANK PROTECTION
ALSO TRANSPORTED D/S
NARROW RIPARIAN ZONE BORDERING
RESIDENTIAL PROPERTY

Site Sketch:



Drawn By: KT Checked By: ____

Channel length is 500 m.
Survey should include atleast 200 m of channel
+ ... proposed permanent cross-sections

PAGE 1

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 14/05	Weather: Sunny	Recorder/Crew: KT/BW
Location: Markham	Stream/Reach: Fonthill Channel (#3) 2 of 3	Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

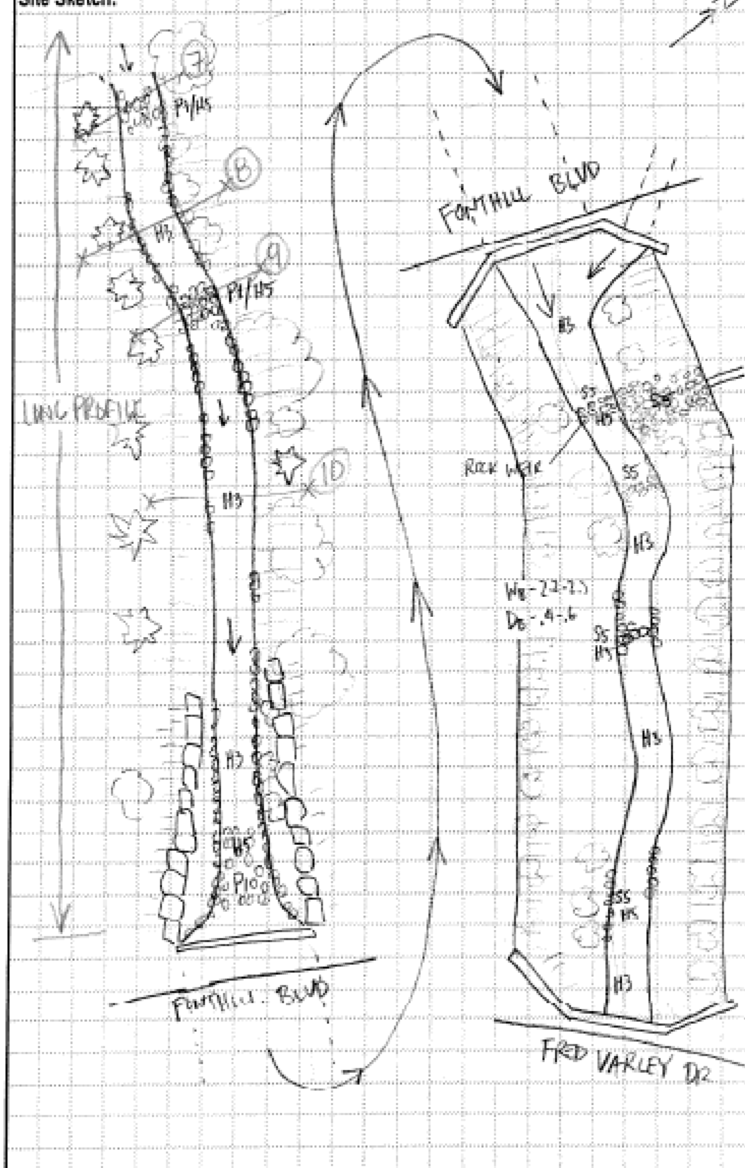
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: FONTHILL CHANNEL (#3) 3 of 3	Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

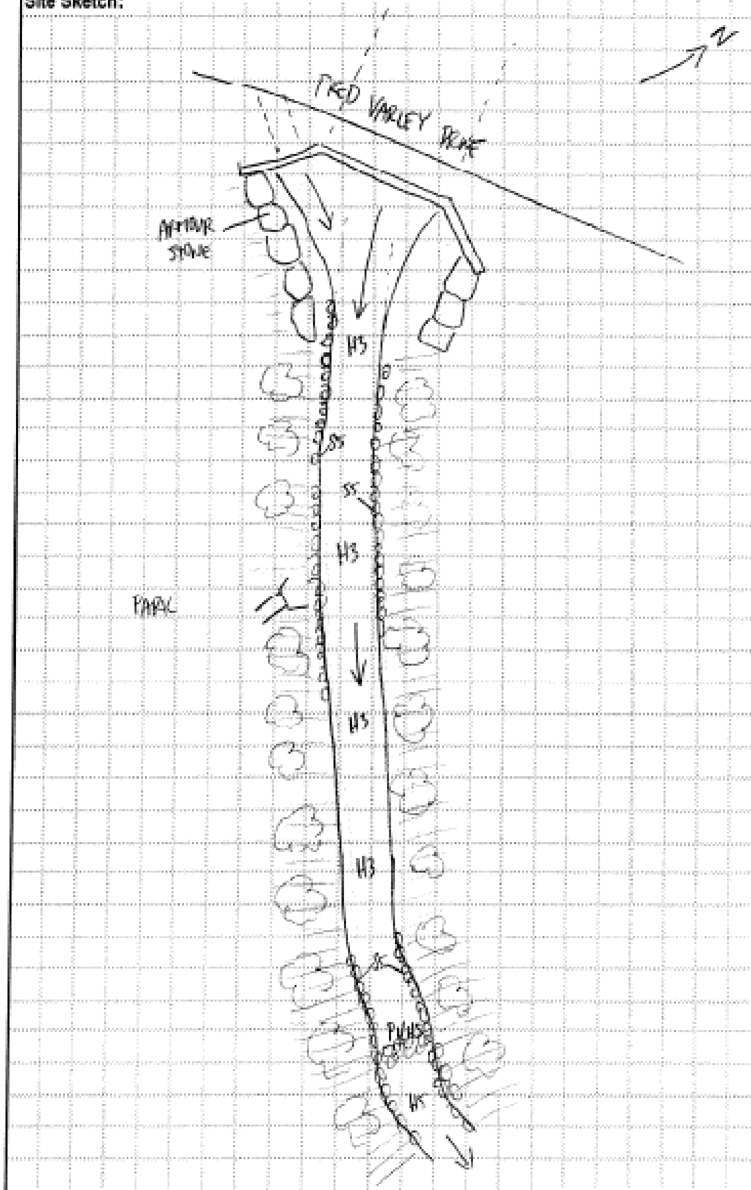
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 3

NCD MONITORING PROGRAM

SITE 5 – HIGHLAND CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	400m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 5 – HIGHLAND CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

WY

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: SCARBOROUGH	Stream/Reach: HIGHLAND CREEK (#5)/1	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

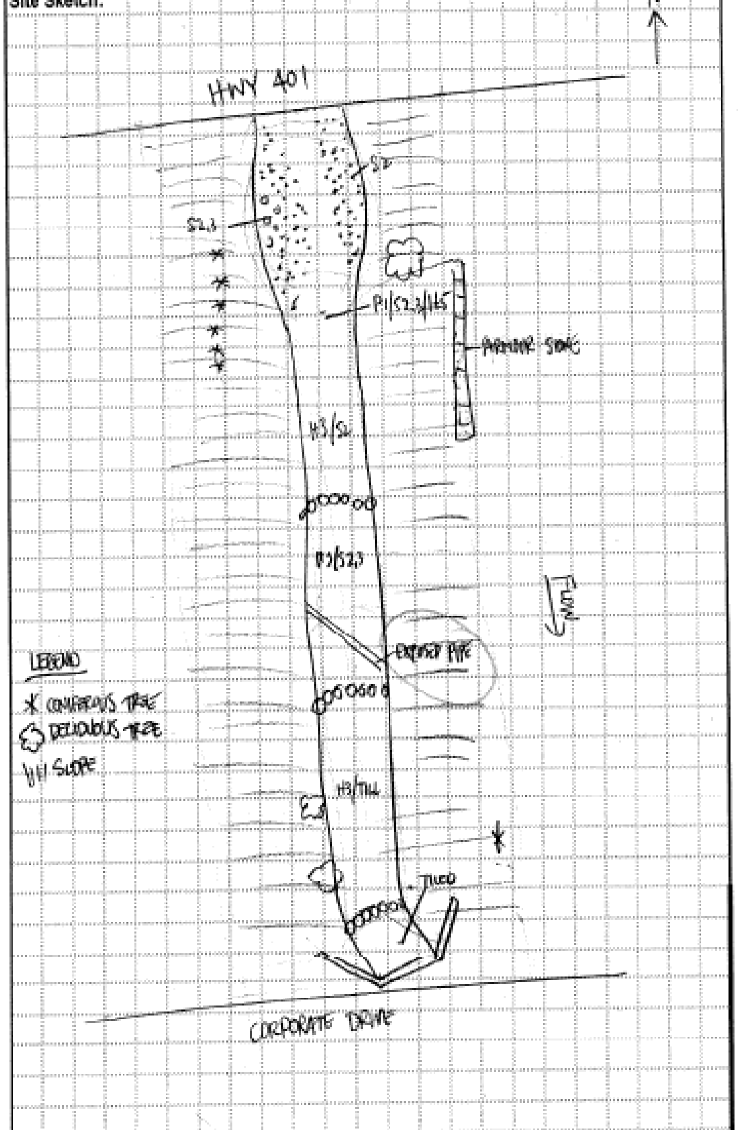
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

STEEP BANKS
NO FLOODPLAIN
RIPARIAN - SHORT GRASSES/SHRUBS

Site Sketch:



Drawn By: KT Checked By: ____

* Channel length 1800 m
[illegible] site available u/s and d/s however heavily modified [illegible]

WP

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 | Weather: SUNNY | Recorder/Crew: KT/BW

Location: SCARBOROUGH | Stream/Reach: HIGHLAND CREEK #5 /2 | Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit
- P1 Riffle
- P2 Pool
- P3 Run
- P4 Glide
- P5 Cascade
- P6 Rapid
- P7 Bedrock outcrop
- P8 Marginal deadwater

Substrate
- S1 Silt
- S2 Sand
- S3 Gravel
- S4 Small Cobble
- S5 Large Cobble
- S6 Small Boulder
- S7 Large Boulder
- S8 Bimodal

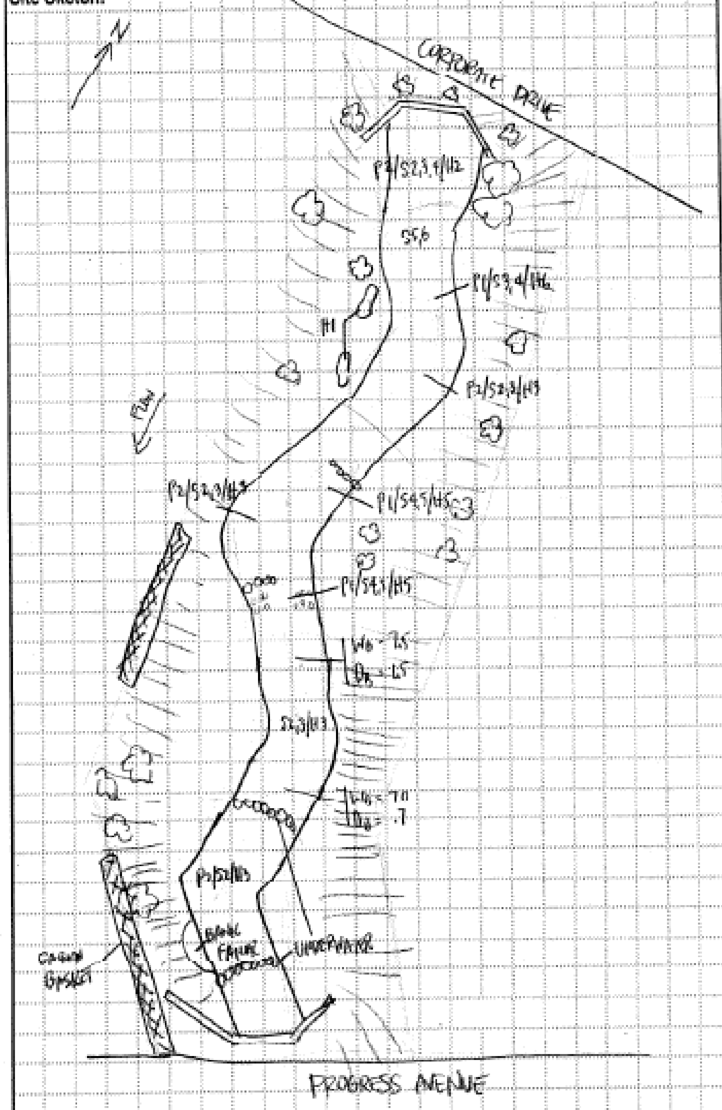
Functional habitats
- F1 Tree roots
- F2 Tree branches
- F3 Woody debris
- F4 Marginal plants
- F5 Leaf litter
- F6 Mosses
- F7 Macroalgae
- F8 Macrophytes

Flow Type
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates : ______

Notes:
GENERALLY STABLE

Site Sketch:



Drawn By: KT Checked By: ____

2 OF 7

WP

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOVEMBER 22/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: SCARBOROUGH	Stream/Reach: HIGHLAND CREEK (#5)/3	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

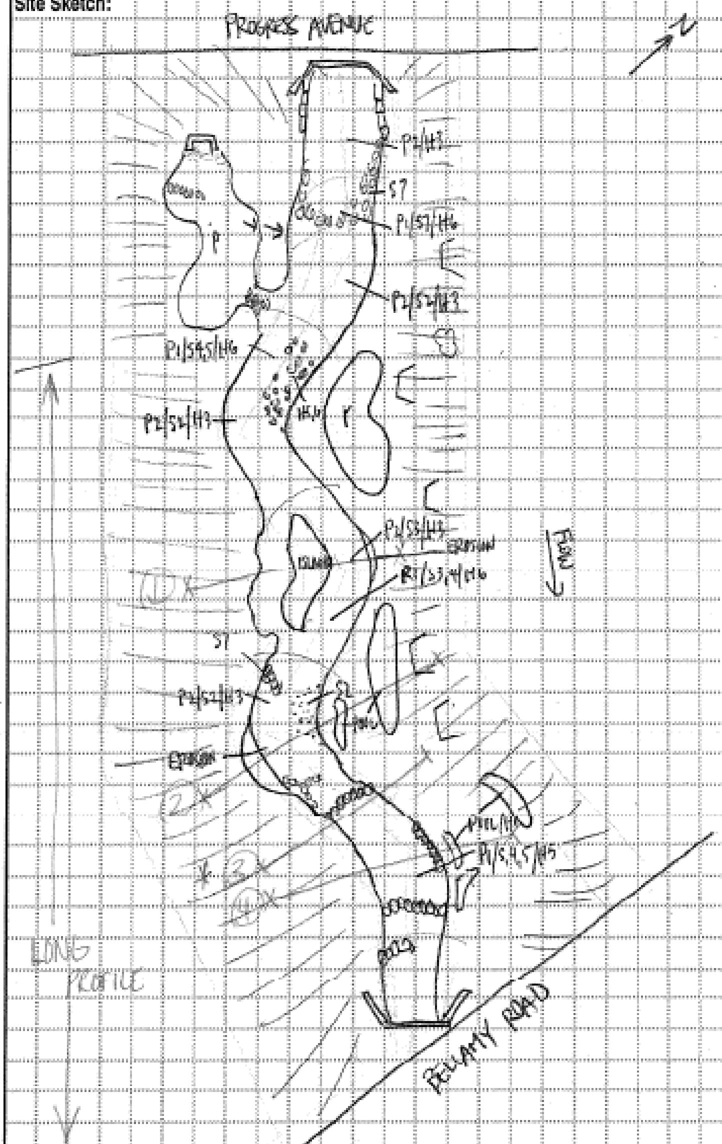
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

SOME PLANIMETRIC ADJUSTMENT
RIPARIAN - GRASSES/SHRUBS

Site Sketch:



Drawn By: KT Checked By: ____

*asterisk at cross-section are proposed permanent cross-sections

3 of 7

WP

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/15 Weather: SUNNY Recorder/Crew: KT/BW

Location: SCARBOROUGH Stream/Reach: HIGHLAND CREEK (#5)/4 Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

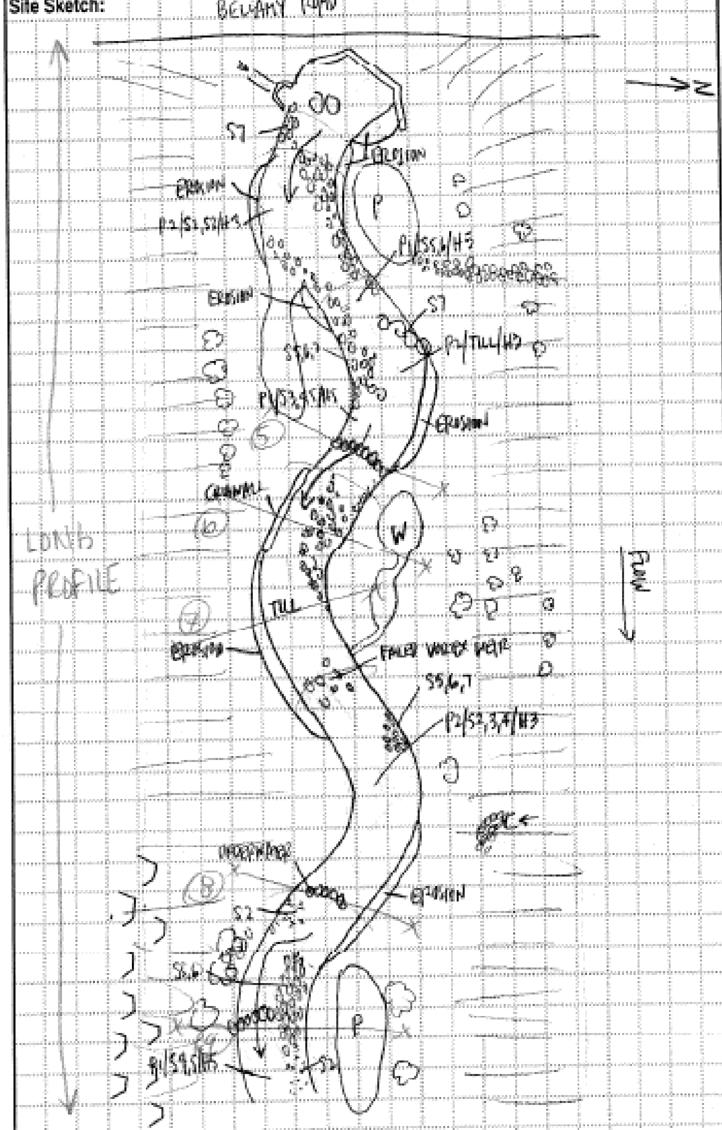
UTM Coordinates :

Notes:

CONSIDERABLE EROSION ON OUTSIDE OF MEANDER BENDS

RIPARIAN - GRASS

Site Sketch:



Drawn By: KT Checked By: ____

4 OF 7

WP

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22 | 05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: SCARBOROUGH	Stream/Reach: HIGHLAND CREEK (#5)/5	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

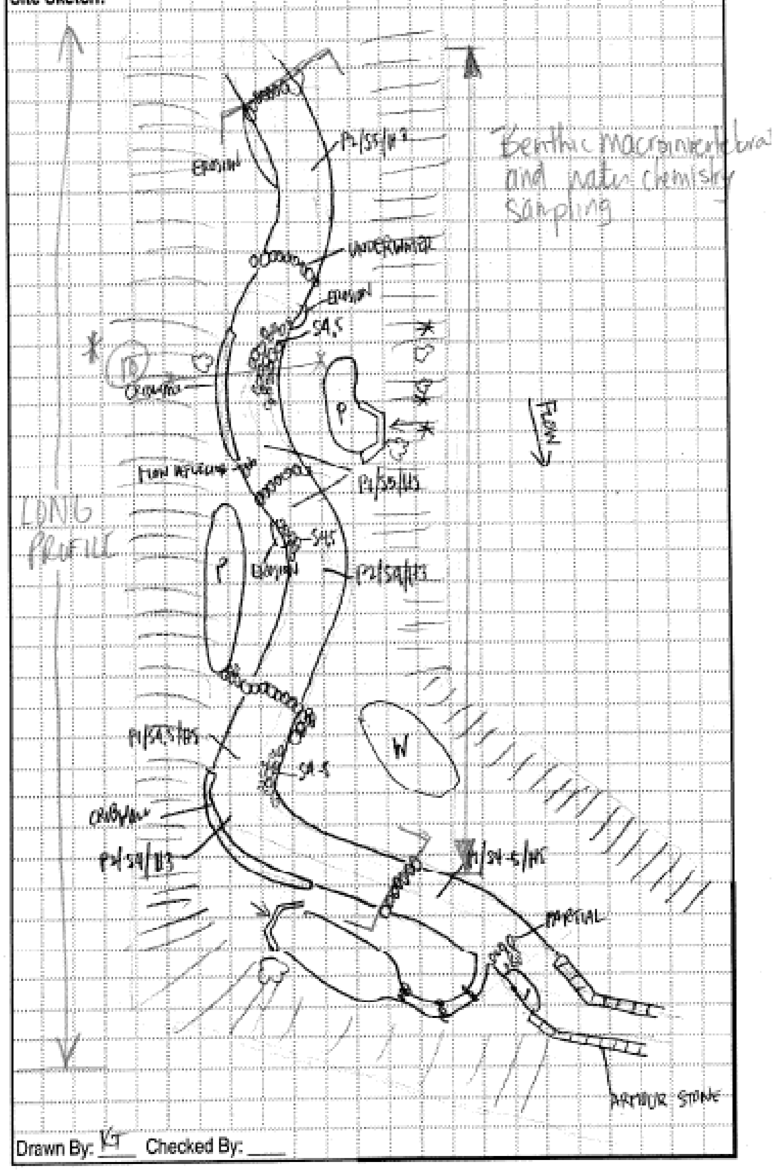
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates: ______

Notes:

EROSION ON OUTSIDE OF BENDS
RIPARIAN - GRASSES
SHRUBS ON OUTSIDE OF BENDS

Site Sketch:



Drawn By: KT Checked By: ____

* asterisk at cross-section are proposed permanent cross-sections

5 OF 7

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: SUNNY	Recorder/Crew: KT/ON
Location: SCARBOROUGH	Stream/Reach: HIGHLAND CREEK (HC)/7	Project Code: 05352.450

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

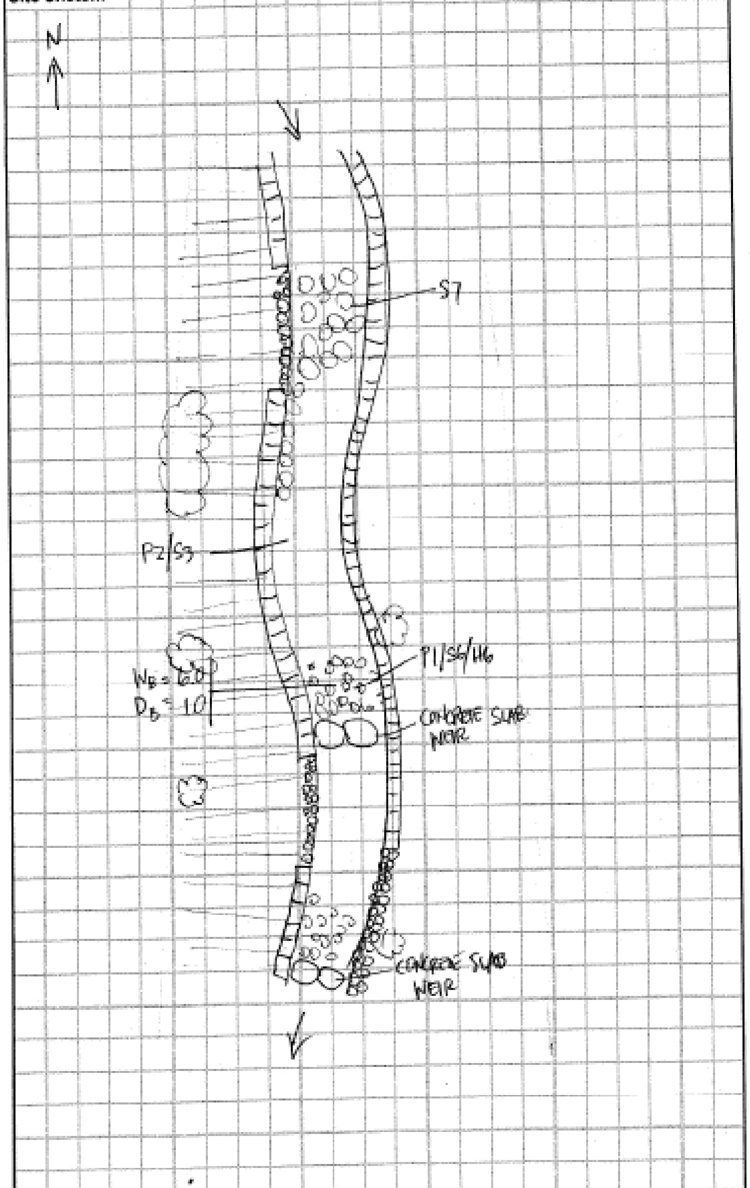
F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

Notes:

Site Sketch:



Drawn By: KY Checked By: ____

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: SUNNY	Recorder/Crew: KG / DH
Location: SCARBOROUGH	Stream/Reach: HIGHLAND CREEK (#5) / 7	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

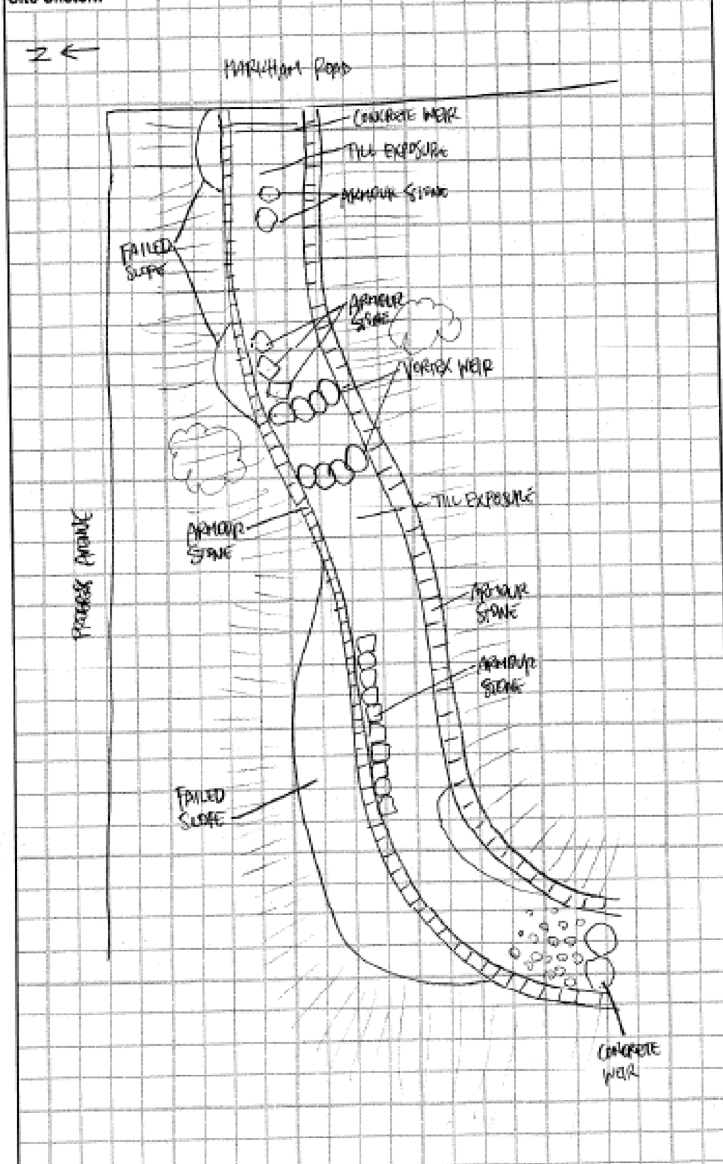
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

NCD MONITORING PROGRAM
SITE 6 – LITTLE ROUGE RIVER

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area (200m).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM

SITE 6 – LITTLE ROUGE RIVER

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 11/05 Weather: CLOUDY Recorder/Crew: KT / BW

Location: CURCIO PROPERTY, MARKHAM Stream/Reach: LITTLE ROUGE RIVER Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

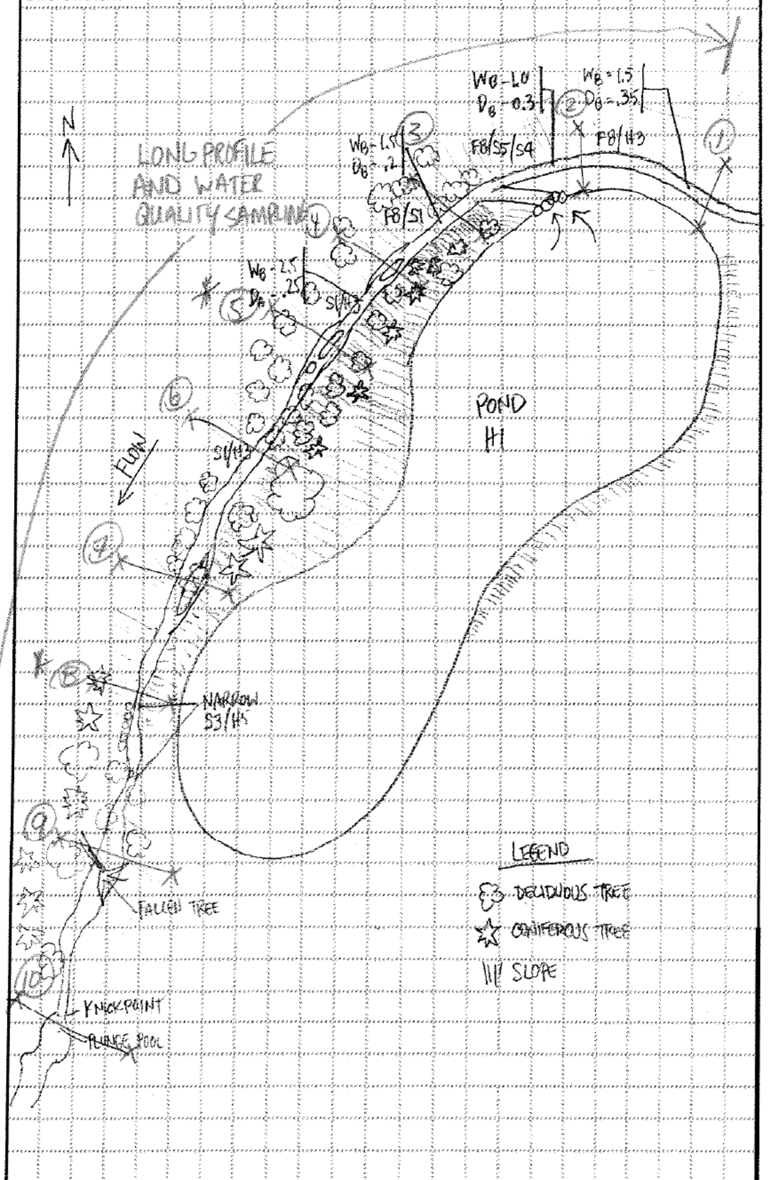
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ______

Notes:

IN-CHANNEL MACROPHYTES & GRASSES EXTENSIVE
SEVERAL IN-CHANNEL ISLANDS FORMING
WELL-VEGETATED RIPARIAN ZONE
LIMITED FLOODPLAIN

Site Sketch:



Drawn By: KT Checked By: ____

* upstream and downstream reference reaches available
* asterisk at cross-section are proposed

NCD MONITORING PROGRAM

SITE 8 – BURDENET CREEK (BERCZY VILLAGE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 8 – BURDENET CREEK (BERCZY VILLAGE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	Two segments of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	Opinion surveys.	Entire project area.	Once during the monitoring period.	Summer (fair weather)

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14 05 Weather: SUNNY Recorder/Crew: KT | BW

Location: MARKHAM Stream/Reach: BURNDENET CREEK (#2) | of 3 Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

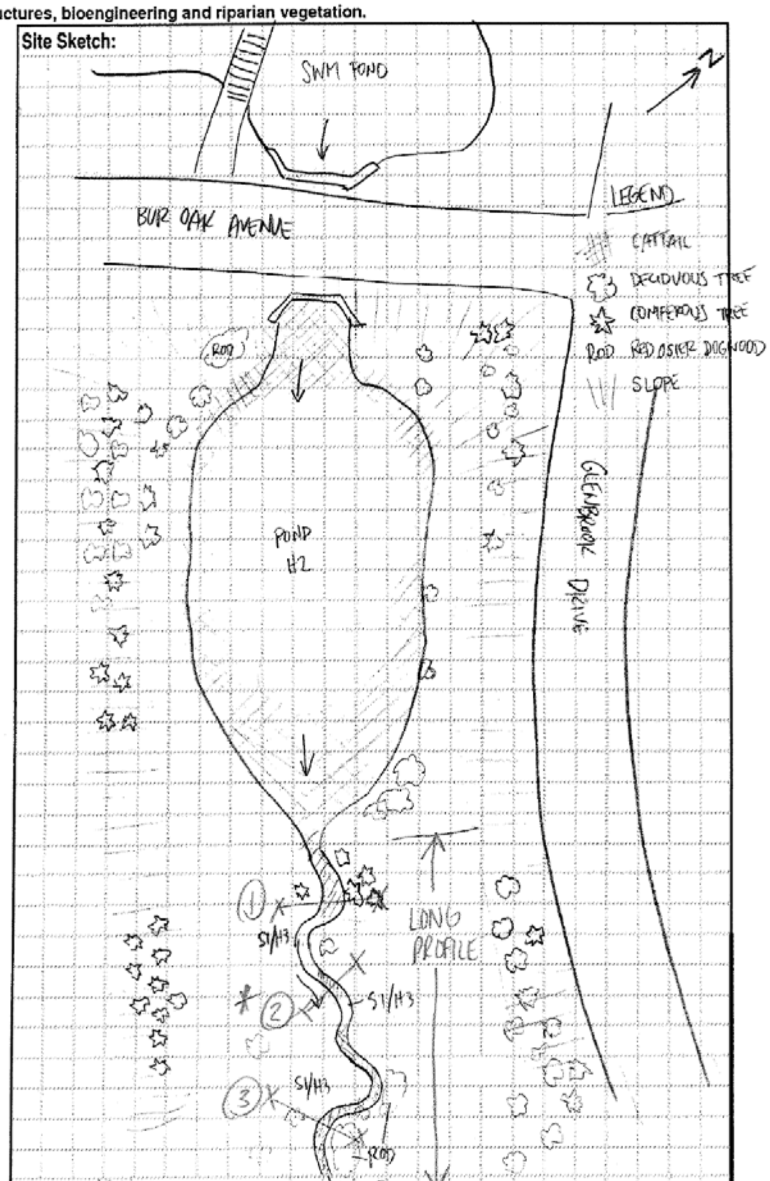
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

RIPARIAN AREA MOSTLY SHORT GRASSES
CATTAIL IN MOST OF CHANNEL
CONTRIBUTING TO SMOOTH SURFACE FLOW

Site Sketch:



Drawn By: KT Checked By: ____

* Channel is 900 m in length. PAGE 1
* asterisk for cross-sect. are proposed permanent cross-sections

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: BURNDENET CREEK (#2)/2 of 3	Project Code:

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit
- P1 Riffle
- P2 Pool
- P3 Run
- P4 Glide
- P5 Cascade
- P6 Rapid
- P7 Bedrock outcrop
- P8 Marginal deadwater

Substrate
- S1 Silt
- S2 Sand
- S3 Gravel
- S4 Small Cobble
- S5 Large Cobble
- S6 Small Boulder
- S7 Large Boulder
- S8 Bimodal

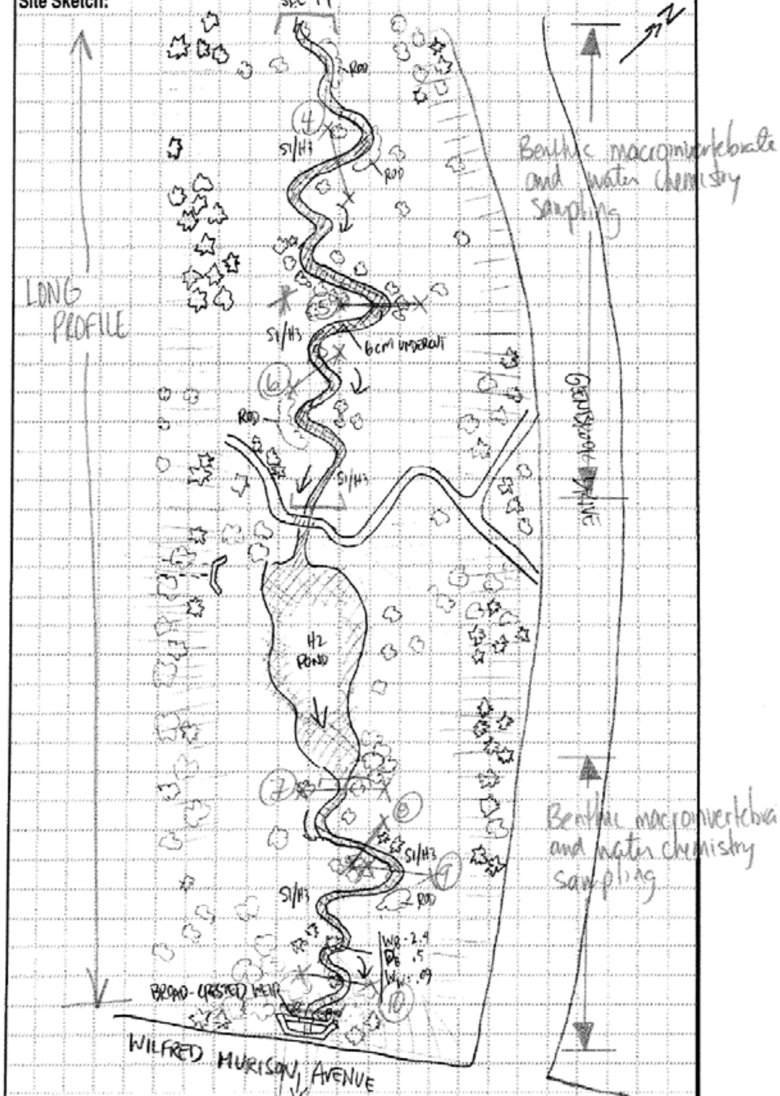
Functional habitats
- F1 Tree roots
- F2 Tree branches
- F3 Woody debris
- F4 Marginal plants
- F5 Leaf litter
- F6 Mosses
- F7 Macroalgae
- F8 Macrophytes

Flow Type
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates : ______

Notes:

Site Sketch:



Drawn By: ____ Checked By: ____

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GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: BURNDENET CREEK (#2) 3 of 3	Project Code:

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

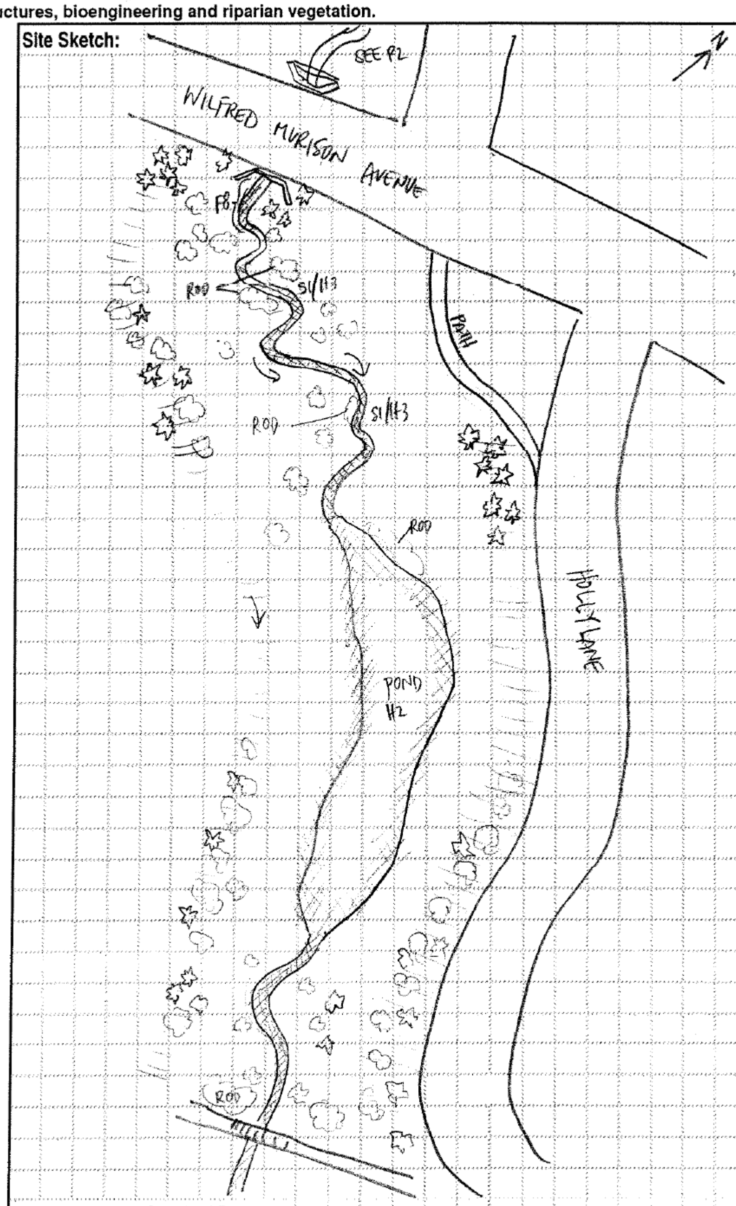
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ______

Notes:

Site Sketch:



Drawn By: ____ Checked By: ____

PAGE 3

NCD MONITORING PROGRAM

SITE 9 – NEW WESTMINSTER CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 9 – NEW WESTMINSTER CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY **BENTHIC MACRO-INVERTEBRATES**	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 11/05	Weather: PARTLY SUNNY	Recorder/Crew: KT/BW
Location: VAUGHAN	Stream/Reach: NEW WESTMINSTER CREEK #9	Project Code: 05351 ACO

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

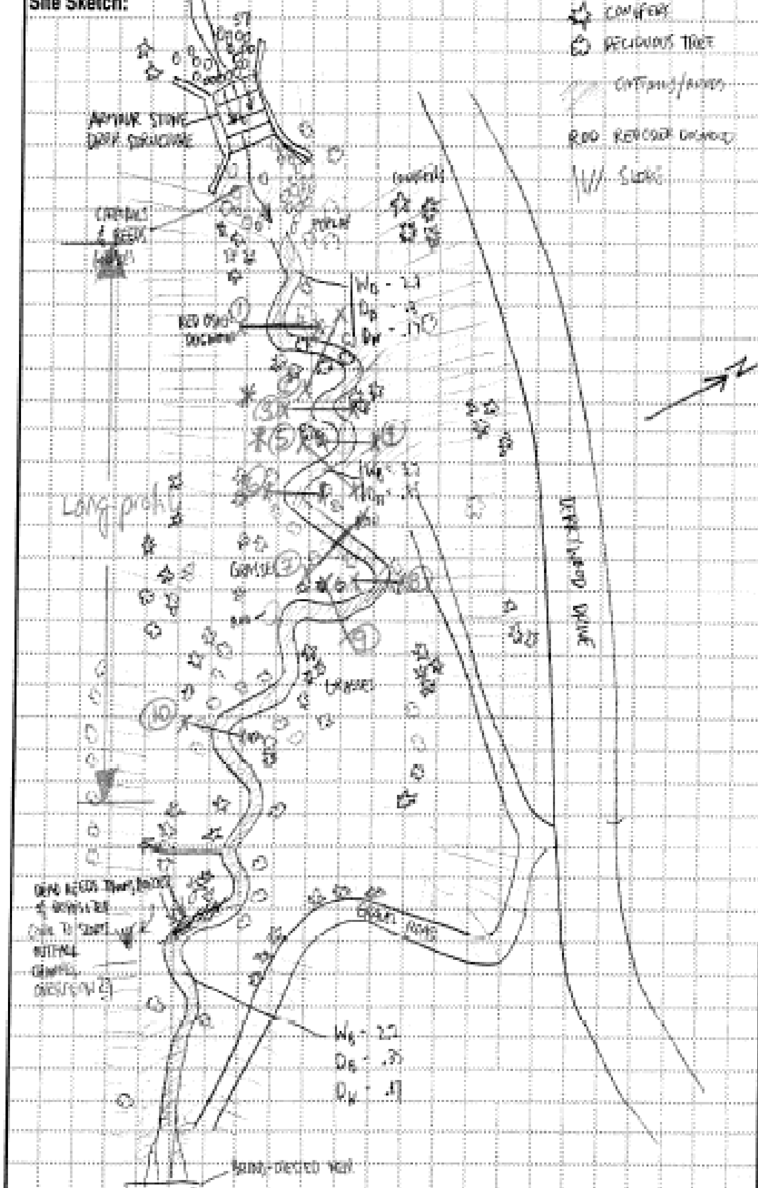
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

CHANNEL HEAVILY VEGETATED WITH CATTAILS
WELL-VEGETATED WITH GRASSES & TREES

Site Sketch:



Drawn By: KT Checked By: ____

* No reference reach available
* asterisk indicates proposed permanent cross-sections

NCD MONITORING PROGRAM
SITE 10 – ROBINSON CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 10 – ROBINSON CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	Opinion surveys.	Entire project area.	Once during the monitoring period.	Summer (fair weather)

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05 | Weather: SUNNY | Recorder/Crew: KT | BW

Location: MARKHAM | Stream/Reach: WISMER (#10) 1 OF 3 | Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

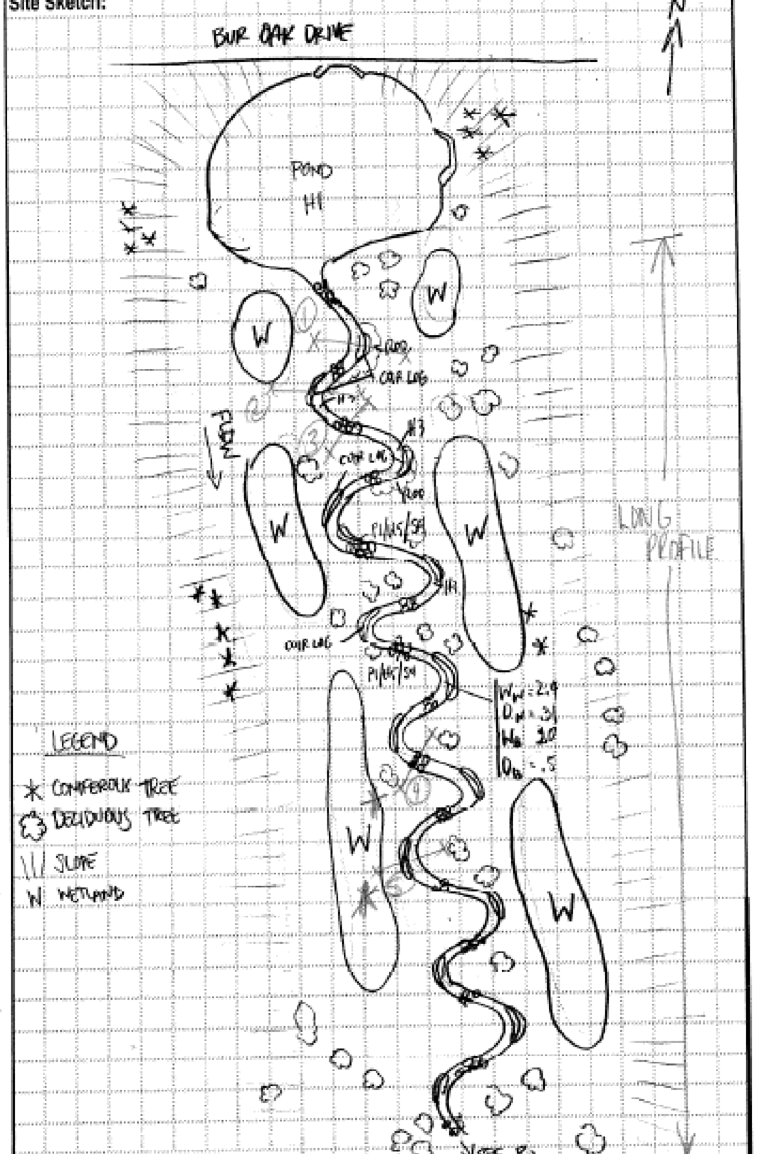
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

CATTAIL IN RIFFLE SECTION
DENSE RIPARIAN VEGETATION (GRASS)
COIR LOG AT ALL BENDS (OUTSIDE)
MOST WETLAND FEATURES VEGETATED
WITH CATTAIL OR GRASS
SOME WETLAND FEATURES INDISTINGUISHABLE
FROM SURROUNDINGS EXCEPT FOR
DEPRESSED ELEVATION

Site Sketch:



Drawn By: KT Checked By: ____

* channel length 760 m
* ... indicates proposed permanent cross-sections

PAGE 1

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: WISMER (#10) 2 OF 3	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

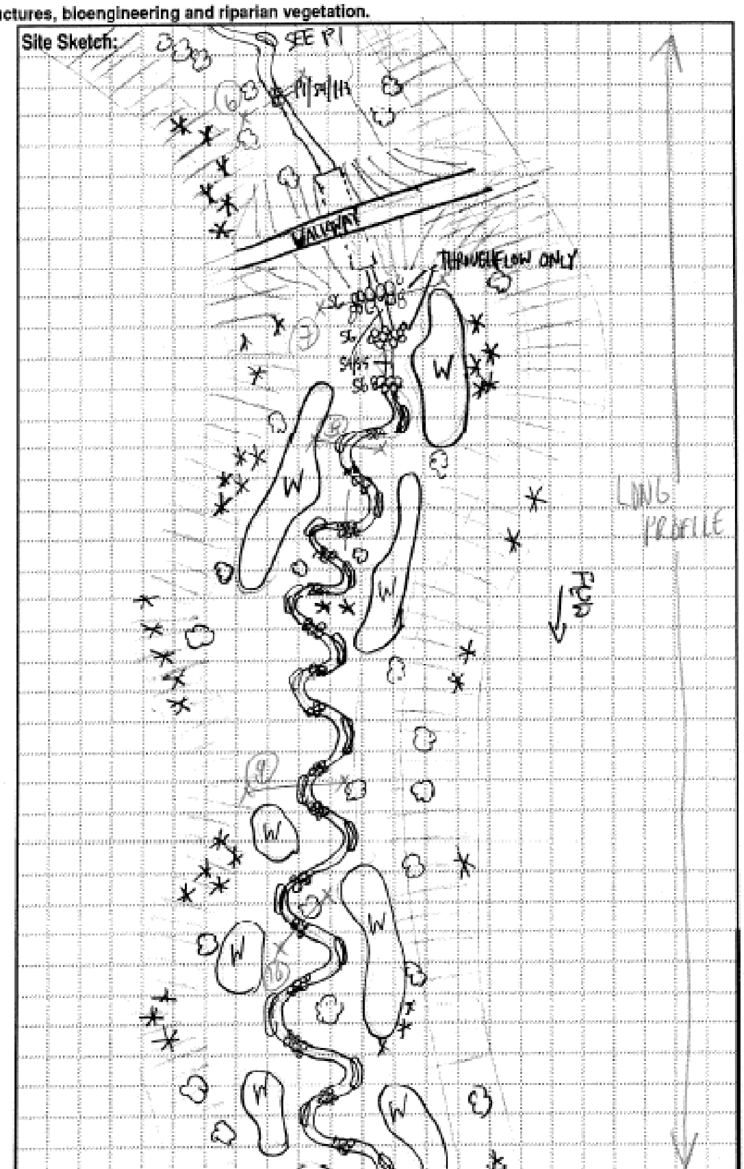
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates: ______

Notes:

ALL RIFFLES D/S OF WALKWAY EXPOSED
TALL RIPARIAN GRASSES

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05 Weather: SUNNY Recorder/Crew: JT/BW

Location: MARKHAM Stream/Reach: WISMER (#10) 3 OF 3 Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

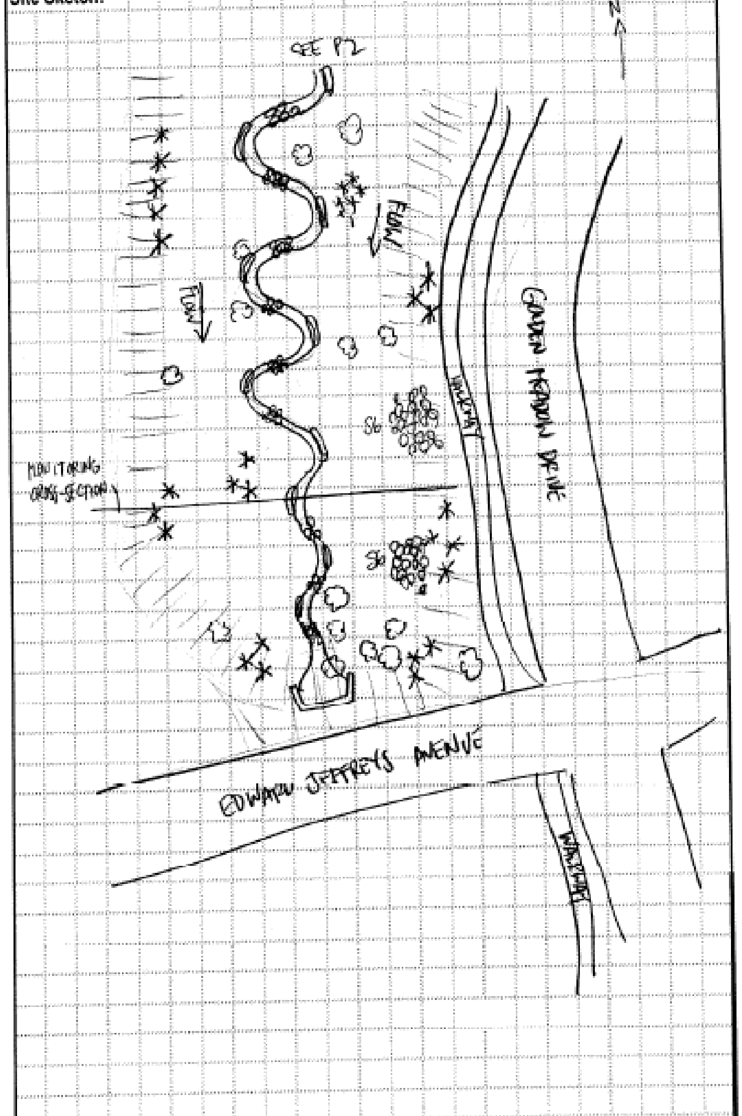
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates: ________

Notes:

ALL RIFFLES EXPOSED
CATTAIL IN CHANNEL, ESP RIFFLES
DENSE RIPARIAN

Site Sketch:



Drawn By: JT Checked By: ____

PAGE 3

NCD MONITORING PROGRAM
SITE 11A – MILLER CREEK REACH 6

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	400m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM
SITE 11A – MILLER CREEK REACH 6

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 27/05 | Weather: SUNNY | Recorder/Crew: KT/BW

Location: AJAX | Stream/Reach: MILLER CREEK (11A) | Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit	
P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater
Substrate	
S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal
Functional habitats	
F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes
Flow Type	
H9 Free Fall	
H8 Chute	
H7 Broken Standing Wave	
H6 Unbroken Standing Wave	
H5 Rippled	
H4 Upwelling	
H3 Smooth Surface Flow	
H2 Scarcely Peceptible Flow	
H1 Standing Water	

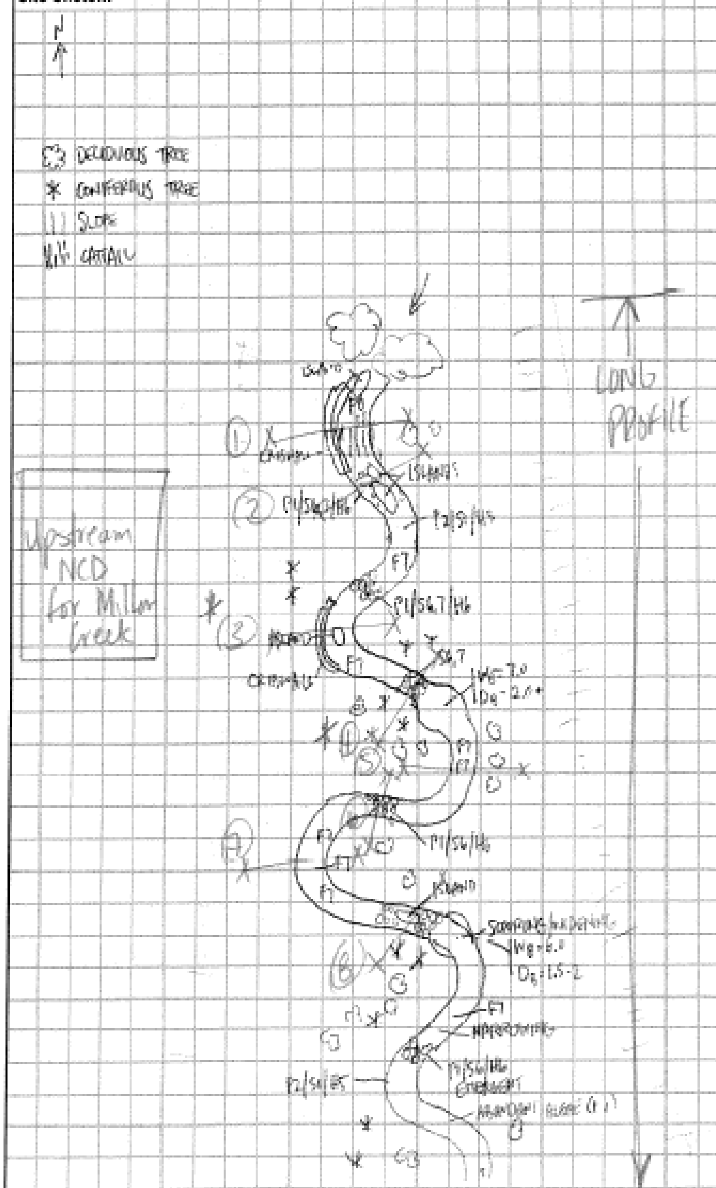
UTM Coordinates : ________

Notes:

MANY EMERGENT RIFFLES

SCOURING & WIDENING OF SEVERAL POOLS

Site Sketch:



Drawn By: ____ Checked By: ____

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: PARTLY CLOUDY	Recorder/Crew: KT/EW
Location: AJAX	Stream/Reach: MILLER CREEK / 1(11A)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

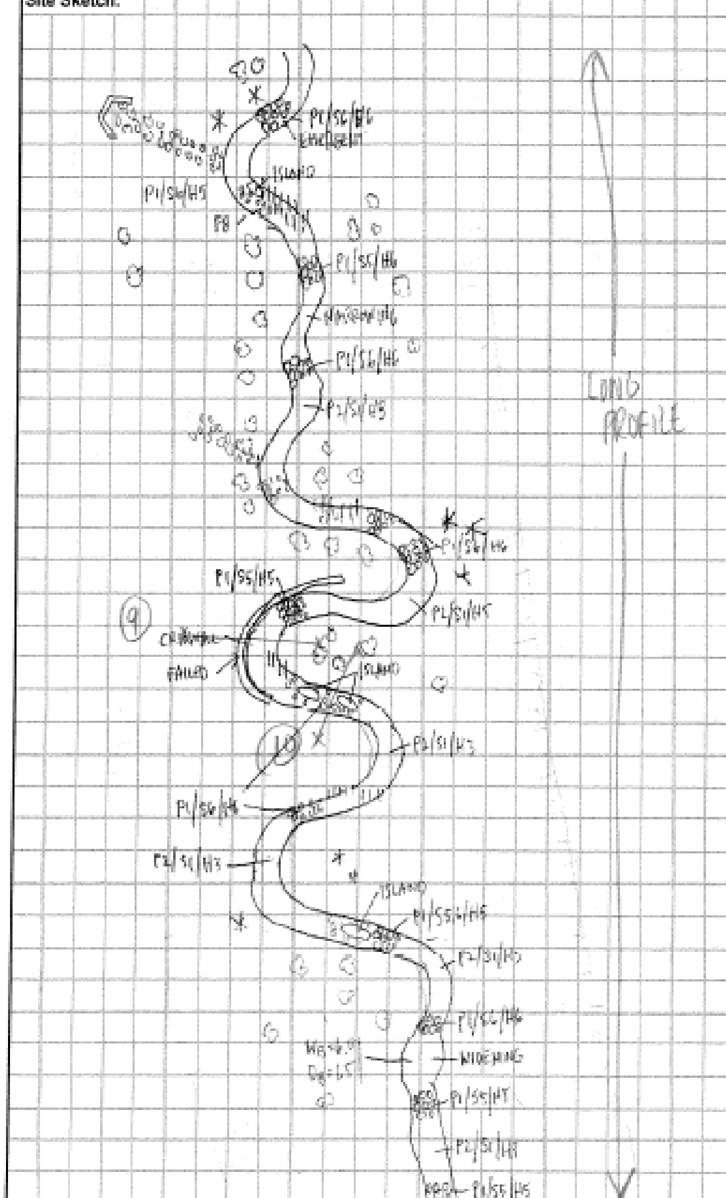
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates : ______

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2 OF 5

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: PARTLY CLOUDY	Recorder/Crew: KT/BH
Location: AJAX	Stream/Reach: MILLER CREEK /1 (11A)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

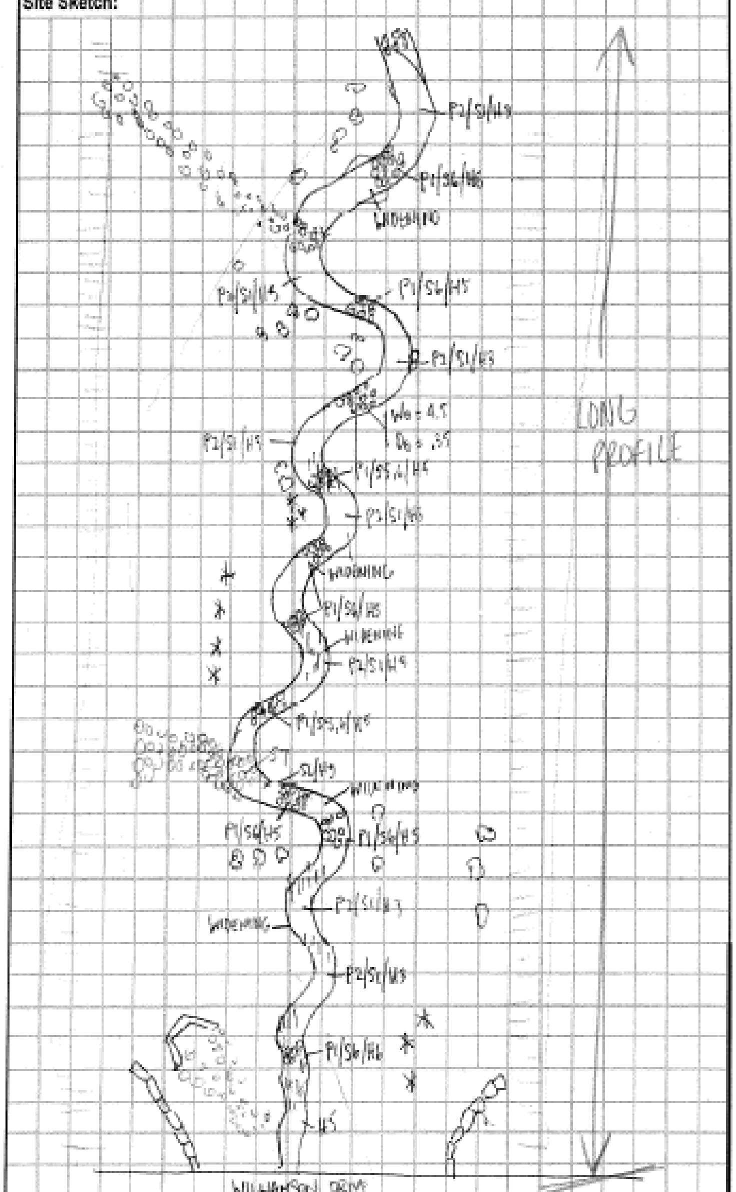
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 3 OF 3

NCD MONITORING PROGRAM

SITE 11B – MILLER CREEK REACHES 1-2

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	400m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM
SITE 11B – MILLER CREEK REACHES 1-2

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY BENTHIC MACRO-INVERTEBRATES	Water quality for this reach is assessed through data collection from Site 11A downstream (Reach 6).			
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 27	Weather: Partly Cloudy	Recorder/Crew: KT/BW
Location: Ajax	Stream/Reach: Miller Creek / 2 (11B)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

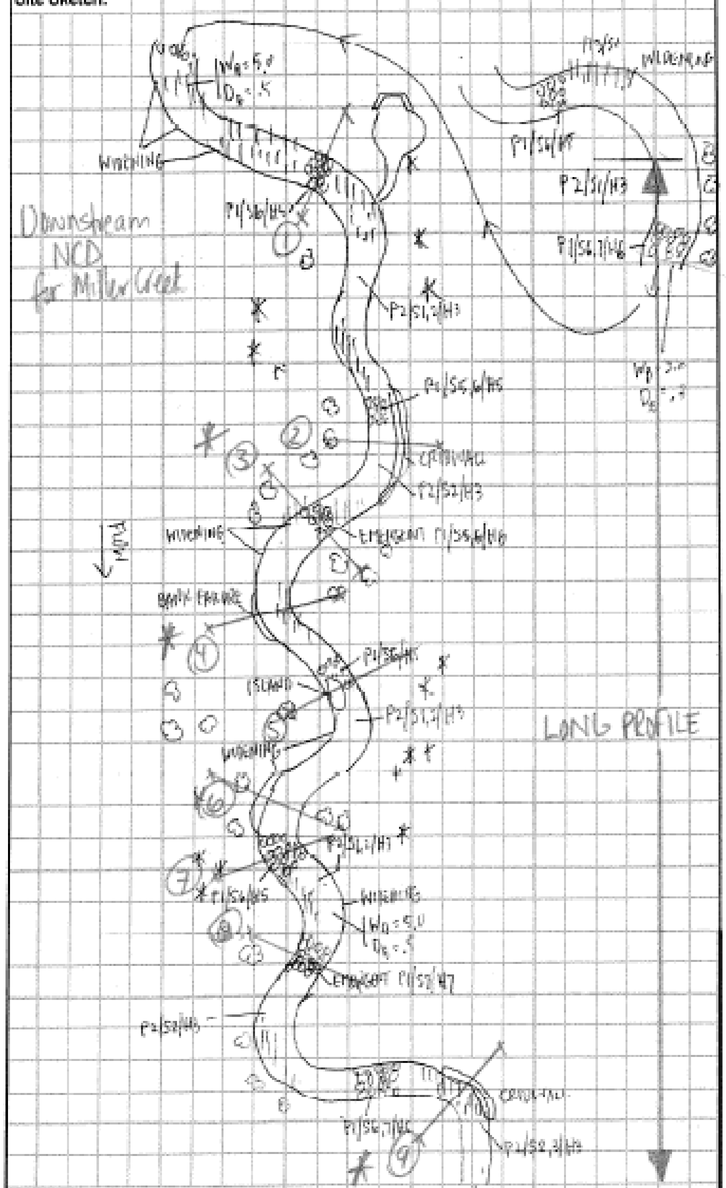
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates :

Notes:

Emergent riffles and cattail growth inhibiting flow

Site Sketch:



Drawn By: KT Checked By: ____

* ... indicates proposed permanent cross-sections ...

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 Weather: SUNNY Recorder/Crew: KT/BW

Location: AJAX Stream/Reach: MILLER CREEK / 2 (11B) Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

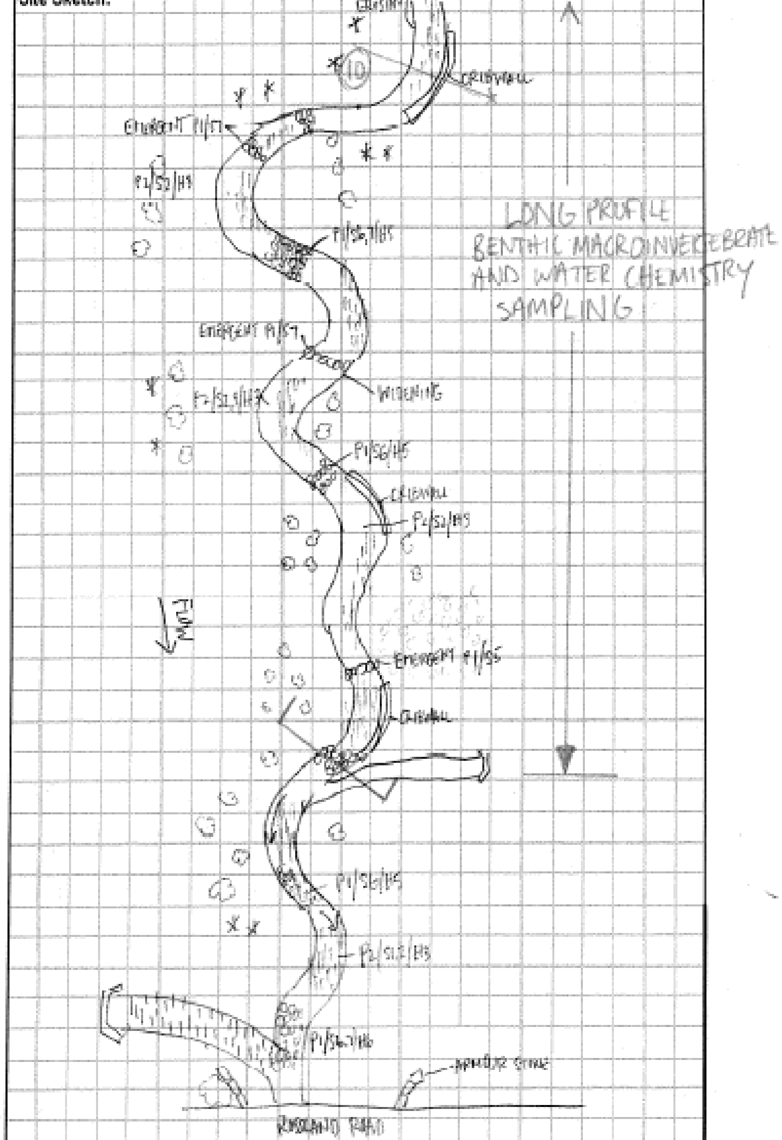
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

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NCD MONITORING PROGRAM
SITE 12A – DON RIVER (UPSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 12A – DON RIVER (UPSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Water quality for this reach is assessed through data collection from Site 12B downstream.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	Opinion surveys.	Entire project area.	Once during the monitoring period.	Summer (fair weather)

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: VAUGHAN (U/S OF 400)	Stream/Reach: DON R. TRIB (R1) 1 OF 6	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

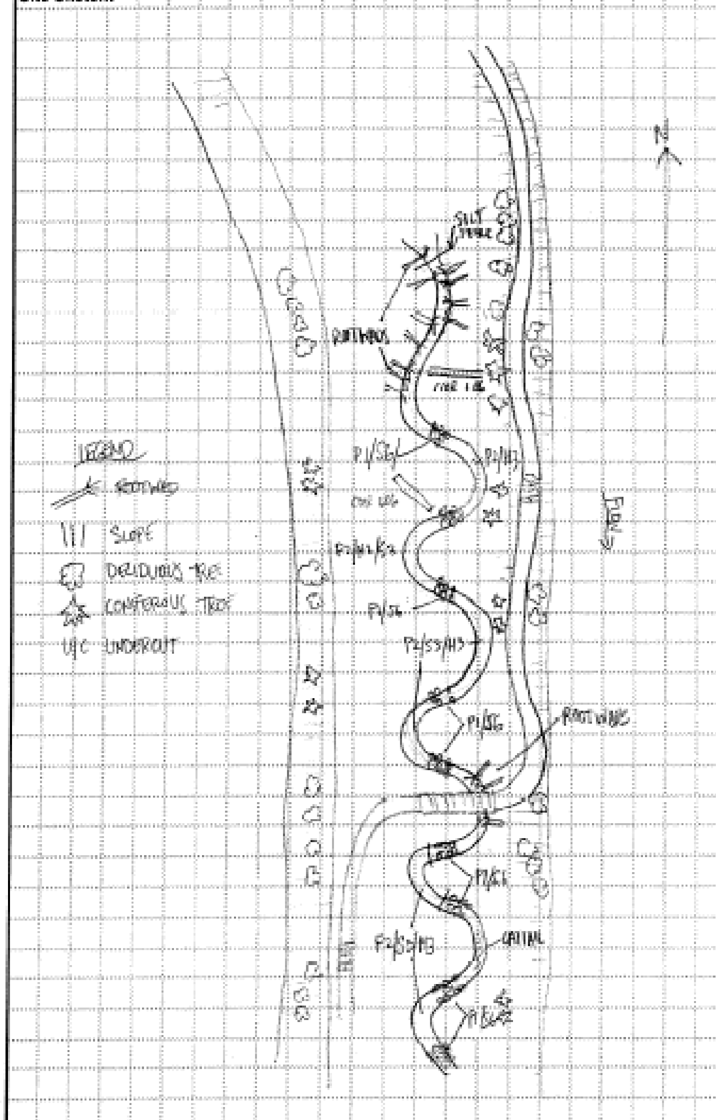
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates : ______

Notes:

RIPARIAN AREA MOSTLY TALL GRASSES
SOME EROSION AROUND ROOTWADS AT BENDS

Site Sketch:



Drawn By: KT Checked By: ____

* Channel length of 1400 m

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GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: VAUGHAN (U/S OF 400)	Stream/Reach: DON R TRIB (FH?) 2 OF 6	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

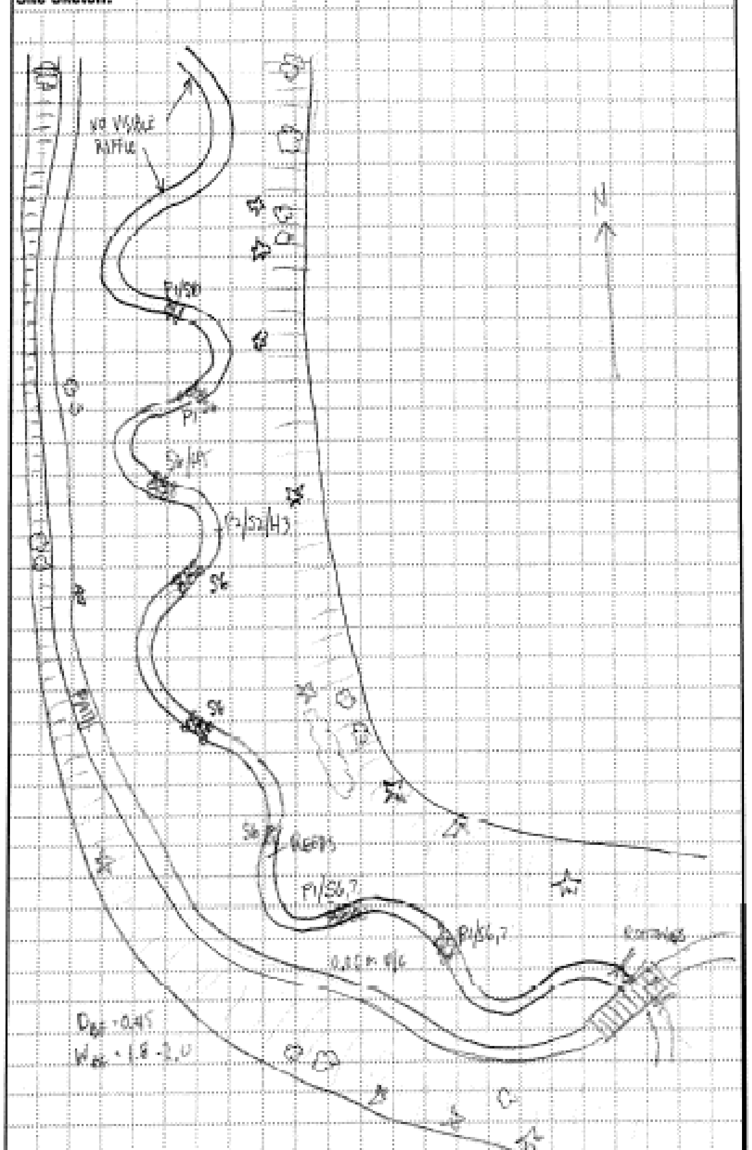
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates : ______

Notes:

ALL RIFFLES EMERGENT & VEGETATED

Site Sketch:



Drawn By: ____ Checked By: ____

PAGE 2 OF 6

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: VAUGHAN (U/S OF 400)	Stream/Reach: DON E TRIB (R12) 3 of 6	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

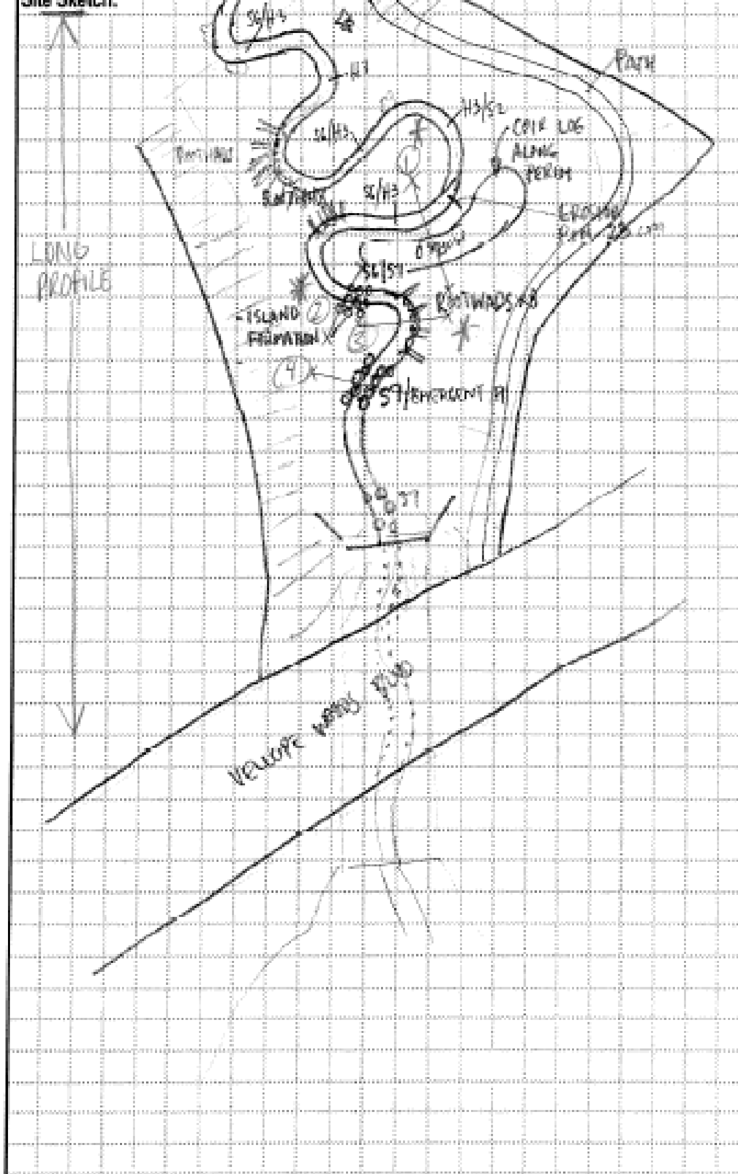
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

Site Sketch:



Drawn By: ____ Checked By: ____

* Asterisk indicates proposed permanent cross-sections

PAGE 3 OF 6

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10 / 05	Weather: OVERCAST	Recorder/Crew: KT / BW
Location: VAUGHAN (U/S OF 4##)	Stream/Reach: DON R TRIB 4 OF 6	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

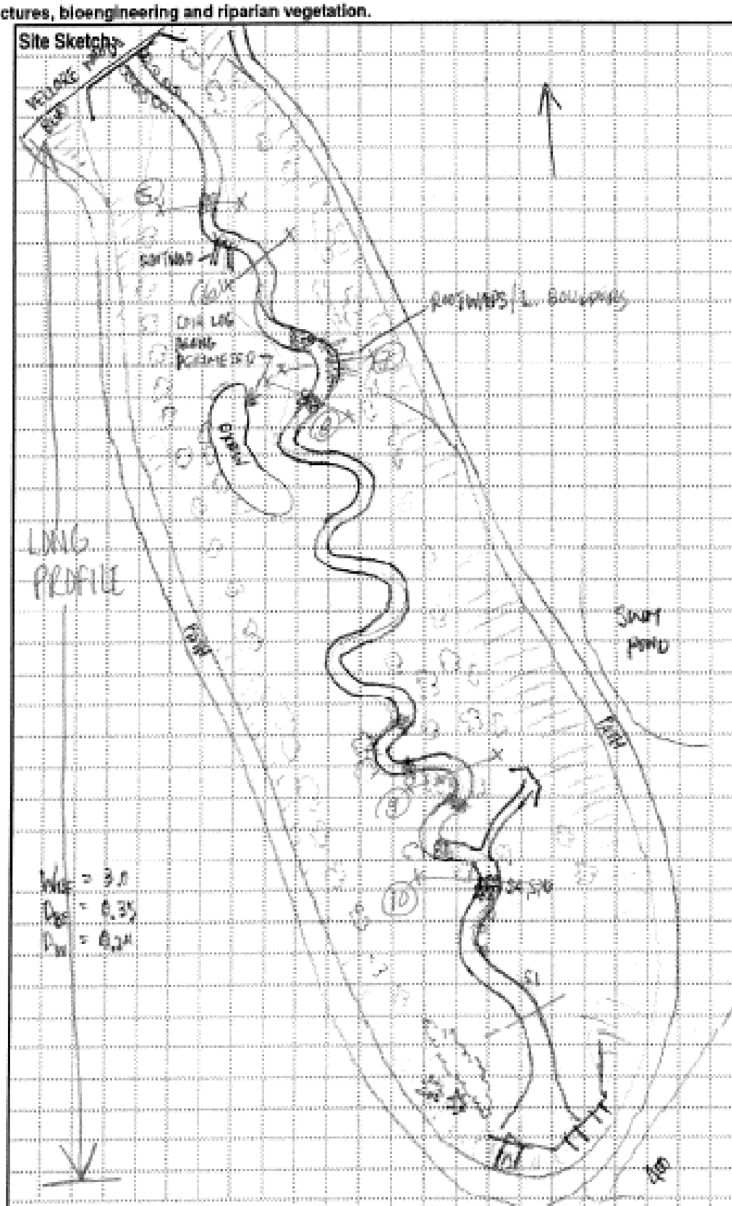
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

RIFFLES OVERGROWN WITH GRASSES
RIFFLES IMPEDING FLOW AND
CAUSING BACKWATER EFFECT

Site Sketch:



Drawn By: ____ Checked By: ____

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NCD MONITORING PROGRAM

SITE 12B – DON RIVER (DOWNSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM

SITE 12B – DON RIVER (DOWNSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: VAUGHAN (DN OF 400)	Stream/Reach: DON R TRIB (R12) 5 OF 6	Project Code: 05351.455

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

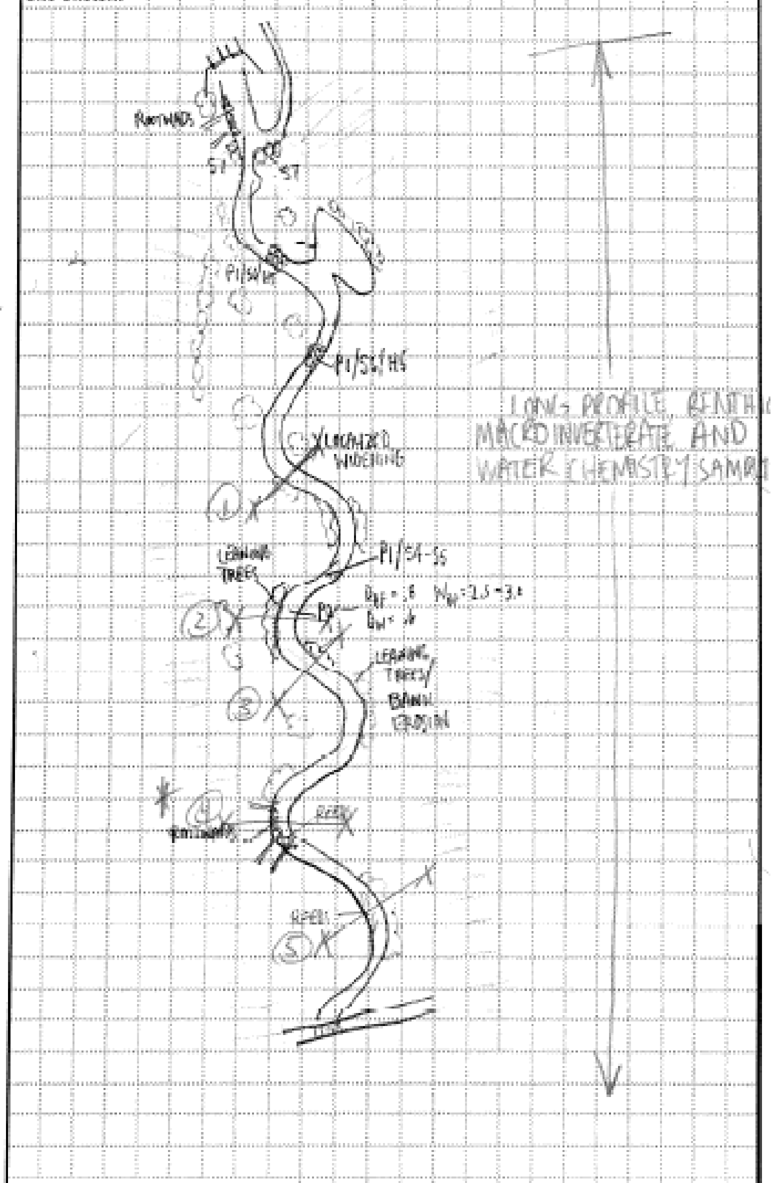
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

FLOODPLAIN PLANTS:
- GRASSES (SHRUB)
- HERBACEOUS SPP
- WILLOW

Site Sketch:



Drawn By: ____ Checked By: ____

PAGE 5 OF 6

* Channel length of 700 m
* Asterisk indicates proposed permanent cross-sections

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: VAUGHAN (DS OF 400)	Stream/Reach: DON R TRIB (412) 6 OF 6	Project Code: 05357.400

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

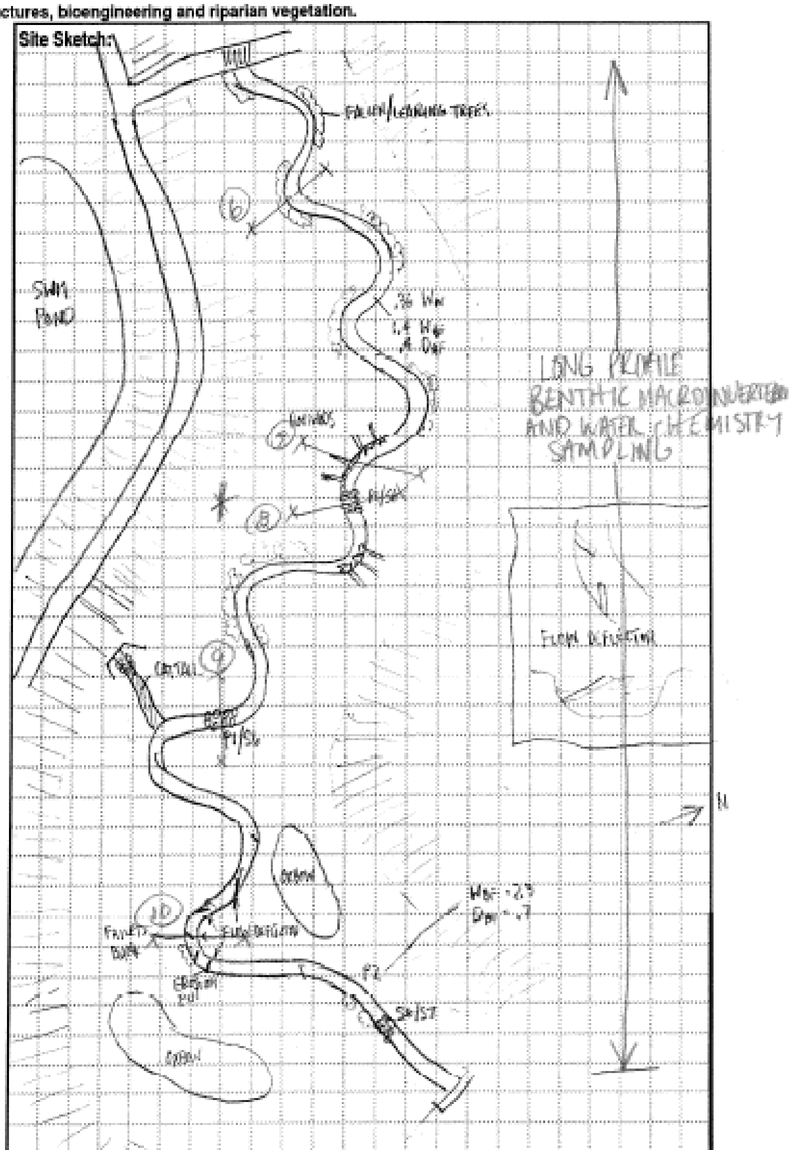
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates: ______

Notes:

ALL TREES ON OUTSIDE OF BENDS COMPRISED OF WILLOW

Site Sketch:



Drawn By: ___ Checked By: ___

PAGE 6 OF 6

NCD MONITORING PROGRAM

SITE 13 – ROBINSON CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 13 – ROBINSON CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY BENTHIC MACRO-INVERTEBRATES	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov. 17/05 | Weather: CLOUDY | Recorder/Crew: KT/BW

Location: MARKHAM | Stream/Reach: ROBINSON CREEK (#13) | Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

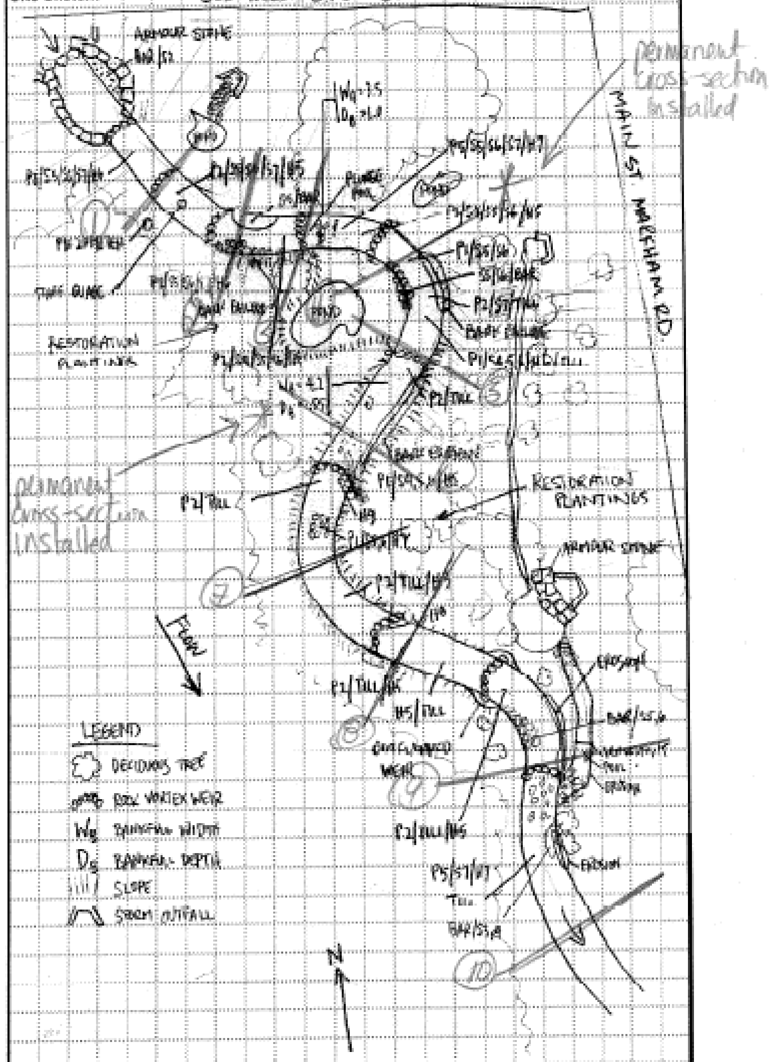
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates: 4859072 643794

Notes:

VORTEX WEIR 1M DIA. STONE
EXTENSIVE TILL EXPOSURE B/S OF 2ND POND
ENTRENCHED
LOCALIZED BANK EROSION

Site Sketch: OLD WELLINGTON ST.



Drawn By: KT Checked By: BW

* Detailed survey already completed.

NCD MONITORING PROGRAM
SITE 14 – GERMAN MILLS CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 14 – GERMAN MILLS CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY **BENTHIC MACRO-INVERTEBRATES**	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 11/05	Weather: Cloudy	Recorder/Crew: VS/BW
Location: Richmond Hill	Stream/Reach: German Mills Creek (H-M)	Project Code: 05351.A57

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

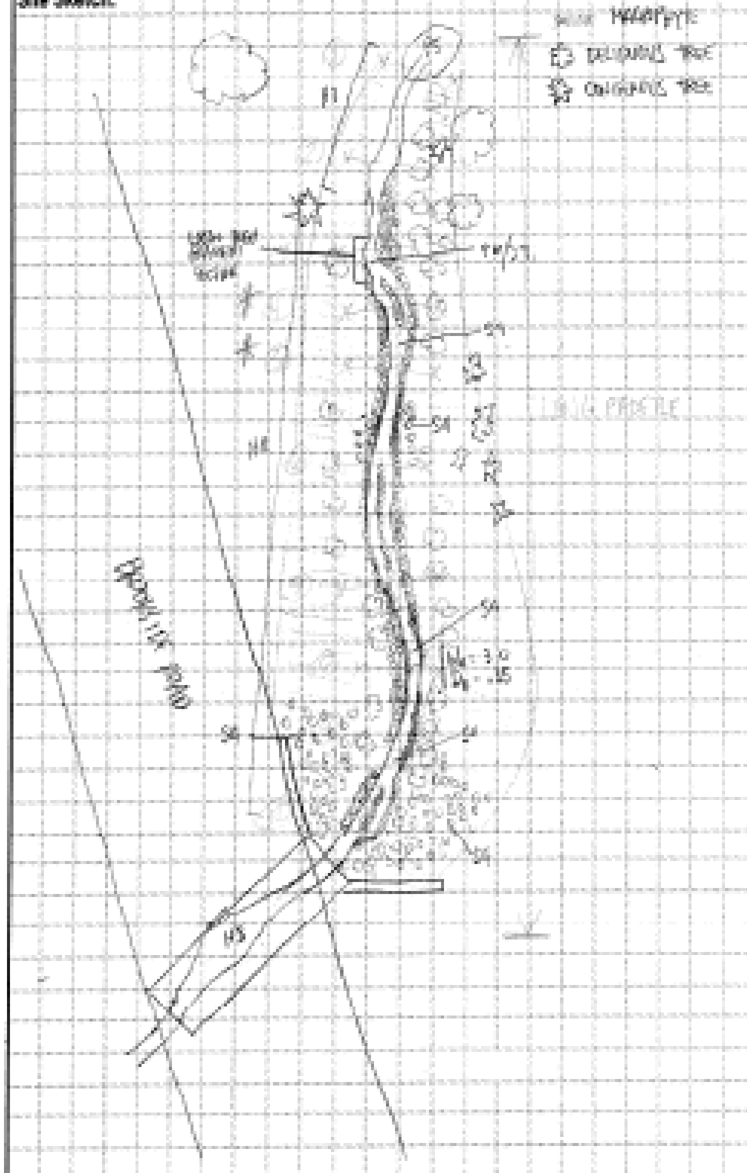
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates: ____________

Notes:

CHANNEL BED COMPOSED OF SMALL COBBLES – MOSTLY EXPOSED
SILTATION OVER COBBLES IN D/S END OF CHANNEL
NO TRUE RIFFLES/POOLS
LIMITED FLOODPLAIN

Site Sketch:



Drawn By: HF Checked By: ____

* Asterisk indicates proposed permanent cross-sections.

NCD MONITORING PROGRAM
SITE 16 – AMBERLEA CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 16 – AMBERLEA CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 22/05	Weather: Sunny	Recorder/Crew: KT/BW
Location: Pickering	Stream/Reach: Amberlea Creek (#16)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

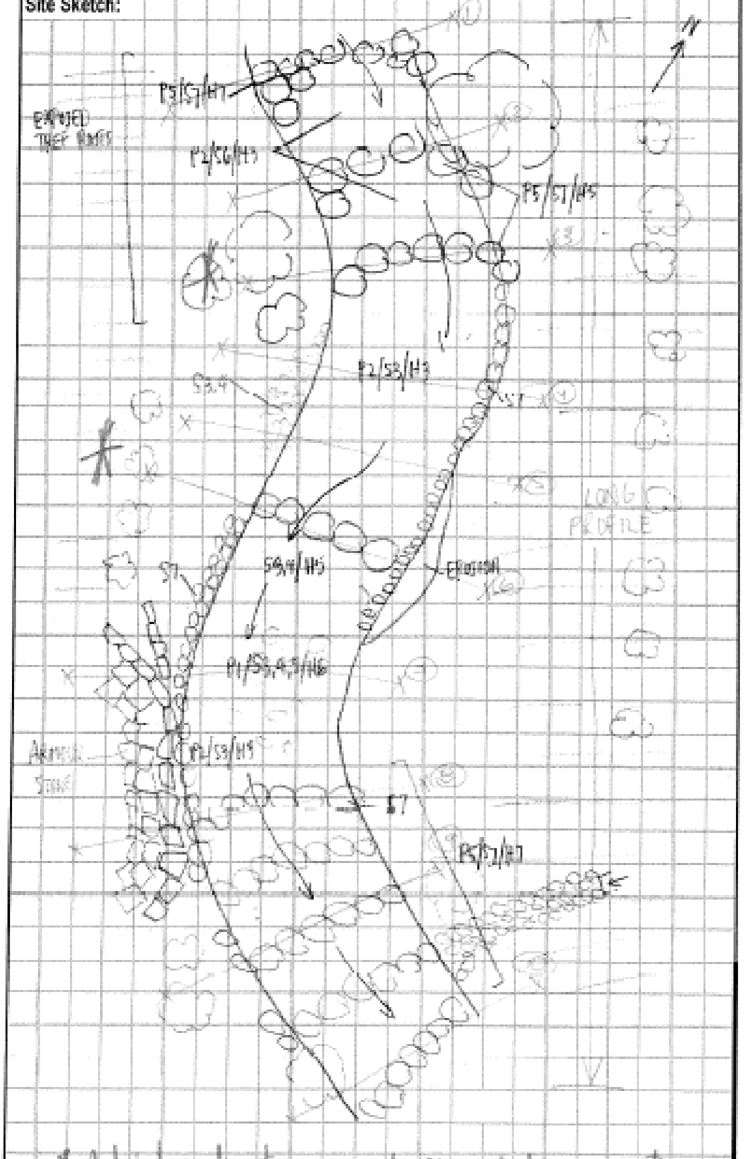
Geomorphic Unit	
P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater
Substrate	
S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal
Functional habitats	
F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes
Flow Type	
H9 Free Fall	
H8 Chute	
H7 Broken Standing Wave	
H6 Unbroken Standing Wave	
H5 Rippled	
H4 Upwelling	
H3 Smooth Surface Flow	
H2 Scarcely Peceptible Flow	
H1 Standing Water	

UTM Coordinates : ______

Notes:

Some bank erosion at outside of 1st bend
Riparian - grasses/shrubs
Old trees remain

Site Sketch:



* Asterisk indicates proposed permanent cross-sections

Drawn By: KT Checked By: ____

* Reference reach available upstream & downstream

NCD MONITORING PROGRAM
SITE 18A – MORNINGSIDE TRIBUTARY (UPSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 18A – MORNINGSIDE TRIBUTARY (UPSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Water quality for this reach is assessed through data collection from Site 18C downstream.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 22/05	Weather: SUNNY	Recorder/Crew: KS/BW
Location: SCARBOROUGH	Stream/Reach: MORNINGSIDE TRIB (#18)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S6 Small Boulder
S2 Sand	S7 Large Boulder
S3 Gravel	S8 Bimodal
S4 Small Cobble	S9 Bedrock
S5 Large Cobble	S10 Till

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

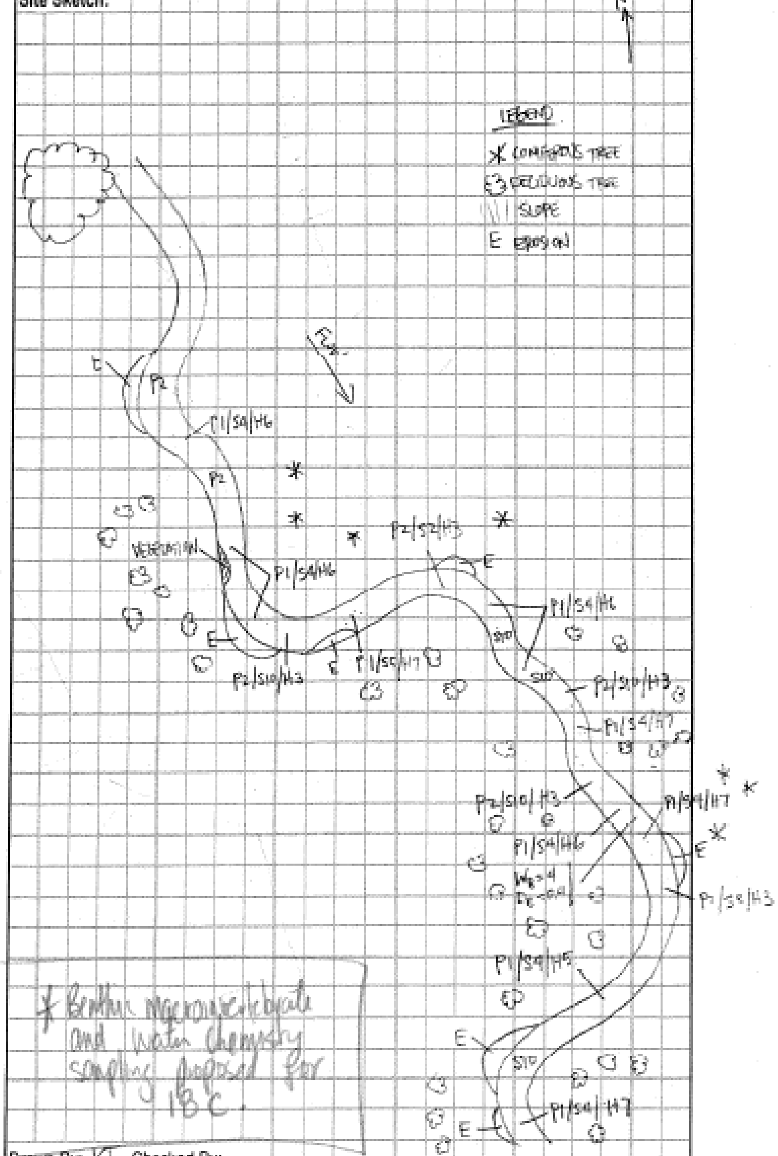
Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

Notes:

UTM:

Site Sketch:



Drawn By: KS Checked By:

1 OF 5

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 Weather: SUNNY Recorder/Crew: VT/BW

Location: SCARBOROUGH Stream/Reach: MORNINGSIDE TRIB (MT8) Project Code: 05352.45P

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S6 Small Boulder
S2 Sand	S7 Large Boulder
S3 Gravel	S8 Bimodal
S4 Small Cobble	S9 Bedrock
S5 Large Cobble	S10 Till

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

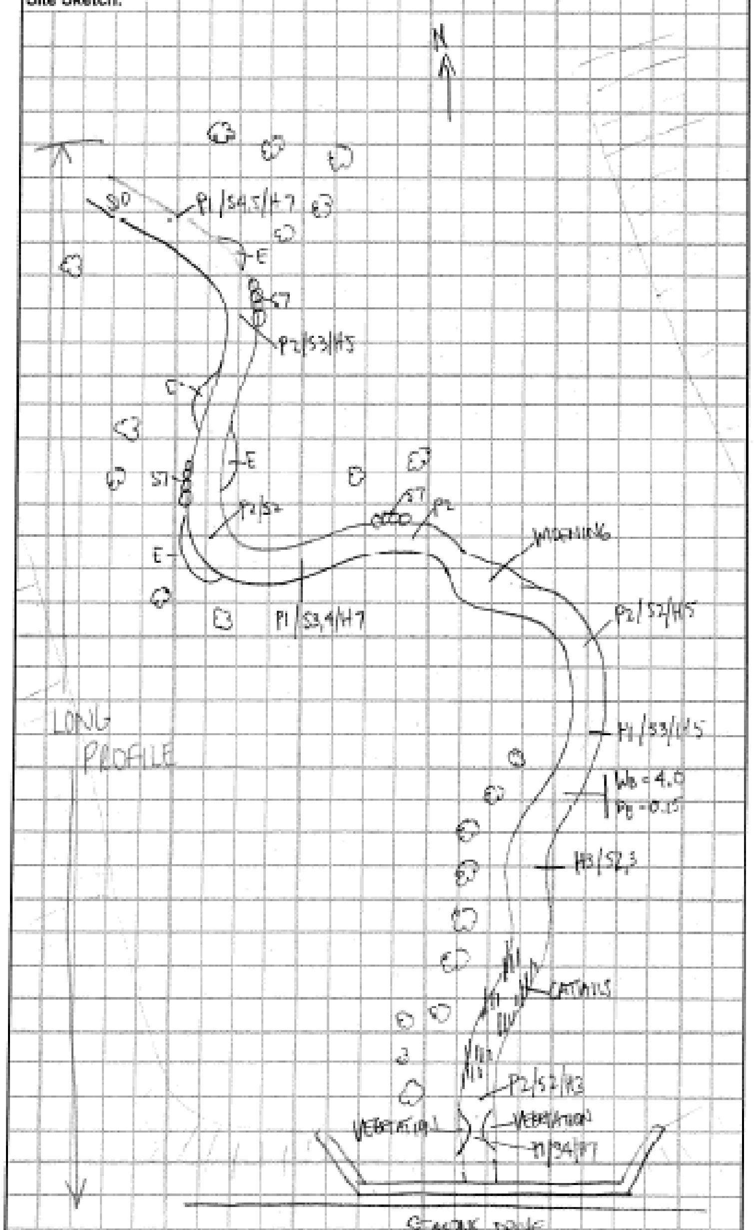
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

Notes:

UTM:

Site Sketch:



Drawn By: VT Checked By: ____

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NCD MONITORING PROGRAM
SITE 18B – MORNINGSIDE TRIBUTARY (MIDDLE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 18B – MORNINGSIDE TRIBUTARY (MIDDLE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Water quality for this reach is assessed through data collection from Site 18C downstream.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 Weather: SUNNY Recorder/Crew: KT / BW

Location: SCARBOROUGH Stream/Reach: MORNINGSIDE TRIB (#1B) Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1	Riffle	P5	Cascade
P2	Pool	P6	Rapid
P3	Run	P7	Bedrock outcrop
P4	Glide	P8	Marginal deadwater

Substrate

S1	Silt	S6	Small Boulder
S2	Sand	S7	Large Boulder
S3	Gravel	S8	Bimodal
S4	Small Cobble	S9	Bedrock
S5	Large Cobble	S10	Till

Functional habitats

F1	Tree roots	F5	Leaf litter
F2	Tree branches	F6	Mosses
F3	Woody debris	F7	Macroalgae
F4	Marginal plants	F8	Macrophytes

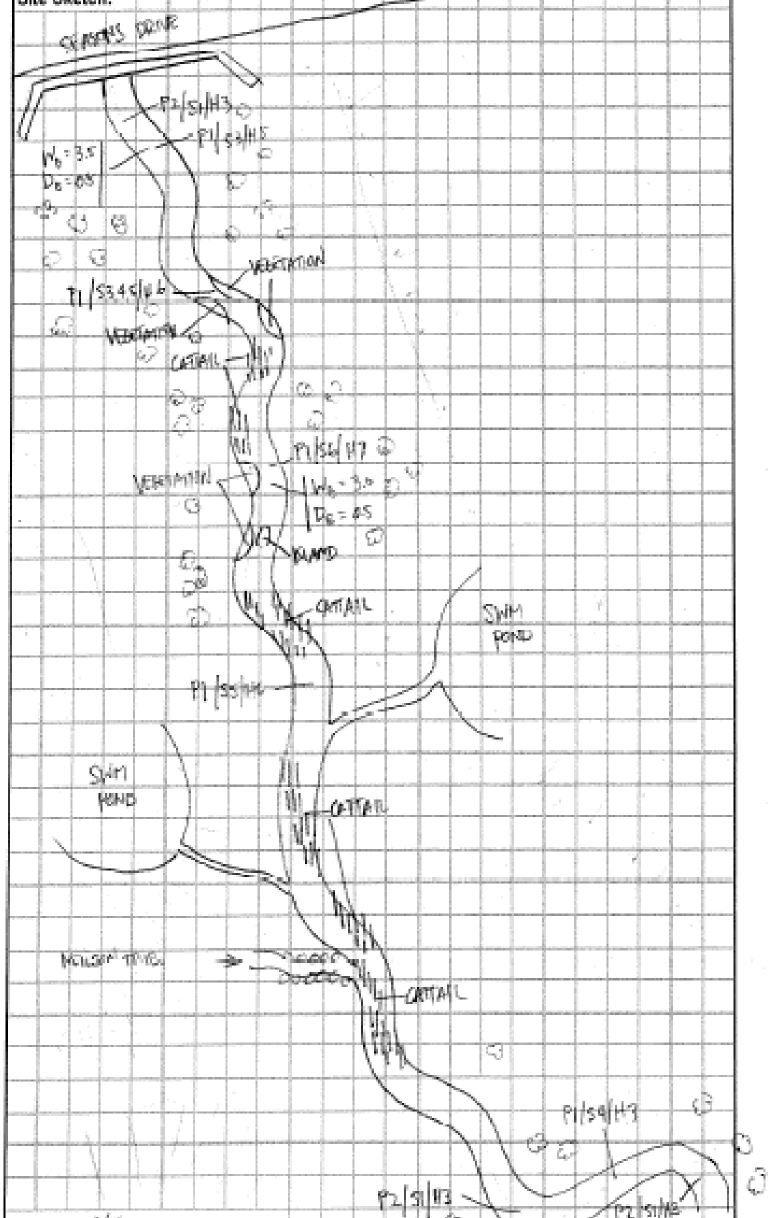
Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Perceptible Flow
- H1 Standing Water

Notes:

UTM: ______

Site Sketch:



Drawn By: KT Checked By: ____

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NCD MONITORING PROGRAM

SITE 18C – MORNINGSIDE TRIBUTARY (DOWNSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 18C – MORNINGSIDE TRIBUTARY (DOWNSTREAM)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	In situ measurement of basic water chemistry parameters.	Upstream, within and downstream of the project area.	Every other year over the monitoring period.	Summer (baseflow)
BENTHIC MACRO-INVERTEBRATES	Section 2 of the Ontario Stream Assessment Protocol.	A characteristic segment of the project area (refer to site map).	Every other year over the monitoring period.	Summer (baseflow)
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05	Weather: SUNNY	Recorder/Crew: LT/BW
Location: SCARBOROUGH	Stream/Reach: MORNINGSIDE TRIB (M.B)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S6 Small Boulder
S2 Sand	S7 Large Boulder
S3 Gravel	S8 Bimodal
S4 Small Cobble	S9 Bedrock
S5 Large Cobble	S10 Till

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

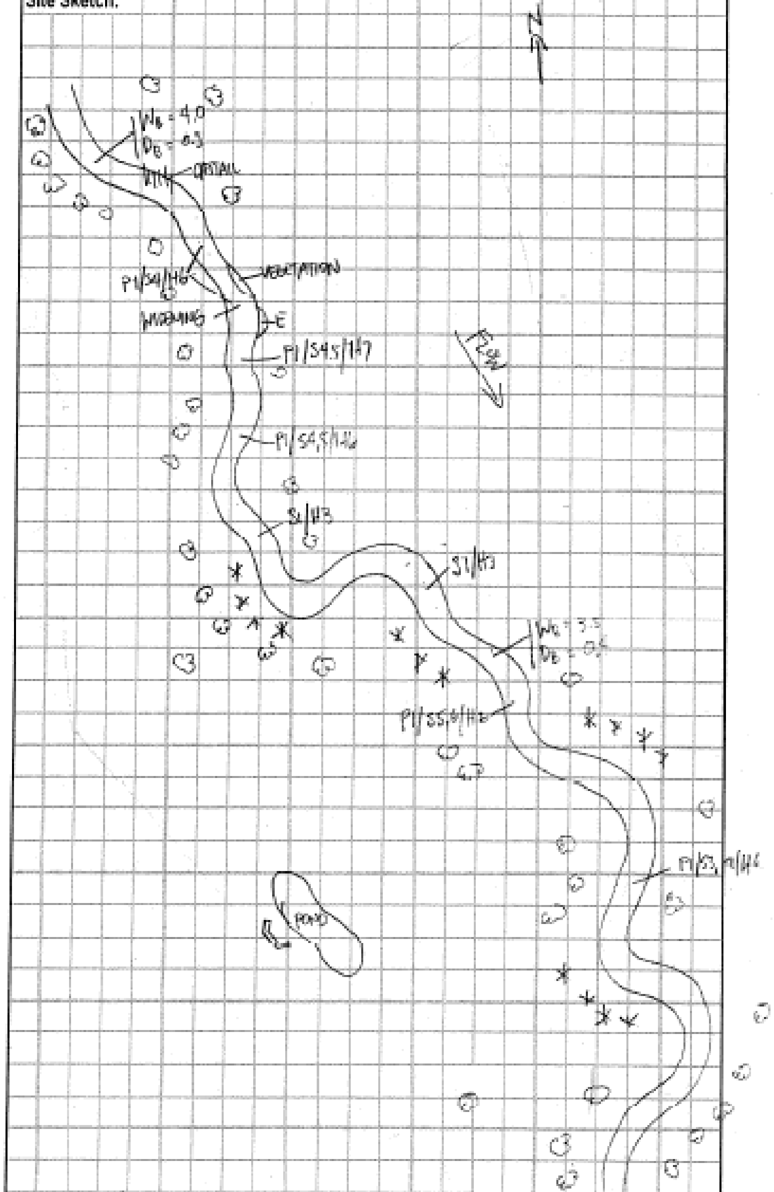
Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

Notes:

UTM:

Site Sketch:



Drawn By: LT Checked By:

1 of 5

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 22/05	Weather: SUNNY	Recorder/Crew: KT/BWJ
Location: SCARBOROUGH	Stream/Reach: MORNINGSIDE TRIB (#B)	Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S6 Small Boulder
S2 Sand	S7 Large Boulder
S3 Gravel	S8 Bimodal
S4 Small Cobble	S9 Bedrock
S5 Large Cobble	S10 Till

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

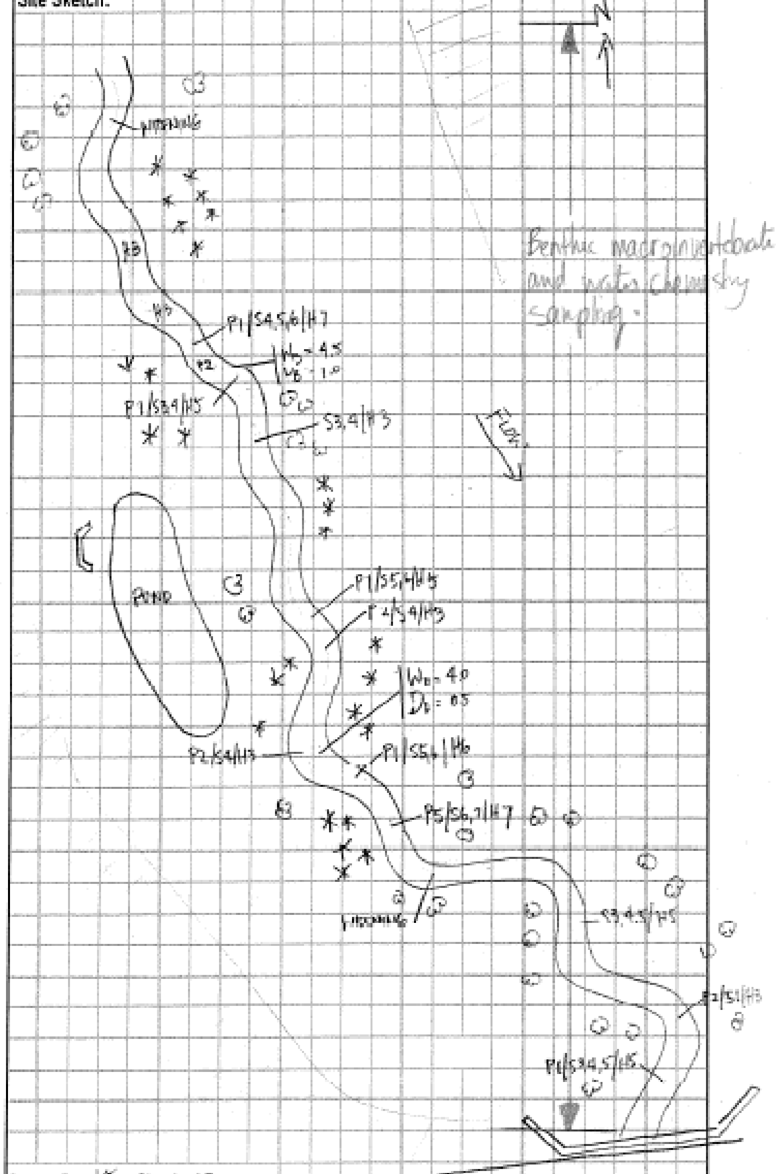
Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Perceptible Flow
- H1 Standing Water

Notes:

UTM:

Site Sketch:



Drawn By: KT Checked By:

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NCD MONITORING PROGRAM

SITE 18D – MORNINGSIDE TRIBUTARY (NEILSON)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 18D – MORNINGSIDE TRIBUTARY (NEILSON)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Water quality for this reach is assessed through data collection from Site 18C downstream.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 22/05 Weather: SUNNY Recorder/Crew: KT/DW

Location: SCARBOROUGH Stream/Reach: NEILSON TRIB (#18) Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

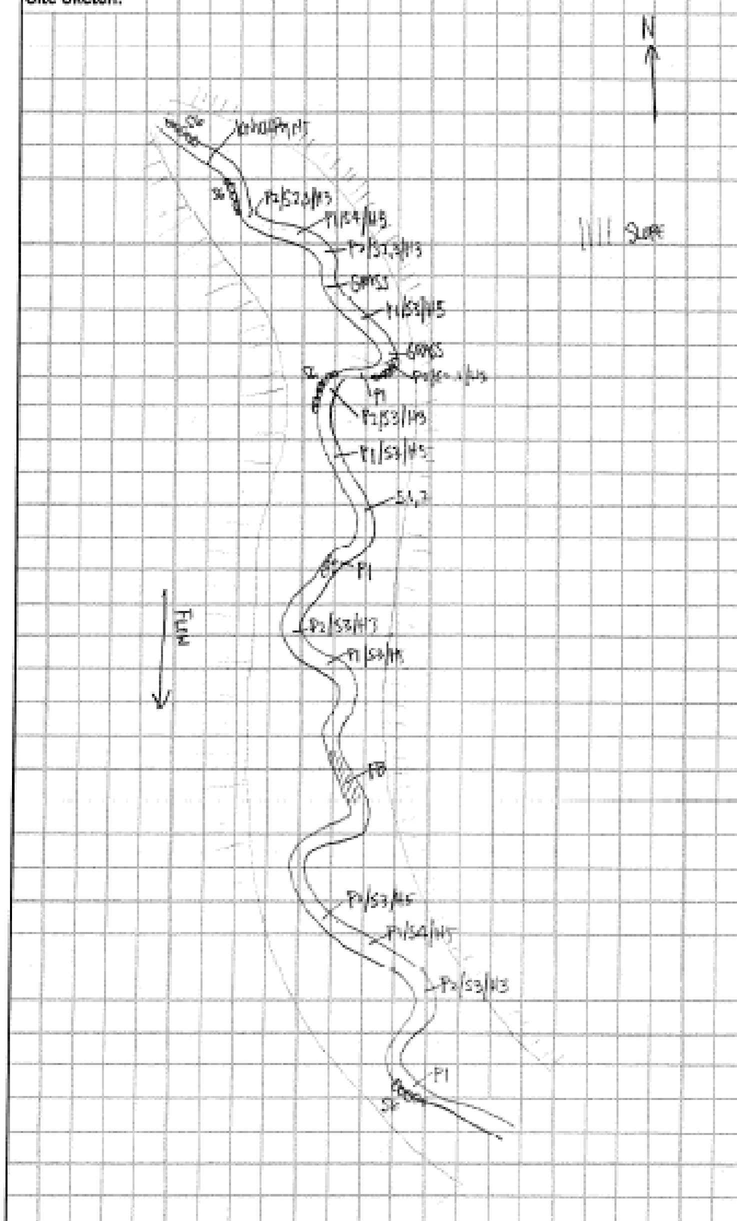
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

CONTINUATION OF A CHANNEL DESIGN U/S BY ANOTHER FIRM

Site Sketch:



Drawn By: KT Checked By:

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 Weather: SUNNY Recorder/Crew: KT/BW

Location: SCARBOROUGH Stream/Reach: NELSON TRIB (#18) Project Code: 05561.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

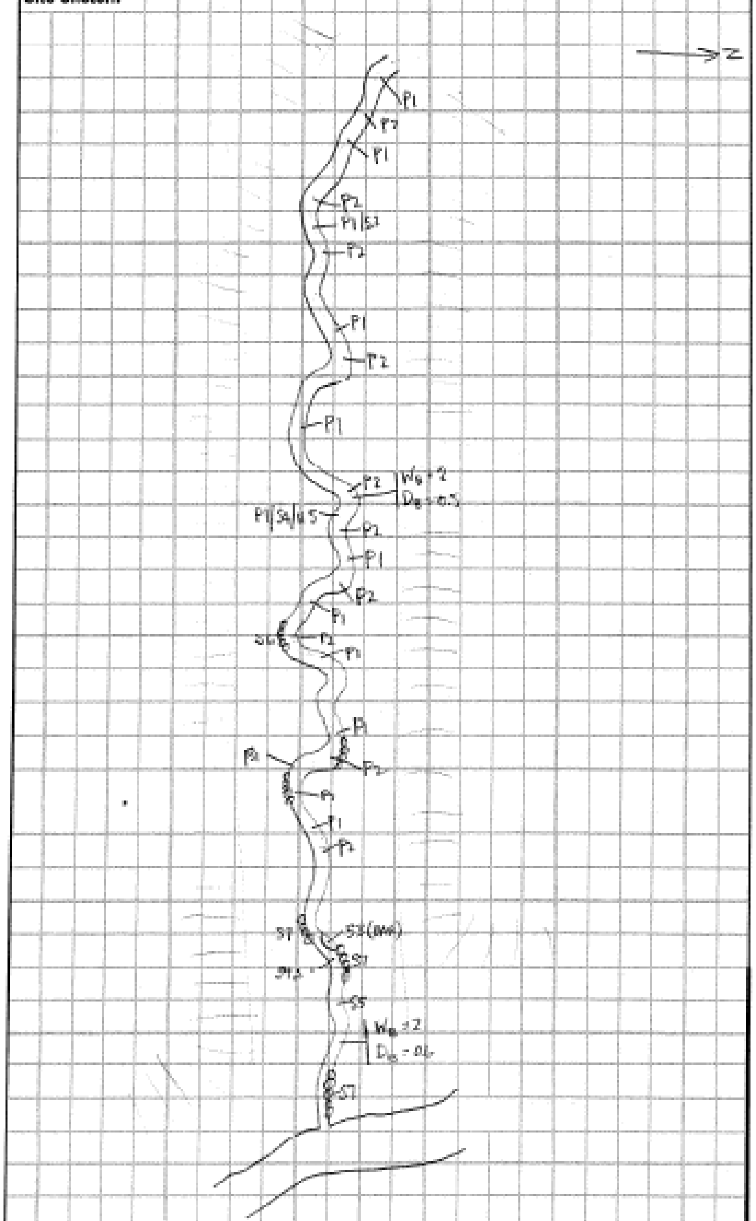
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ______

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

NCD MONITORING PROGRAM
SITE 20 – LOWER MILNE CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM
SITE 20 – LOWER MILNE CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 17/05	Weather: CLOUDY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: LOWER MILNE CREEK (#20)/1	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ________

Notes:

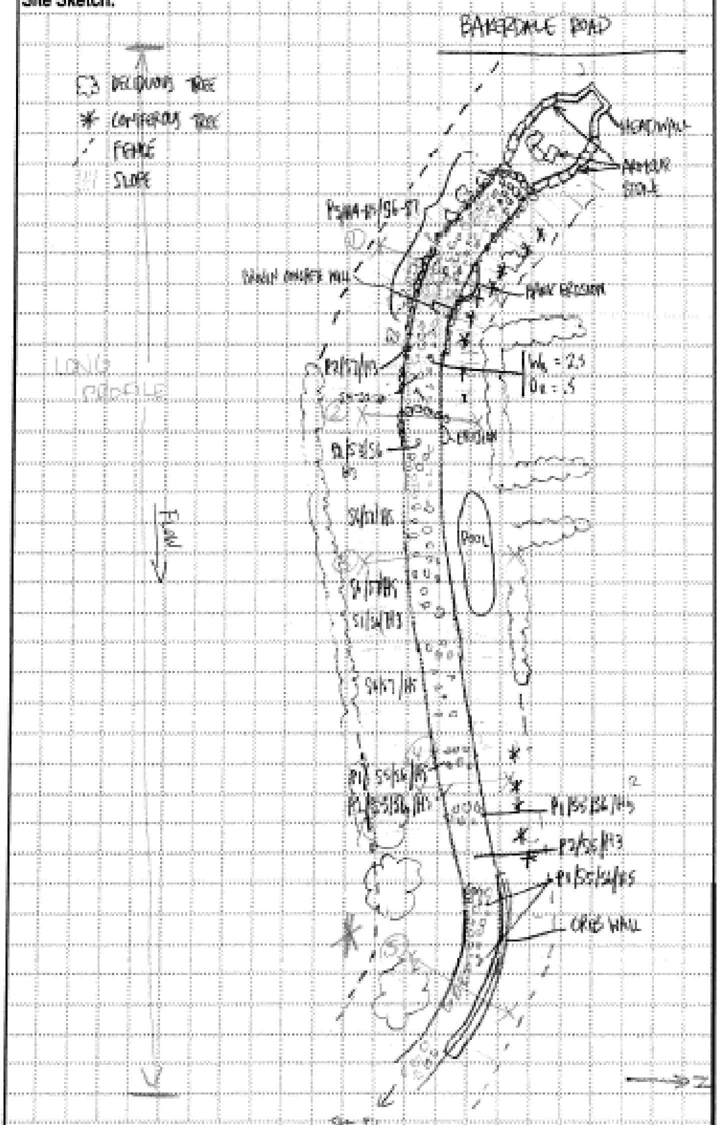
WATTLES/FASCINES ALONG BOTH BANKS FOR ENTIRE CHANNEL – MOSTLY EXPOSED BUT MANY ESTABLISHED PLANTS

INSTALLED VORTEX WEIRS FAILED IN ALL CASES EXCEPT ONE

MANY LARGE BOULDERS USED FOR VORTEX WEIRS AND BANK PROTECTION WASHED D/S AND DEPOSITED IN CHANNEL

RIPARIAN ZONE WELL VEGETATED WITH GRASSES & SHRUBS

Site Sketch:



Drawn By: KT Checked By: ____

* No reference reach available
* Asterisk indicates proposed permanent cross-sections

PAGE 1 OF 2

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 17/05	Weather: CLOUDY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: LOWER MILNE CREEK (#20)/2	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

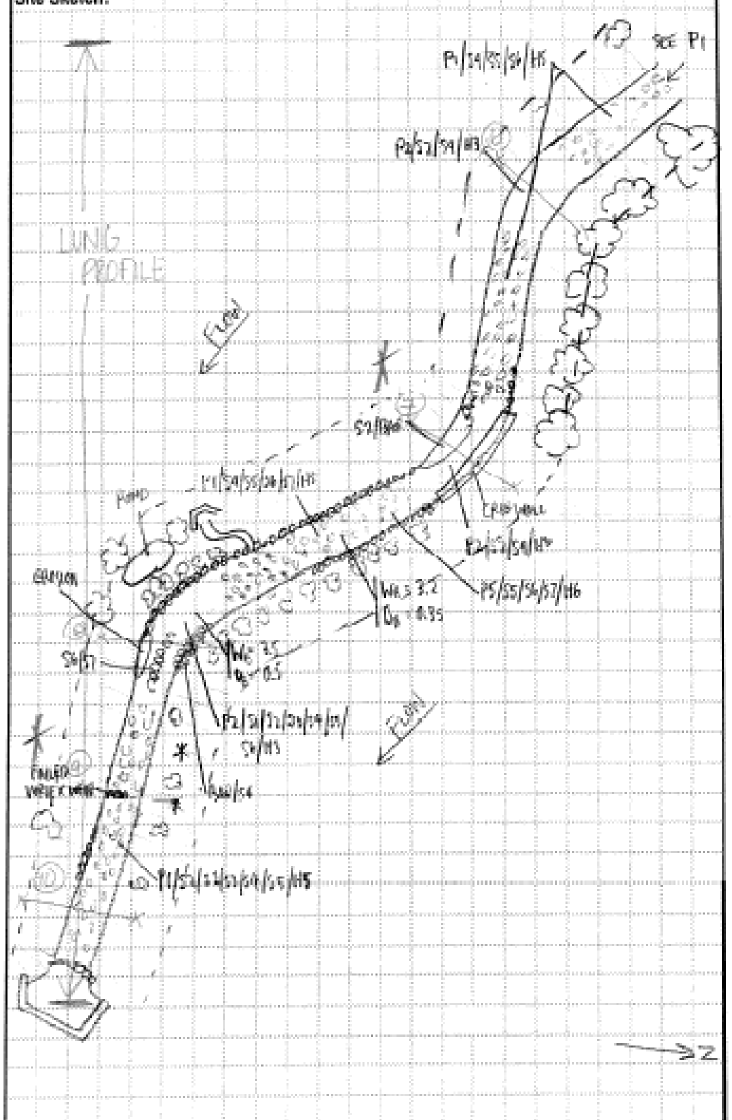
Flow Type

H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____

Notes:

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2 OF 2

NCD MONITORING PROGRAM

SITE 21 – MIMICO CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM
SITE 21 – MIMICO CREEK

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KT/BW
Location: BRAMPTON	Stream/Reach: MIMICO CREEK #21	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P0 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

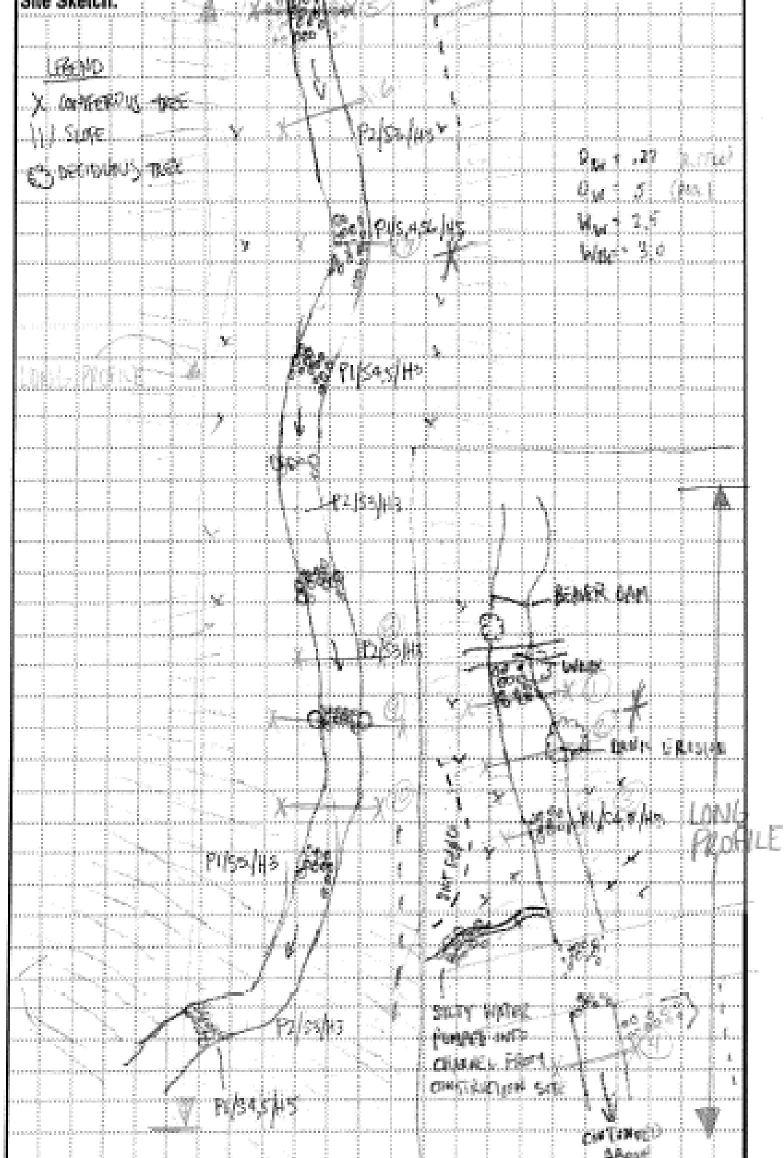
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

RIPARIAN ZONE VEGETATED WITH TALL GRASSES & SHRUBS

Site Sketch:



Drawn By: KT Checked By: ____

* Reference reach available upstream and downstream

* Asterisk indicates proposed permanent cross-sections.

NCD MONITORING PROGRAM

SITE 23 – CARRUTHERS CREEK NORTH OF ROSSLAND RD

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 23 – CARRUTHERS CREEK NORTH OF ROSSLAND RD

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 22/05 Weather: PARTLY CLOUDY Recorder/Crew: KT/AW

Location: AJAX Stream/Reach: CARRUTHERS CREEK (#25 Project Code: 05351.40

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

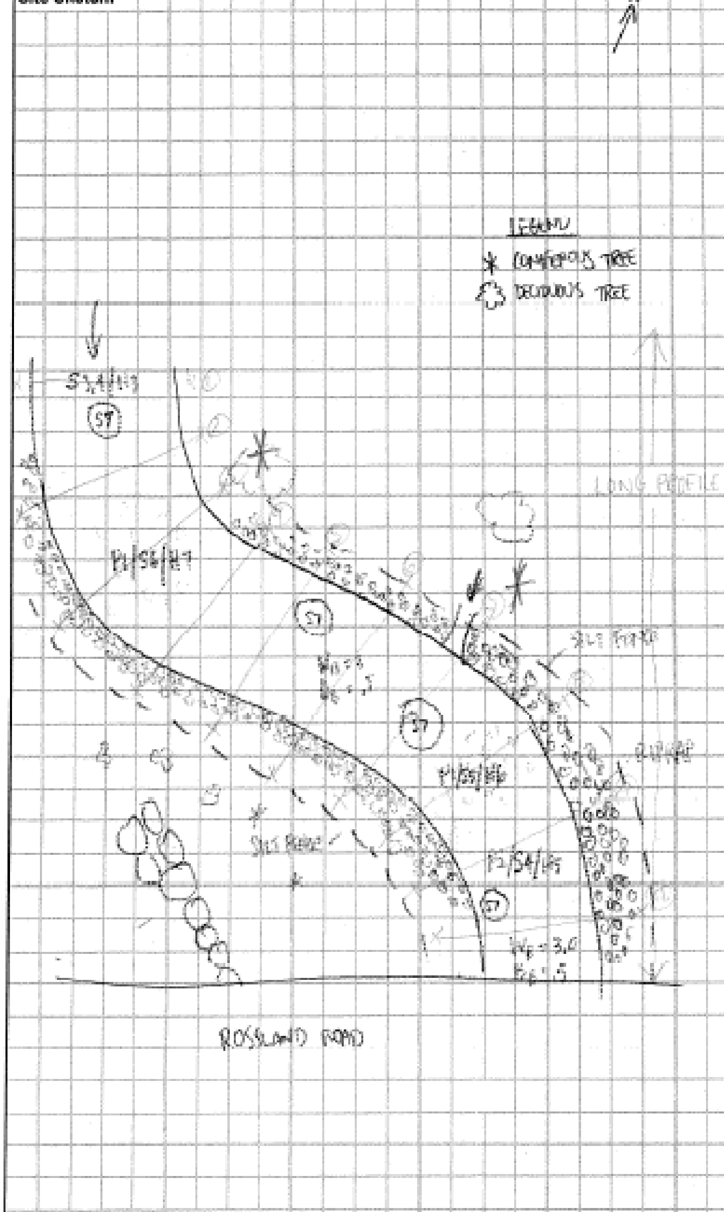
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

STABLE CHANNEL WITH RIPRAP

Site Sketch:



Drawn By: ____ Checked By: ____

* Reference reach available upstream and downstream.

NCD MONITORING PROGRAM
SITE 24 – NEILSON TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	Formal fluvial geomorphology monitoring already established through other project.			
LONGITUDINAL PROFILE				
SURFICIAL SEDIMENT CHARACTERISTICS				
RAPID ASSESSMENTS				
SUB-REACH MAP				
PHOTOGRAPHS FROM FIXED VANTAGE POINTS				
BANK EROSION PINS				
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Section 4 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 24 – NEILSON TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Water quality for this reach is assessed through data collection from Site 18C downstream.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05
Weather: SNOW
Recorder/Crew: KT/BW

Location: SCARBOROUGH
Stream/Reach: NEILSON TRIB (B24)/1
Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

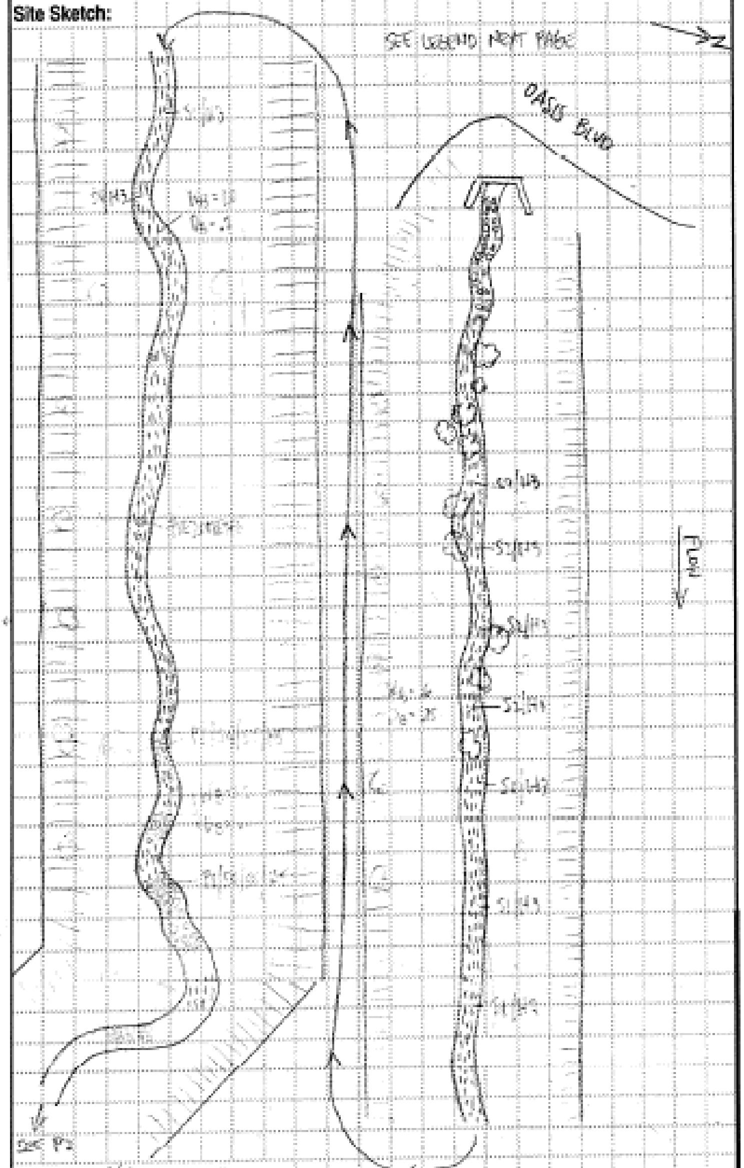
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

HEAVILY GRASSED CHANNEL CORRIDOR
CHANNEL POORLY DEFINED DUE TO
GRASS COVERAGE (UP TO POINT WHERE
CHANNEL BEGINS FLOWING WEST)
∴ NO RIFFLES OR POOLS
MID-CHANNEL TREES WITH EXPOSED
ROOTS FOR FIRST ~20 m FROM
OASIS BLVD

Site Sketch:



Drawn By: KT Checked By: ____

* Channel length of <25 m.
Follow geo-protocol already in place.

PAGE 1 OF 3

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SNOW	Recorder/Crew: KT/BW
Location: SCARBOROUGH	Stream/Reach: NELSON TRIB (#24) / 2	Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

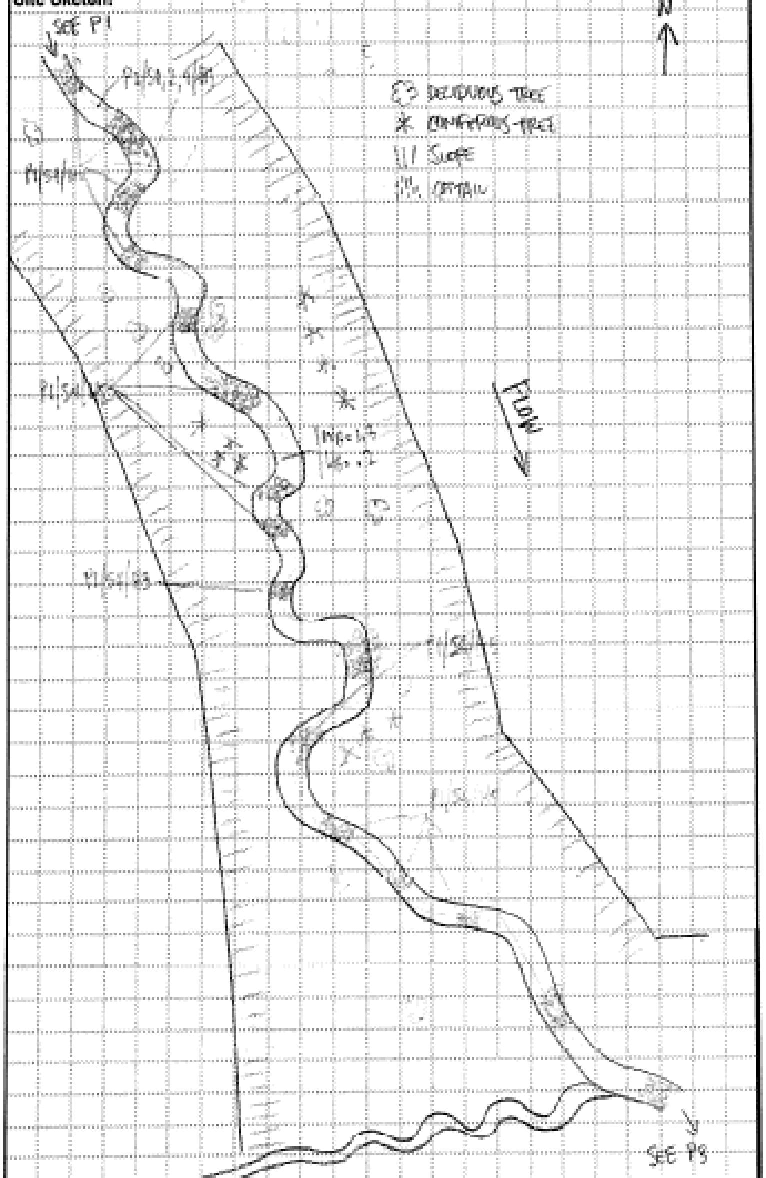
Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates :

Notes:

Site Sketch:



Drawn By: KT Checked By:

PAGE 2 OF 3

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: Nov 14/05 | Weather: Snow | Recorder/Crew: KT/BW

Location: Scarborough | Stream/Reach: Neilson Trib (#24)/3 | Project Code: 05352.400

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit
- P1 Riffle
- P2 Pool
- P3 Run
- P4 Glide
- P5 Cascade
- P6 Rapid
- P7 Bedrock outcrop
- P8 Marginal deadwater

Substrate
- S1 Silt
- S2 Sand
- S3 Gravel
- S4 Small Cobble
- S5 Large Cobble
- S6 Small Boulder
- S7 Large Boulder
- S8 Bimodal

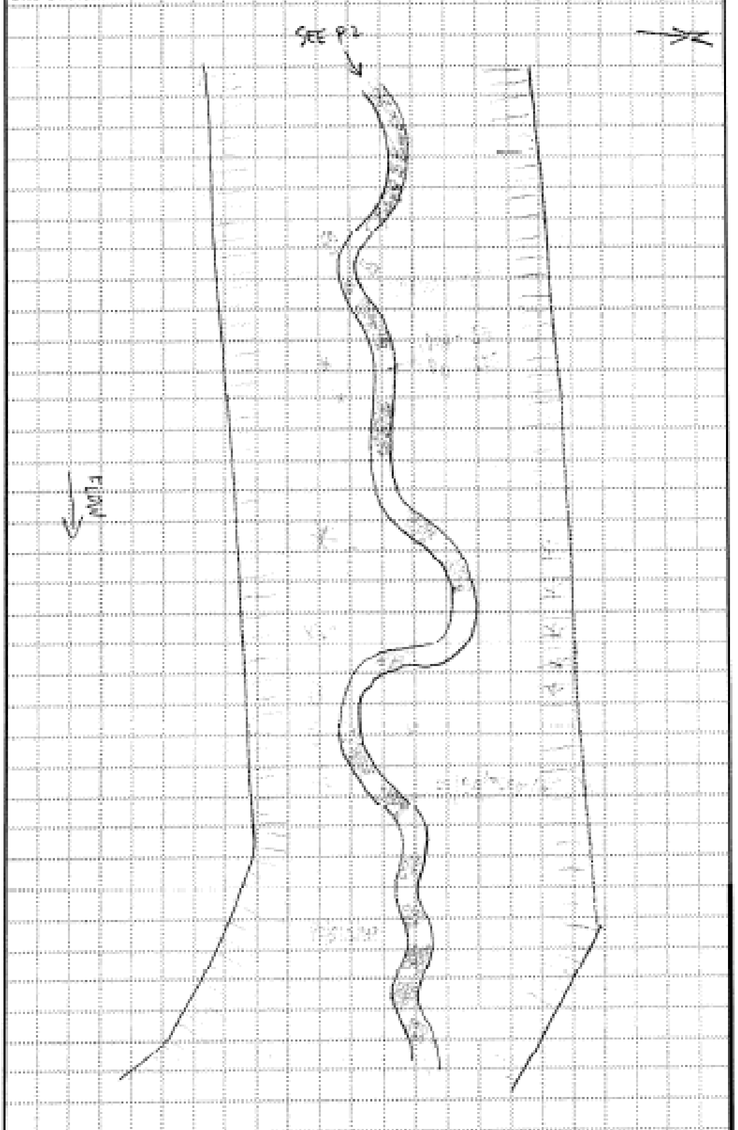
Functional habitats
- F1 Tree roots
- F2 Tree branches
- F3 Woody debris
- F4 Marginal plants
- F5 Leaf litter
- F6 Mosses
- F7 Macroalgae
- F8 Macrophytes

Flow Type
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Perceptible Flow
- H1 Standing Water

UTM Coordinates :

Notes:

Site Sketch:



Drawn By: KT Checked By:

PAGE 3 OF 3

NCD MONITORING PROGRAM

SITE 25 – TENNIS CANADA

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	Single-pass electrofishing survey following Section 3 of the Ontario Stream Assessment Protocol.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer

NCD MONITORING PROGRAM

SITE 25 – TENNIS CANADA

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 8/05	Weather: SUNNY	Recordor/Crew: DC/BW
Location: DOWNSVIEW	Stream/Reach: HOOVER CREEK #2S	Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

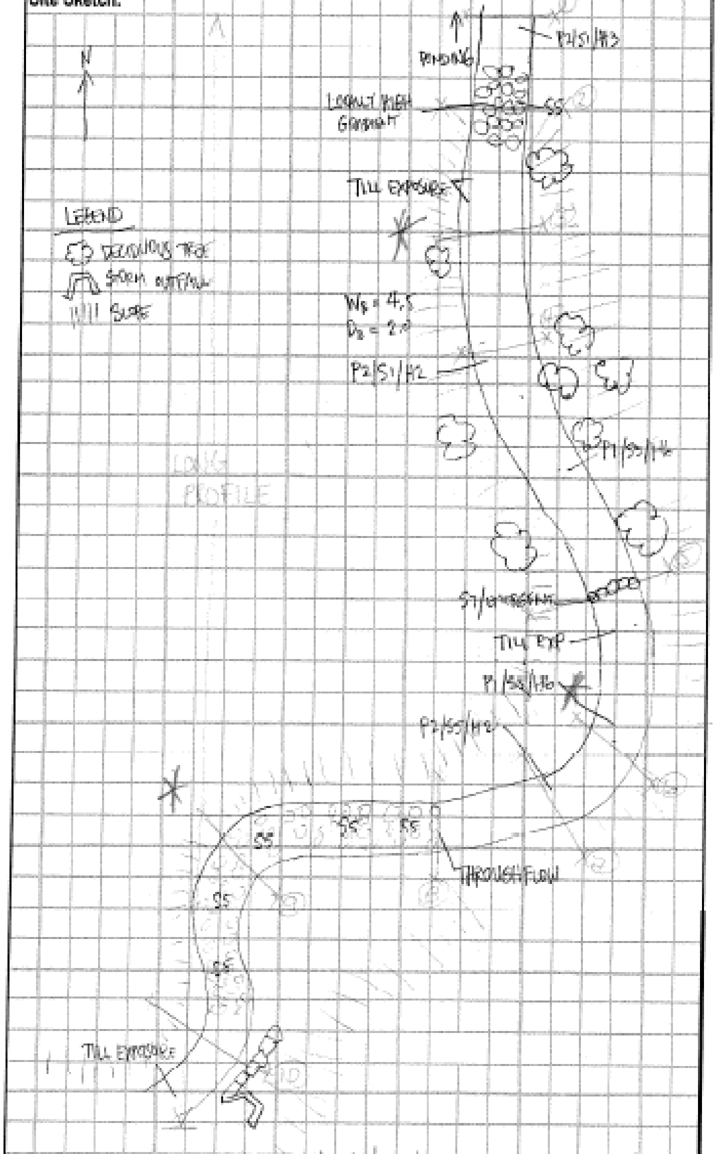
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

RIFFLE MATERIALS TRANSPORTED D/S
LARGE BOULDERS PRESENT BARRIERS TO FISH PASSAGE

Site Sketch:



Drawn By: VT Checked By: ____

* Asterisk indicates proposed permanent

NCD MONITORING PROGRAM
SITE 26 – FANSHORE WATERCOURSE

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 26 – FANSHORE WATERCOURSE

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 8/05 Weather: OVERCAST Recorder/Crew: BW/DC

Location: BRAMPTON Stream/Reach: SALT CREEK TRIB (#26) Project Code: 05357.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

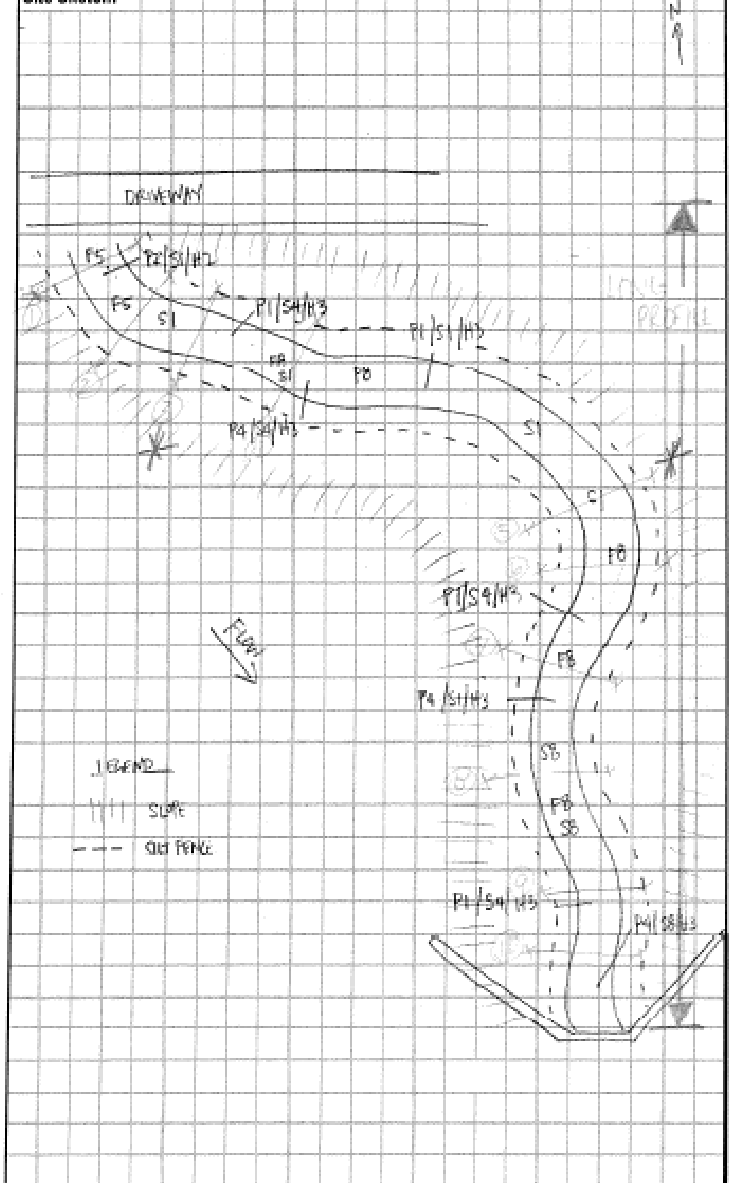
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : 4849990 601728

Notes:

- VERY LOW FLOW ON DAY OF OBSERVATION
- EXTENSIVE ALGAE GROWTH
- EURASIAN MILFOIL IN STREAM
- D/S CULVERT - FLOW DISAPPEARS INTO CRACK & REAPPEARS D/S IN CHANNEL
- RIPARIAN - MOSTLY TALL GRASSES

Site Sketch:



Drawn By: KT Checked By: ____

NCD MONITORING PROGRAM
SITE 27 – MIMICO CREEK TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	6 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 27 – MIMICO CREEK TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	No engineered or bioengineered elements were identified at this site.			
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 10/05	Weather: OVERCAST	Recorder/Crew: KG/BW
Location: BRAMPTON	Stream/Reach: MIMICO CREEK #29	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

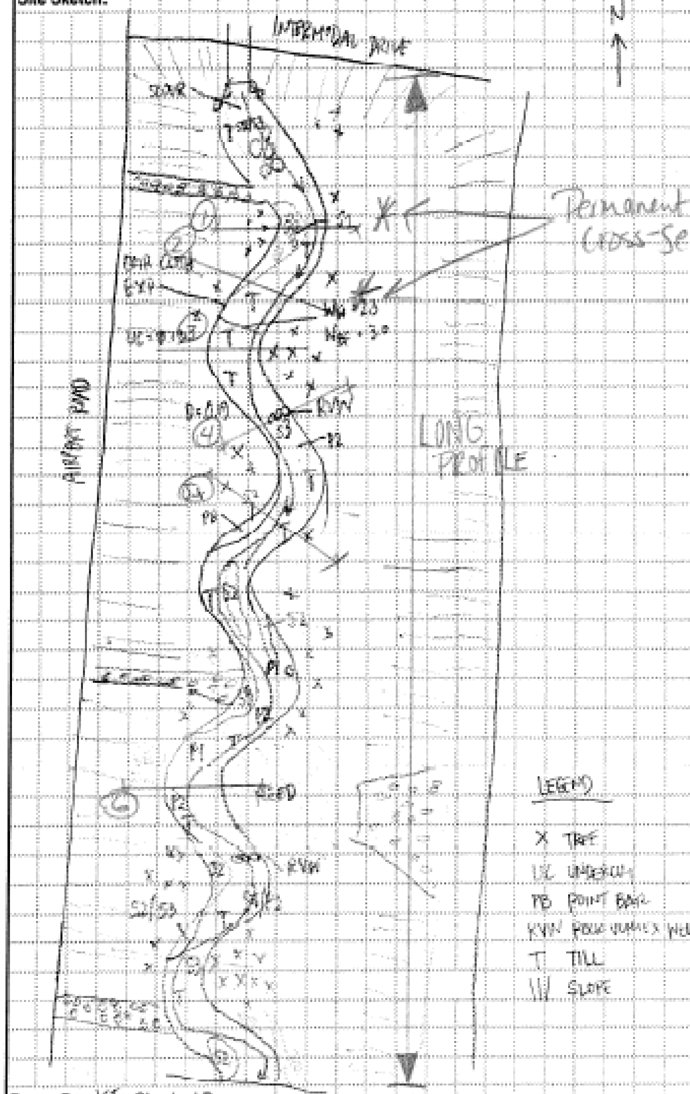
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates:

Notes:

RIPARIAN AREA MOSTLY SHORT GRASSES
& SHRUBS
EXTENSIVE TILL EXPOSURE

Site Sketch:



Drawn By: KT Checked By: ____

* Detailed Study Complete

NCD MONITORING PROGRAM
SITE 28 – ROUGE RIVER TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Seasonal up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 28 – ROUGE RIVER TRIBUTARY

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS
NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 14/05	Weather: SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: ROUGE R. TRIB 1 (#28)	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

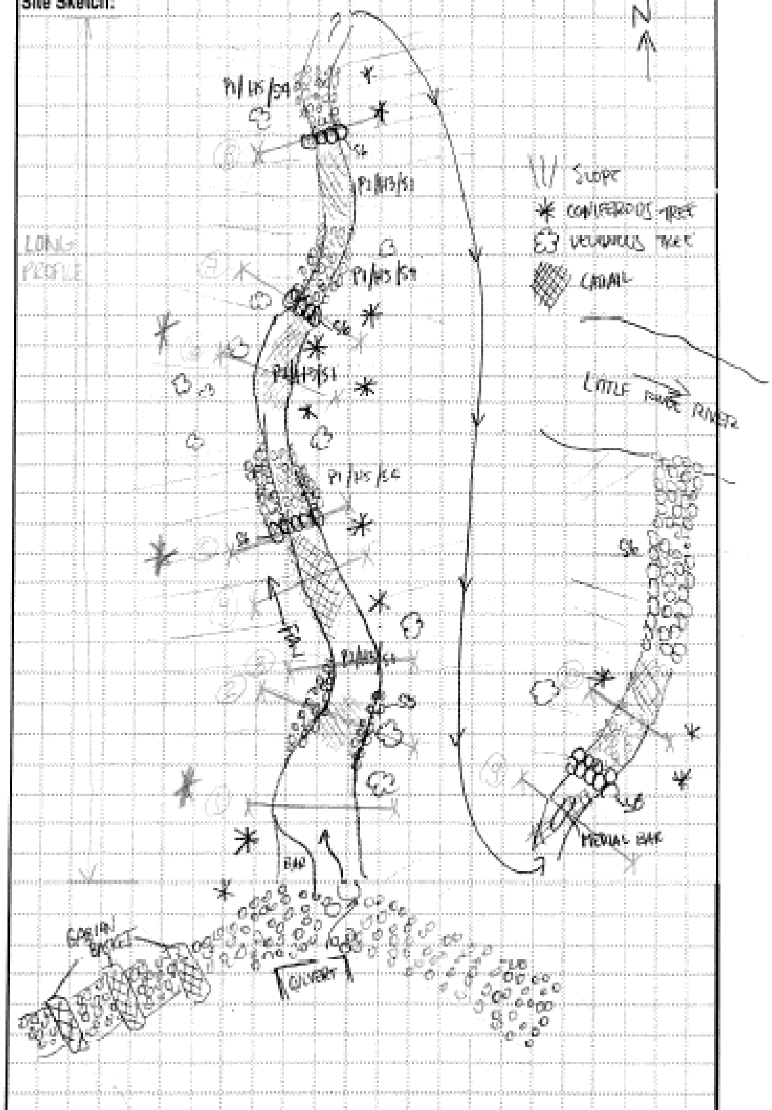
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Perceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

GABION IN LARGE PORTION OF CHANNEL
RIPARIAN AREA MOSTLY SHRUBS GRASSES
SILTATION IN POOLS

Site Sketch:



Drawn By: KT Checked By: ____ MARKHAM RD BYPASS

* No reference reach available
* Asterisk indicates proposed permanent cross-sections.

NCD MONITORING PROGRAM
SITE 29 – TRANQUILITY STREAM

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Every other year over the monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	200m representative section (refer to site map).	Every other year over the monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Every other year over the monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Every other year over the monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Every other year over the monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Every other year over the monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Every other year over the monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM
SITE 29 – TRANQUILITY STREAM

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Every other year over the monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Every other year over the monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV. 11/05	Weather: CLOUDY	Recorder/Crew: KT/BW
Location: RICHMOND HILL	Stream/Reach: TRANQUILITY STREAM (#8) 1 of 2	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

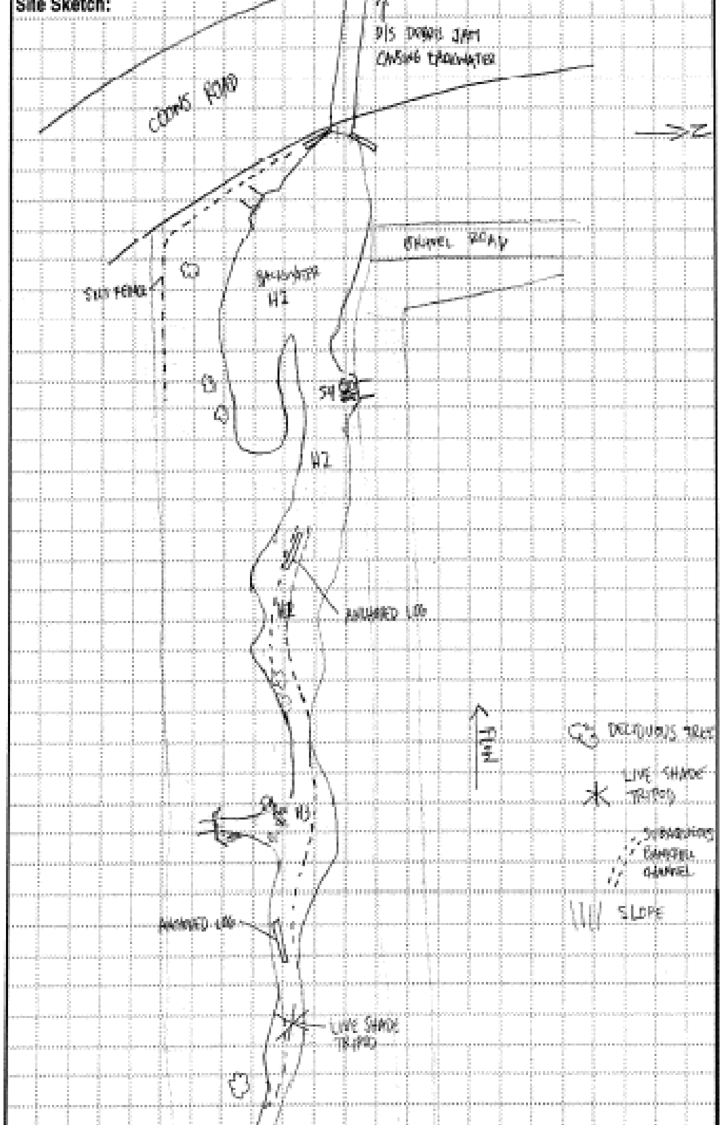
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

MOST OF CHANNEL WITH GRASS AND CATTAIL ENCROACHMENT, ESP. D/S
CHANNEL POORLY DEFINED
DESIGN CHANNEL INTERMITTENTLY DEFINED UNDERWATER

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 1 of 3

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 11/05	Weather: CLOUDY	Recorder/Crew: KT/BJ
Location: RICHMOND HILL	Stream/Reach: TRANQUILITY STREAM (#3) 2 of 3	Project Code: 05352.45U

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

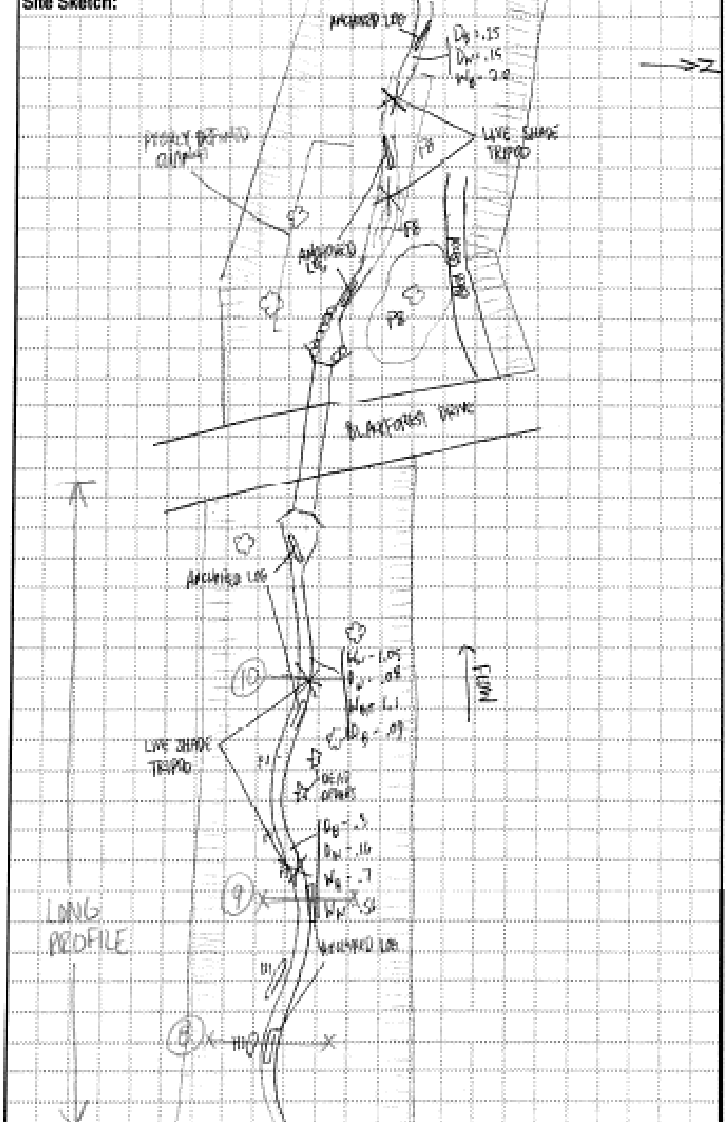
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates : ____________

Notes:

MACROPHYTE IN CHANNEL D/S OF BLACKFOREST DR
- INCREASE IN D/S DIRECTION

Site Sketch:



Drawn By: KT Checked By: ____

PAGE 2 OF 3

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 11/05 | Weather: CLOUDY | Recorder/Crew: KT/BH

Location: RICHMOND HILL | Stream/Reach: TRANQUILITY STREAM (Hwy) 3 of 3 | Project Code:

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P8 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

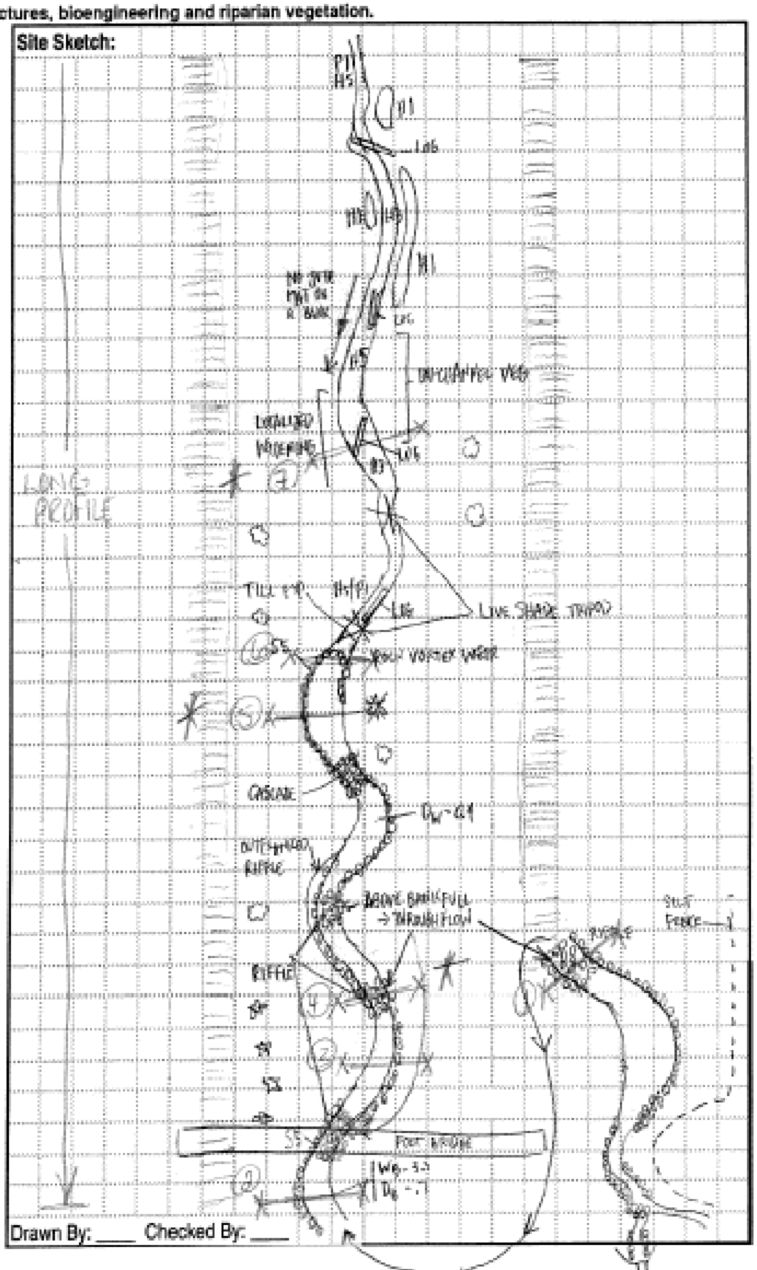
H9 Free Fall
H8 Chute
H7 Broken Standing Wave
H6 Unbroken Standing Wave
H5 Rippled
H4 Upwelling
H3 Smooth Surface Flow
H2 Scarcely Peceptible Flow
H1 Standing Water

UTM Coordinates :

Notes:

RIPARIAN ZONE - MOSTLY GRASSES & HERBS

Site Sketch:



Drawn By: ____ Checked By: ____

*Channel distance is 800 m. Survey should include first 200 m of channel.

PAGE 2 OF 3

* Asterisk indicates proposed permanent cross-sections.

NCD MONITORING PROGRAM

SITE 30A – UPPER MILNE CREEK (SOUTH OF BULLOCK DRIVE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Seasonal up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM

SITE 30A – UPPER MILNE CREEK (SOUTH OF BULLOCK DRIVE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment

General Site Characteristics

Date/Time: NOV 17/05 | Weather: PARTLY SUNNY | Recorder/Crew: KT/BW

Location: MARKHAM | Stream/Reach: UPPER MILNE CREEK (#30)/1 | Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

- P1 Riffle
- P2 Pool
- P3 Run
- P4 Glide
- P5 Cascade
- P6 Rapid
- P7 Bedrock outcrop
- P0 Marginal deadwater

Substrate

- S1 Silt
- S2 Sand
- S3 Gravel
- S4 Small Cobble
- S5 Large Cobble
- S6 Small Boulder
- S7 Large Boulder
- S8 Bimodal

Functional habitats

- F1 Tree roots
- F2 Tree branches
- F3 Woody debris
- F4 Marginal plants
- F5 Leaf litter
- F6 Mosses
- F7 Macroalgae
- F8 Macrophytes

Flow Type

- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

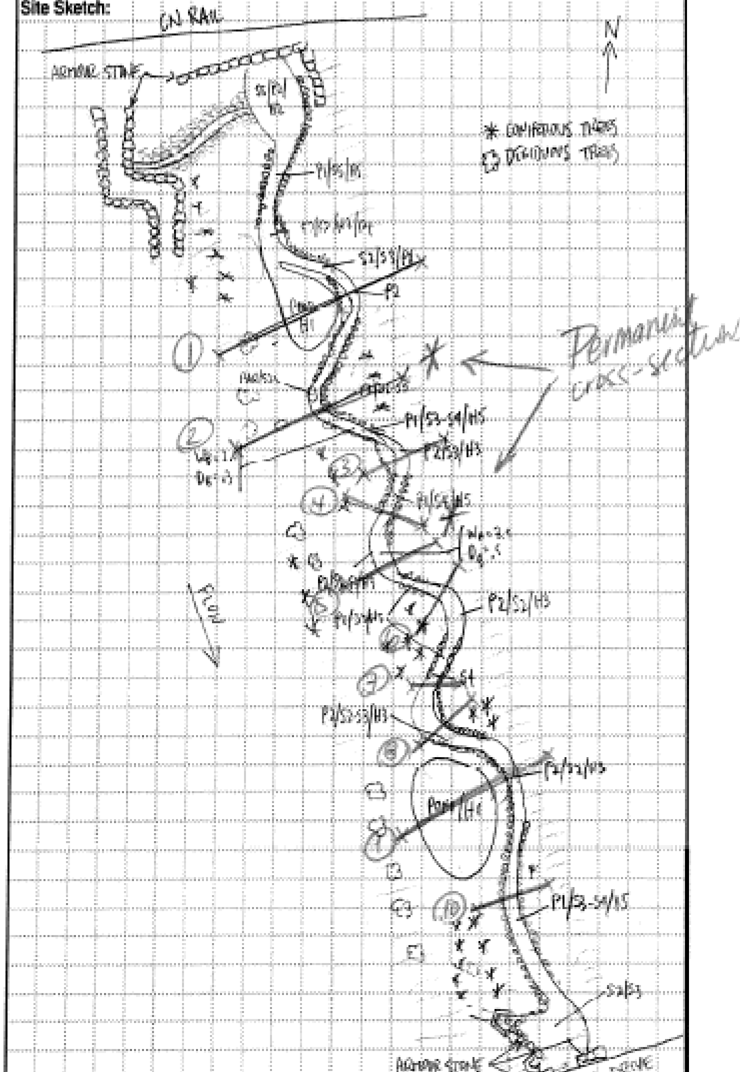
UTM Coordinates: 4859159 638177

Notes:

CHANNEL DESIGN NEAR COMPLETION

REQUIRES BANK TREATMENT

Site Sketch:



Drawn By: KT Checked By: BW

* Detailed study already completed

PAGE 1 OF 2

NCD MONITORING PROGRAM

SITE 30B – UPPER MILNE CREEK (NORTH OF BULLOCK DRIVE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
FLUVIAL GEOMORPHOLOGY				
CHANNEL CROSS-SECTIONS	10 monumented cross-sections installed above bankfull.	Within longitudinal profile area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
LONGITUDINAL PROFILE	Monumented longitudinal profile using survey equipment.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SURFICIAL SEDIMENT CHARACTERISTICS	Pebble count at cross-sections.	Performed at cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
RAPID ASSESSMENTS	Rapid Geomorphic Assessment (MOE 2003) and Rapid Stream Assessment Technique (Galli 1996).	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
SUB-REACH MAP	Observation-based mapping of project area on standard forms.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
PHOTOGRAPHS FROM FIXED VANTAGE POINTS	Photographic documentation of project.	Taken at each cross-section and throughout project area including upstream and downstream extents.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
BANK EROSION PINS	Installation of erosion pins.	Installed at permanent cross sections.	Seasonal up to and including 2008, then every other year over the remaining monitoring period.	Summer / Fall
AQUATIC HABITAT				
IN-STREAM HABITAT ASSESSMENT	Instream habitat to be evaluated using fluvial geomorphology data.			
FISH COMMUNITY				
SPECIES INVENTORY	No specific fish community targets known at this time. Monitoring of this parameter to be determined.			

NCD MONITORING PROGRAM

SITE 30B – UPPER MILNE CREEK (NORTH OF BULLOCK DRIVE)

MONITORING MEASURE	METHOD	SPATIAL SCALE	MONITORING FREQUENCY	TIMING
WATER QUALITY				
WATER CHEMISTRY	Site is less than 1000m in length, therefore no water quality monitoring is recommended.			
BENTHIC MACRO-INVERTEBRATES				
RIPARIAN CONDITIONS				
RIPARIAN AREA / RESTORATION PLANTING ASSESSMENT	Visual inspection of riparian vegetation and Line Intercept Transects (Harris 2005).	At channel cross-sections.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
ENGINEERED / BIOENGINEERED ELEMENTS				
VISUAL ASSESSMENT	Visual qualitative assessment and photographic documentation of structural and vegetation components.	Entire project area.	Annual up to and including 2008, then every other year over the remaining monitoring period.	Summer
SOCIAL / CULTURAL ELEMENTS				
OPINION SURVEYS	No opinion survey is recommended as the site is not in a high public-use area.			

GEOMORPHIC SOLUTIONS

NCD Monitoring Rapid Assessment
General Site Characteristics

Date/Time: NOV 17/05	Weather: PARTLY SUNNY	Recorder/Crew: KT/BW
Location: MARKHAM	Stream/Reach: UPPER MILNE CREEK (#30)/1	Project Code: 05352.450

Location and Condition of: Instream structures, bioengineering and riparian vegetation.

Legend

Geomorphic Unit

P1 Riffle	P5 Cascade
P2 Pool	P6 Rapid
P3 Run	P7 Bedrock outcrop
P4 Glide	P0 Marginal deadwater

Substrate

S1 Silt	S5 Large Cobble
S2 Sand	S6 Small Boulder
S3 Gravel	S7 Large Boulder
S4 Small Cobble	S8 Bimodal

Functional habitats

F1 Tree roots	F5 Leaf litter
F2 Tree branches	F6 Mosses
F3 Woody debris	F7 Macroalgae
F4 Marginal plants	F8 Macrophytes

Flow Type

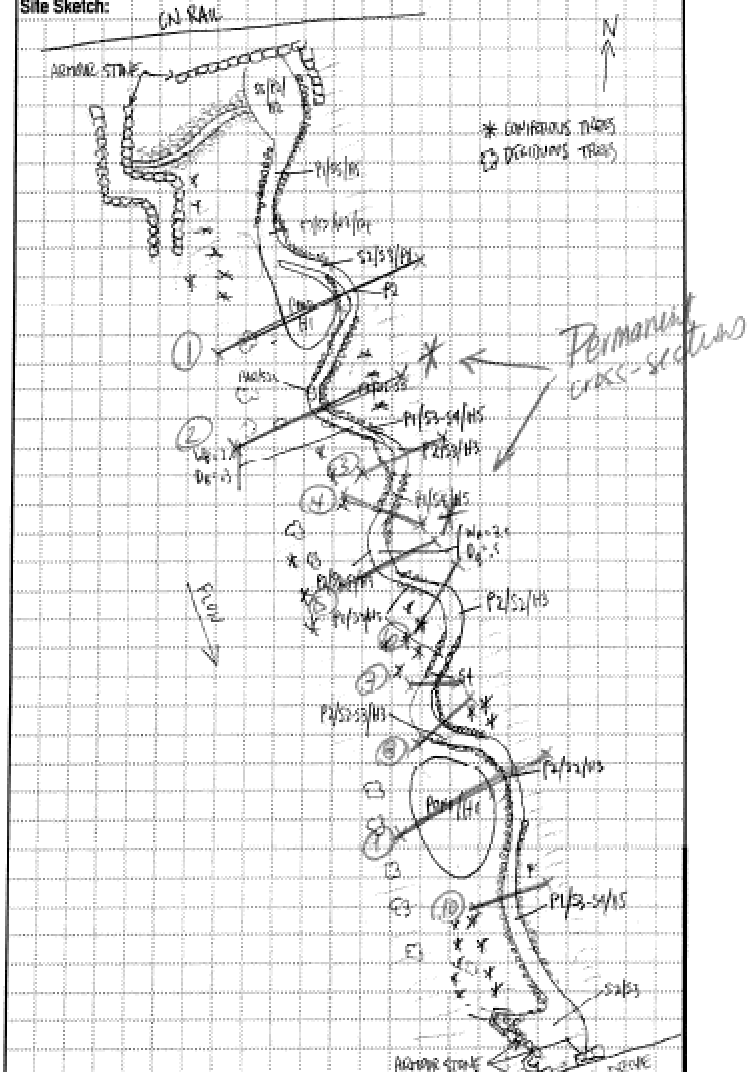
- H9 Free Fall
- H8 Chute
- H7 Broken Standing Wave
- H6 Unbroken Standing Wave
- H5 Rippled
- H4 Upwelling
- H3 Smooth Surface Flow
- H2 Scarcely Peceptible Flow
- H1 Standing Water

UTM Coordinates: 4859159 638177

Notes:

CHANNEL DESIGN NEAR COMPLETION
REQUIRES BANK TREATMENT

Site Sketch:



Drawn By: KT Checked By: BW

* Detailed study already completed

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