FERNBANK
COMMUNITY DESIGN PLAN

ENVIRONMENTAL MANAGEMENT PLAN
Volume 1 of 2

DRAFT

JUNE 2009

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COMMUNITY DESIGN PLAN

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Volume 1 of 2

NOVATECH
ENGINEERING
CONSULTANTS LTD.

May 26, 2009

BY COURIER

City of Ottawa
Planning, Transit and the Environment Department
Community Planning & Design Division
110 Laurier Ave West, 4th Floor
Ottawa, Ontario
K2P 1J1
Mail Code 1-15

Attention: Myles Mahon

Dear Sir:

Reference: ***DRAFT*** **Environmental Management Plan**
Fernbank Community Design Plan
Our File No.: 101108

Please find enclosed thirty-eight (38) copies of the ***DRAFT*** **Environmental Management Plan** in support of the Fernbank Community Design Plan. We respectfully submit this report to your office for public circulation.

Do not hesitate to contact the undersigned should you have any questions or comments.

Sincerely,

NOVATECH ENGINEERING CONSULTANTS LTD

Mike Petepiece, P.Eng.
Project Engineer

cc:	Mr. Peter Nesbitt	Brookfield Homes (Ontario) Ltd.
	Mr. Steve Upton	Del Corporation
	Mr. Rob Pierce	Monarch Corporation
	Mr. David Kardish	Regional Group of Companies
	Ms. Wendy Nott	Walkner Nott Dragicevic Associates Ltd.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Executive Summary

Introduction

The Fernbank Community is proposed to encompass approximately 674 gross hectares of land between the established communities of Stittsville, Kanata West and Kanata South. The Study Area extends from Hazeldean Road on the north, the Carp River and Terry Fox Drive on the east, Fernbank Road to the south and, the existing Urban Area of Stittsville on the west.

EA Process

Three concurrent and integrated Class Environmental Assessment Studies/Master Plans were initiated: Transportation to provide the road network; Master Servicing Plan for water and sanitary; and an Environmental Management Plan (EMP) for the natural environment and stormwater. These reports have been prepared in conjunction with the Community Design Plan (CDP) for lands within the Study Area of the Fernbank Community. Approval of the CDP and subsequent development applications under the *Planning Act* will be supported by these Class Environmental Assessments/Master Plans. The three studies were prepared in accordance with the *Planning Act* provision of the *Municipal Engineers Association Class Environmental Assessment Process* (September 2007) (Class EA).

EA Project Amendment/Change Process

The EMP outlines the process to deal with changes which occur after filing and obtaining approval of the environmental assessments and prior to construction. The change process distinguishes between minor and major changes. A major design change would require completion of an amendment to this EA, while a minor change would not. For either kind of change, it is the responsibility of the proponent to ensure that all possible concerns of the public and affected agencies are addressed.

Minor Changes
Minor design changes may be defined as those which do not appreciably change the expected net impacts associated with the project. For example, a design change in lighting treatment, landscaping, noise attenuation, median width, pathway connections, and underground infrastructure sizes, would be considered minor. Slight changes in alignment or facility footprints, which to not affect more than 2 participating landowners, would also be considered as minor. All affected landowners and appropriate stakeholders will be provided details of the modification. The majority of such changes could likely be dealt with during the detailed design phase and would remain the responsibility of the proponent to ensure that all relevant issues are taken into account.

Major Changes
Major changes may be defined as those which change the intent of the EAs or appreciably change the expected net impacts associated with the project. An example of a major change would result from a proposed shift in a preferred design alignment or configuration which would warrant changes in mitigation as described in the EA and affect 3 or more landowners. If the proposed modification is major the recommendations and conclusions in this report would require updating. An addendum to the EA would be required to document the change, identify the associated impacts and mitigation measures and allow related concerns to be addressed and reviewed by the appropriate stakeholders.

Public & Agency Consultation

Consultation and the exchange of information was undertaken throughout the assessments using a variety of methods including meetings with community associations and the general public, electronic information distribution and regular meetings with the Study Team, approval agencies, and the three Ward Councillors.

The consultation undertaken was extensive and involved various stakeholders from the public and government agencies. A Core Project Team (CPT) met nine (9) times from project initiation to the development of the preferred land use and demonstration. There was also a Technical Advisory Committee (TAC) and Public Advisory Committee (PAC) which met four (4) and two (2) times at key project milestones. Four (4) Public Meetings were held with a total attendance of almost three hundred (300) people. Additional meetings were held with area land owners and community groups as required. Scheduling of consultation opportunities corresponded to key project milestones throughout the process.

Meeting details, Public Notices, and Presentation Materials are contained in a separate report Fernbank Community Design Plan – Public Consultation Report along with the comments and inputs received.

Existing Conditions Environmental Inventory

The existing conditions reports provided the basis for identifying and mapping natural features within the limits of the Fernbank study area. The environmental inventory provides an integrated summary and assessment of the natural features identified through the existing conditions investigations.

Environmental Constraints & Opportunities Plan

An Environmental Constraints & Opportunities Plan has been created that outlines:

- environmental features targeted for preservation and/or enhancement;
- environmental features that may impact the implementation of the proposed development (wells, tile drainage, hydro corridors);
- setbacks from watercourses to be preserved;

Stormwater Management Criteria

Stormwater Management Criteria were established with input from various agencies that have regulatory approval for works within a waterbody including:

- MVC and RVCA, Section 28 of the Conservation Authorities Act – Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses
- CAs and DFO, Section 35 of the Federal Fisheries Act – Fish Habitat
- OMAFRA, Drainage Act
- MOE, Ontario Water Resources Act
- City of Ottawa

Evaluation of SWM Alternatives

The development of a preferred stormwater management strategy for the Fernbank Community included the assessment of several storm drainage and stormwater management alternatives. Alternatives for stormwater management were developed using a two stage process. The first stage was the development of preliminary alternatives and a coarse screening process. The second stage was the selection of a preferred alternative, and refinement of that alternative to generate more detailed solutions.

For the large drainage areas comprising the Fernbank Community, wet ponds are considered to represent the most viable option to provide baseflow enhancement, erosion control, water quality control and peak flow control. Lot level and conveyance controls will provide additional treatment and promote infiltration of storm runoff, which will reduce the impact of the proposed development on the hydrologic cycle.

The assessment of stormwater management alternatives for the Fernbank Community was refined to focus on the locations of the proposed SWM facilities. Alternative locations for the proposed SWM facilities for each subwatershed were comparatively evaluated to determine which alternative best met the SWM objectives for each services area.

Environmental Management Guidelines and Recommendations

The results of the existing conditions analysis and the evaluation of the post-development impacts formed the basis of the recommended environmental management strategy for the Fernbank CDP lands. The size and location of the recommended SWM facilities, riparian corridors and other areas recommended for retention have been integrated into the demonstration land use plan (**Figure 11.1**) for the Fernbank Community along with the recommended solutions for land use planning and transportation. Recommendations are given in regard to the following:

- Urban Natural Features / Natural Environment Area
- Species of Special Concern
- Watercourses & Riparian Corridors
- Floodplains
- Hydro Corridors
- Protection and Preservation of Hydrogeologic Functions
- Tree Planting Restrictions
- Tile Drains
- Water Supply Wells
- Stormwater Best Management Practices (BMPs)
- Infiltration Targets
- SWM Facilities
- Baseflow Temperature Maintenance

Recommended SWM Strategy

Eight (8) wet ponds are recommended to provide stormwater management for the Fernbank Community. Recommended SWM Facility designs will incorporate:

- Baseflow enhancement;
- Water quality control;
- Erosion control based on erosion thresholds; and
- Peak flow control based on the design criteria and/or the downstream capacity of the outlet watercourse.
- Measures to mitigate thermal impacts of SWM facilities, including:
  - Bottom draw outlets;
  - Discharge through subsurface trenches;
  - Minimize footprint of permanent pool and maximize length-to-width ratio; and
  - Shading of ponds using riparian vegetation.

Recommendations for watercourses include:

- Retention of a riparian Corridor for Hazeldean Creek;
- Naturalization of the Main Branch of the Monahan Drain;

- Preservation & enhancement of the lower reach of the Carp River Tributary;
- Lowering of the Flewellyn Drain downstream of Fernbank Road. Lowering is not required, but would reduce grade raise requirements on-site.

Recommendations for Lot Level and Conveyance Controls include:

- Promotion of infiltration of storm runoff using
  - Perforated RYCB leads with infiltration trenches under rearyard swales;
  - Roof drains for commercial / industrial sites directed to infiltration trenches;
  - Promote infiltration in parks and boulevards.

Adaptive Management Strategy

Long-term performance monitoring of the outlet watercourses is recommended to ensure that they will not be affected by future changes in channel morphology resulting from the proposed development of the Fernbank Lands.

The monitoring results will be used to assess the evolution of the stream channels. If the assessment indicates that any of the outlet watercourses have been adversely impacted, an appropriate solution will be determined. This will entail the integration of professionals from various disciplines (geomorphic, aquatic habitat, hydraulic, hydrologic and geotechnical conditions).

The developer will be responsible for initiation of any monitoring programs and the associated costs until such time as the City accepts ownership of the associated SWM facilities and/or watercourses. Continuation of the monitoring program would then become the responsibility of the City. It is anticipated that monitoring would be an open-ended program as part of an ongoing adaptive management strategy.

Planning for Flexibility

The Fernbank CDP demonstration plan included in this report has been developed through the integrated EA process, and represents one possible development scenario for the CDP lands, based on the Environmental Constraints Plan developed as part of the EMP. The demonstration plan is intended to illustrate the feasibility of implementing the recommended environmental management strategy.

The intent of the Environmental Management Plan is to: create an inventory of existing features; provide an evaluation of those features; consider the impacts of any land-use activities on natural features; develop a recommended strategy to mitigate adverse effects and protect, enhance or restore the natural system for the pleasure of all. Several land use plans were evaluated based on the results of the environmental inventory, and discussions with the public and regulatory agencies through the EA process. The EMP represents a blueprint for development of the Fernbank Area, while maintaining sufficient flexibility to allow for future changes to the recommended land use plan.

Cost Estimates

Cost estimates were prepared for the proposed SWM Facilities, as well as for any proposed modifications and/or enhancements to watercourses.

Project Listing

The Environmental Management Plan component of the Fernbank CDP, in conjunction with the Master Servicing Plan and the Transportation Master Plan, satisfies the requirements of Phase 1 and 2 of the Integrated EA & Planning Act Process.

The following projects fall under the *Environmental Assessment Act*:

- Stormwater Management Pond #1 and associated storm sewers (Schedule B)
- Stormwater Management Pond #2 and associated storm sewers (Schedule B)
- Stormwater Management Pond #3 and associated storm sewers (Schedule B)
- Stormwater Management Pond #4 and associated storm sewers (Schedule B)
- Stormwater Management Pond #5 and associated storm sewers (Schedule B)
- Stormwater Management Pond #6 and associated storm sewers (Schedule B)
- Stormwater Management Pond #7 and associated storm sewers (Schedule B)
- Stormwater Management Pond #8 and associated storm sewers (Schedule B)
- Enclosing a portion of the Granite Ridge Outlet in a storm sewer (Schedule B)

The Fernbank CDP satisfies the EA requirements under the *Planning Act*. The implementation of the proposed development plan will require additional approvals for projects regulated by the following acts and policies:

- *Ontario Water Resources Act* (SWM Facilities)
- *Drainage Act* (Modifications & Abandonment of Drains)
- *Fisheries Act* (Fish Habitat & Compensation Works)
- *Conservation Authorities Act* (Alterations to Shorelines and Watercourses)
- *Official Plan Policy* (Natural Environment Areas)

Implementation & Phasing

The overall phasing plan for development of the Fernbank Community is determined by a number of factors including:

- Early construction of the North-South Arterial Road;
- Approved planning status of the lands;
- Location relative to the existing sanitary sewer pump station and the existing watermain distribution system which will service the lands;
- Road access opportunities; and,
- Physical site characteristics and initial pond locations dictated by topography.

It is anticipated that within each individual phase, development will occur incrementally through Plans of Subdivision with associated infrastructure and services being installed. Details of proposed works and improvements will be influenced by the future development rate, municipal budgeting priorities, and front-ending agreements.

Section 1.0 Introduction

The Fernbank Community is proposed to encompass approximately 674 gross hectares of land between the established communities of Stittsville, Kanata West and Kanata South, and the Study Area extends from Hazeldean Road on the north, the Carp River and Terry Fox Drive on the east, Fernbank Road to the south and, the existing Urban Area of Stittsville on the west, as shown on **Figure 1.1**.

Approximately 455 gross hectares of the Study Area are currently designated for urban development within the City of Ottawa (2003) Official Plan. The balance of the Study Area, while currently *non-designated*, will likely be incorporated into the urban boundary as part for the City of Ottawa Comprehensive Five-Year Review of the Official Plan. Irrespective of the precise timeline, this plan and the infrastructure required to support the CDP provides for eventual integration of these lands into the urban area and no further MEA Class EA approval requirements would be necessary.

The Study Area encompasses the entire area between Stittsville and Kanata extending from Hazeldean Road south to Fernbank Road which includes lands that were not approved as ‘General Urban – Special Policy Area” and “Future Urban Area” in the OMB’s decision. It is anticipated that these lands will eventually be developed for urban purposes. The time horizon is not known at this time, however this plan and the infrastructure required to support the CDP will provide for eventual integration of these lands into the urban area.

Three concurrent and integrated Class Environmental Assessment Studies/Master Plans were initiated: Transportation to provide the road network; Master Servicing Study for water, storm drainage and sanitary; and an Environmental Management Plan (EMP) for the natural environment and stormwater management/outlets. These reports have been prepared in conjunction with the Community Design Plan (CDP) for lands within the Study Area of the Fernbank Community. Approval of the CDP and subsequent development applications under the *Planning Act* will be supported by these Class Environmental Assessments/Master Plans. The three studies were prepared in accordance with the *Planning Act* provision of the Municipal Engineers Association Class Environmental Assessment Process (June 2000 as amended in 2007) (Class EA):

- Environmental Management Plan
- Master Servicing Study
- Transportation Master Plan

The purpose of this introductory section of the report is to:

- Explain the planning and environmental assessment approval processes that the three Class EAs followed;
- Describe the co-ordination and integration involved in the Class EAs and the supporting studies;
- Document the public and agency consultation undertaken; and
- Outline the implementation plan as part of the next steps.

Figure 1.1: Study Area

1.1 Integration of the Environmental Assessment Act and the Planning Act

The Class EA process recognizes the benefits of integrating approvals under the *Environmental Assessment Act* and the *Planning Act*. Any project which would otherwise be subject to the Municipal Class EA, that meets the intent of the Class EA (Section A.2.9 attached) and receives approval under the *Planning Act* is considered to be a Schedule A project and may proceed to construction.

Specific projects within the Fernbank CDP that are subject to the requirements of the *Environmental Assessment Act* include:

- Construction of new roads or other linear paved facilities (>$2.2 Million - Schedule C);
- Widening of existing roads or other linear paved facilities (>$2.2 Million - Schedule C);
- Construction of a new transit system (Schedule C)
- Establish, extend or enlarge a water distribution system where the facilities are not in an existing road allowance or utility corridor (Schedule B);
- Establish, extend or enlarge a sewage collection system where the facilities are not in an existing road allowance or utility corridor (Schedule B); and,
- Establish new stormwater retention/detention ponds and appurtenances or infiltration systems including outfall to receiving water body (Schedule B).
- Transit projects are now eligible to follow the new process that will allow a faster implementation for transit projects. The findings and conclusions of this CDP will become supporting documentation for future transit EA studies.

The municipal infrastructure projects for the Fernbank CDP are being identified, planned and approved through the development application process under Section 51 of the *Planning Act* in a manner that fulfills the requirements of the Municipal Class Environmental Assessment (Section A.2.9) process. As such, these projects will have satisfied the requirements outlined in Section A.2.9 of the Class EA process and will require no additional EA approvals. This allows the integration of both planning processes while ensuring the intent and requirements of both Acts are met (**Figure 2.1**). Section A.2.9 of the Class EA requires the following steps be incorporated into the planning process to fulfill the EA requirements:

Phase 1 and 2

- Identify the problem or opportunity;
- Identify alternative solutions;
- Inventory existing environmental conditions;
- Impact assessment and evaluation of alternative solutions;
- Selected preliminary preferred solution;
- Consult with the review agencies and the public; and,
- Select preferred solution.

If the project is a Schedule B, issue a Notification to allow for public review of the documentation of the work undertaken.

If the project is a Schedule C, continue as follows:

Phase 3 and 4

- Identify alternative design concepts for the selected alternative solution;
- Update existing conditions inventory (as required);
- Impact assessment and evaluation of alternative design concepts;
- Select preliminary preferred alternative design concept;
- Consult with the review agencies and the public;
- Select preferred alternative design concept;
- Document the work undertaken; and,
- Issue a Notification to allow for public review of the documentation of the work undertaken.

Following the review and approval of the Schedule B and C Class EAs, the projects can proceed to Phase 5 as follows:

Phase 5
- Complete design drawings and tender documents;
- Construction and operation; and
- Monitor for environmental provisions and commitments.

This process was outlined, reviewed and accepted in the Terms of Reference for the Fernbank CDP (June 2006) in consultation with the City of Ottawa and approval agencies (RVCA, MVCA, MOE, MNR).

Review agencies and the public will have an opportunity to review the Class EA documentation being prepared for the Fernbank CDP, and have the ability to appeal to the OMB. The assessment and review process is being harmonized with the *Planning Act* as the development application process is occurring simultaneously. Notification of the conditions of planning approvals and the Class EA documents will be advertised through a Notice of Completion.

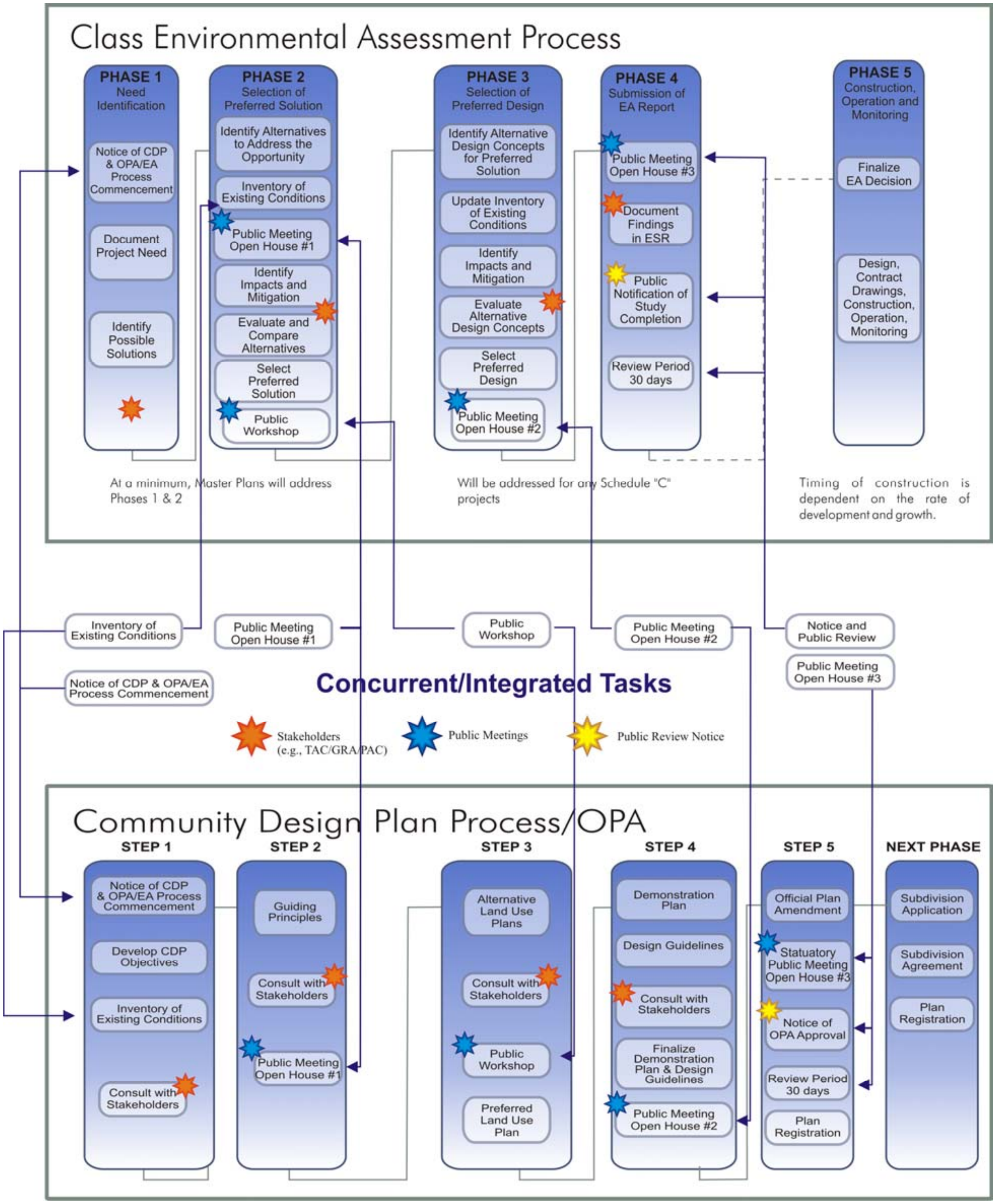
An integrated MEA Class EA *Planning Act* approach as identified in section A.2.9 of the MEA Class EA document allows for:

- A single point of contact ("One-Window") at the City and ensures consistent responses and notification to the public and media. If the CDP process and associated *Planning Act* application and Class EAs were not integrated, there could potentially be several different notices for meetings and public review periods in order to meeting the requirements of both processes.
- One approval framework schedule assists in ensuring that infrastructure and development would not proceed or be delayed if only one of the Class EA projects received a Part II Order request.
- Integrated Consultation – Consolidating the Planning Act and Municipal Class EA consultation will save time and money. Meetings can meet the requirements of both the land use planning and Class EA processes. This also helps to ensure consistent responses and notification to the public and media.
- Harmonized Review - Review agencies and the public will have an opportunity to review the Class EA documentation and the CDP documentation as an inclusive package and, accordingly, would be better able to understand the decision making processes.
- Integrated Review and Approvals – With the approval of the Official Plan Amendment and, by extension, the MEA Class EA projects through the Planning Act, any appeals will be considered by the OMB and it will have access to all the studies needed for an informed decision.

Once approved, the preferred municipal infrastructure projects will generally not be subject to additional MEA Class EA approval requirements with the submission of subsequent site plan or plan of subdivision applications. This ensures that the environmental protection measures identified in the MEA Class EAs to permit development in the Study Area will be adhered to by any subsequent developments. Any amendments or revisions would be made using the addendum procedures in the Municipal Class EA, with the appropriate public review.

The implementation, over time, of the Fernbank CDP and the required supporting infrastructure will take place as *Conditions of Approval*. The approvals will be conducted under the *Planning Act*.

Figure 2.1: Integrated Environmental Assessment and Planning Act Process



1.2 Co-ordination and Integration

The Study Team is large and consists of municipal staff from various City departments, many landowners, consultants, and approval agencies. The project proceeded under the direction of the City of Ottawa and benefitted from the direct involvement and guidance of:

- A Core Project Team (CPT) consisting of City staff and Councillors, Sponsoring Landowners and the consultants in a variety of disciplines;
- A Technical Advisory Committee (TAC) consisting of representatives from select government agencies and approval bodies;
- A Public Advisory Committee (PAC) consisting of representatives from directly affected Community Associations and interested community groups; and
- Government Review Agencies (GRA) who represent government agencies who administer specific permits and approvals.

Meetings were held and information was reviewed and shared amongst each of the study participants. Decisions were made in an integrated and iterative process throughout the course of the studies. Through this iterative discussion and consultation many additional tasks and investigations were undertaken to ensure compatibility between the various infrastructure requirements. The following table highlights the current activities/studies, how they were utilized and how they were integrated into the decision making process for the Study Team.

Table 1-1: Report Integration

Report/Action	Function/Role	Utilization
Fernbank Community Design Plan Existing Conditions Report - Natural Environment (Muncaster Environmental Planning, January 2007 / Addendum January 2008)	To review the existing documentation regarding the natural environment features and functions in and adjacent to the Study Area.	Used by Novatech to identify natural features and develop existing conditions and environmental constraints plans. Used by Delcan to avoid and assess potential impacts of the transportation network on the natural environment Used by WND to develop land use patterns in consideration of the natural features of the study area.
Fernbank Community Design Plan Existing Conditions Report – Hydrogeology (J.F. Sabourin & Associates, January 2008)	To describe the site's geology and the groundwater conditions associated with that geology in terms of infiltration potentials, groundwater recharge and discharge, and the groundwater flow systems.	Used by Novatech to identify groundwater conditions and to assess the potential impact of development on the groundwater system, including wells to be abandoned and groundwater infiltration targets
Fernbank Community Design Plan Existing Conditions Report – Fluvial Geomorphological Assessment (Parish Geomorphic, March 2008)	The intent of this report is to document the existing conditions of the streams, channels and watercourses within the Study Area.	Used by Novatech to develop existing conditions plans, to delineate reach boundaries and channel sensitivities; identify and prioritize key issues in the watershed and recommend both structural and non-structural rehabilitation and restoration measures to establish natural levels of erosion in

Report/Action	Function/Role	Utilization
		the watershed (resulting in the environmental constraints plan).
Fernbank Preliminary Geotechnical Evaluation Report (Houle Chevrier, July 2007)	To provide preliminary engineering guidelines based on preliminary sub-surface conditions, as identified by borehole and test pit investigations	Used by Novatech to identify soils conditions and develop servicing and grading plans in consideration of potential grade raise restrictions.
Fernbank Community Design Plan Existing Conditions Report - Storm Drainage (Novatech, January 2007)	To document the existing storm drainage and hydrology for the Study Area including the Monahan, Flewellyn and Faulkner Municipal Drains which lie within the Jock River Subwatershed and the tributary of the Carp River and Hazeldean Creek within the Carp River Subwatershed.	Used by Novatech to establish existing conditions flows and constraints in all receiving watercourses, which are used as a baseline for evaluation of post development stormwater management solutions.
Fernbank Community Design Plan Existing Conditions Report - Municipal Infrastructure (Novatech, March 2007)	To document and provide an overview of the existing high-level water, sanitary, and utility infrastructure that currently services lands in the vicinity of the Study Area.	Used by Novatech establish the capacities and configuration of existing servicing infrastructure which was used as a Baseline for determining impact and additional infrastructure required to service the development area.
Fernbank Community Design Plan Existing Conditions Report – Transportation (Delcan, January 2007)	To describe the current transportation infrastructure networks and operating conditions in the vicinity of the proposed Fernbank Community.	Used by Delcan to confirm existing intersection and screenline levels of transportation service. Baseline for determining long-term future peak traffic volumes and appropriate major transportation infrastructure needs (roads/rapid transit) to serve the proposed Fernbank and adjoining communities.
Fernbank Community Design Plan Existing Conditions Report – Archaeological (Kinickinick Heritage Consultants, January 2007)	To prepare a Stage 1 archaeological Assessment of the Fernbank Community lands, to identify areas of low or nil archaeological potential.	Used by WND to identify areas where additional archaeological assessment may be required prior to development.

Report/Action	Function/Role	Utilization
Fernbank Community Design Plan Existing Conditions Report – Land Use (WND, January 2007)	To review the existing physical land use planning conditions, policy framework and other City initiatives that would affect the development of future plans for the Fernbank Study Area.	Used by WND to identify alternative and preferred land use concepts for the Fernbank CDP.
Below Ground Infrastructure (Water/Sewer/Storm)	Develop infrastructure collection/distribution system to service the Fernbank Community	Integrated with the roadway network development.

The reports and planning were undertaken in an integrated fashion in a similar time frame which resulted in an iterative planning and decision making process which is illustrated below followed by examples of interrelated aspects of the infrastructure and land use planning process such as:

- Analysis of existing conditions led to the Environmental Constraints Plan which was utilized as the starting point for the Land Use/Demonstration Plan.
- The establishment of drainage corridors to be preserved and/or enhanced led to the stormwater management facility configuration which was also utilized for developing the Land Use/Demonstration Plan.
- The establishment of sanitary collector sewers along proposed road facilitates to support orderly and cost effective phasing of development;
- The internal water distribution system was developed which reflects the transportation network;
- The development of a rapid transit plan which is integrated with the transportation network.

These examples of collaboration between the different studies were key to ensuring the requirements of all the land use and infrastructure components were accommodated in an acceptable manner.

1.3 Public and Agency Consultation

Consultation is an integral part of both the Planning and Class Environmental Assessment process. Consultation and the exchange of information was undertaken throughout the assessments using a variety of methods including meetings with community associations and the general public, electronic information distribution and regular meetings with the Study Team, approval agencies, and the three Ward Councillors.

The consultation undertaken was extensive and involved various stakeholders from the public and government agencies. A Core Project Team (CPT) met nine (9) times from project initiation to the development of the preferred land use and demonstration. There was also a Technical Advisory Committee (TAC) and Public Advisory Committee (PAC) which met four (4) and two (2) times at key project milestones. Four (4) Public Meetings were held with a total attendance of almost three hundred (300) people. Additional meetings were held with area land owners and community groups as required. Scheduling of consultation opportunities corresponded to key project milestones throughout the process.

Meeting details, Public Notices, and Presentation Materials are contained in a separate report Fernbank Community Design Plan – Public Consultation Report along with the comments and inputs received.

1.3.1 Summary of Public Comments

A summary of the primary issues raised at the public meetings, from comment sheets and other submissions to the Study Team and Area Councillors are contained in **Table 1-2** along with the response provided and any additional actions or clarifications. A more detailed account of the comments is contained in the Public Consultation Report.

Table 1-2: Summary of Comments and Responses

Issue Raised	Response
Natural Environment	Significant natural areas have been identified and incorporated into the CDP.
Density	A mix of densities has been incorporated into the CDP with consideration of existing adjacent densities in the Kanata and Stittsville communities.
Land use	Buffers have been incorporated into the CDP with consideration of existing adjacent land uses in the Kanata and Stittsville communities. A mix of land uses has been provided to serve the existing and future communities.
Schools	Primary and secondary school boards have provided input into the location and number of schools needed.
Internal Roads	A road network has been developed to serve the needs of both the existing and planned communities. Traffic circles have been incorporated where appropriate. Internal and external connectivity have been considered.
Transit	Identification of a rapid transit corridor, stations and Park and Ride lots have been included in the CDP. OC Transpo has been involved in the identification of potential local transit routes and the protection of appropriate right-of-way widths.

1.3.2 Government Agencies and Municipal Departments

Many government agencies, municipal departments and approval authorities were involved in the process. Agencies and individuals were contacted for specific advice and input regarding relevant issues and approvals or were given opportunities to review draft reports including:

Written and verbal comments were received from agencies and departments through the Advisory committee meetings and technical circulations. The comments received were typically focused on the agency's areas of interest or priorities. Some comments provided direction and guidance for upcoming approval and permitting requirements and others focused on specific technical issues. Input from these agencies was addressed through various means including:

- Individual and group agency meetings to provide clarification;
- Inter-agency sharing of comments, rationalizations, and decisions;
- Opportunities for continuing input;
- Completion of additional technical works;
- Design clarifications; and,
- Corrections and additions to the reports as appropriate.

Overall the studies benefited from a broad range of technical advice and direction.

1.4 Summary

Table 1-3: Information Way Finding

Information	Source/Report
Road Network	Fernbank Community Design Plan Existing Conditions Report – Transportation (Delcan, January 2007) Fernbank Transportation Master Plan (Delcan, June 2009)
Rapid Transit Corridor	Fernbank Community Design Plan Existing Conditions Report – Transportation (Delcan, January 2007) Fernbank Transportation Master Plan (Delcan, June 2009)
Stormwater Management	Fernbank Community Design Plan Existing Conditions Report - Natural Environment (Muncaster, January 2007) Fernbank Community Design Plan Existing Conditions Report – Storm Drainage (Novatech, January 2007) Fernbank Community Design Plan Existing Conditions Report – Fluvial Geomorphological Assessment (Parish, March 2008) Fernbank Master Servicing Plan (Novatech, June 2009) Fernbank Environmental Management Plan (Novatech, June 2009)
Drinking Water System Distribution	Fernbank Community Design Plan Existing Conditions Report – Municipal Infrastructure (Novatech, March 2007) Fernbank Master Servicing Plan (Novatech, June 2009)
Sanitary Sewers	Fernbank Community Design Plan Existing Conditions Report – Municipal Infrastructure (Novatech, March 2007) Fernbank Master Servicing Plan (Novatech, June 2009)
Land Use	Fernbank Community Design Plan Existing Conditions Report – Land Use (WND, January 2007) Fernbank Community Design Plan (WND, June 2009)
Natural Environment (watercourses, woodlots)	Fernbank Community Design Plan Existing Conditions Report - Natural Environment (Muncaster, January 2007) Fernbank Environmental Management Plan (Novatech, June 2009)
Archaeology	Fernbank Community Design Plan Existing Conditions Report – Archaeological (Kinickinick Heritage Consultants, January 2007)
Public Consultation	Fernbank Community Design Plan – Public Consultation Report (WND, March 2008)

Section 2.0 Environmental Management Plan

Section 2.4.3 of the City of Ottawa Official Plan (2003) outlines policies defining the requirements for an Environmental Management Plan for specific areas:

- Where implementation of a subwatershed plan requires further detail or coordination of environmental planning and stormwater management among several sites, the City will coordinate the preparation of an Environmental Management Plan, in consultation with the Conservation Authorities.
- An Environmental Management Plan will address such matters as:
    - Delineation of creek corridor widths;
    - Specific mitigation measures to protect significant features, such as creeks, identified for preservation at the subwatershed level;
    - Conceptual and functional design of stormwater management facilities and creek corridor restoration and enhancement.
- Recommendations from environmental management plans will be implemented largely through development approval conditions and stormwater site management plans.

2.1 Scope of Work & Detailed Work Program

The Scope of Work prepared for the Environmental Management Plan and the Detailed Work Program created for the Fernbank CDP are provided in **Appendix A**.

2.2 Process

The EMP has been completed in conformance with the requirements of the Environmental Assessment Act, and fulfills Phases 1 and 2 of the Municipal Class Environmental Assessment Process. The EMP has been completed in parallel with the development of the Land Use Plan, Transportation Plan, and Master Servicing Plan through the integrated planning and EA process.

Development of the preferred environmental management strategy has included identification of the specific projects which will be required, including approval processes, costs, and phasing/timing.

The demonstration land use plan for the Fernbank Community has been developed through the integrated EA process, and represents one possible development scenario for the CDP lands, based on the Environmental Constraints Plan developed as part of the EMP. The demonstration plan is intended to illustrate the feasibility of implementing the recommended environmental management strategy.

The intent of the Environmental Management Plan is to:

- create an inventory of existing natural features (terrestrial and aquatic), and provide an evaluation of those features;
- consider the impacts of any land-use activities on natural features; and
- develop a recommended strategy to mitigate adverse effects and protect, enhance or restore the natural system for the pleasure of all.

Several land use plans were evaluated based on the results of the environmental inventory, and discussions with the public and regulatory agencies through the EA process. The EMP represents a blueprint for development of the Fernbank Area, while maintaining sufficient flexibility to allow for future changes to the recommended land use plan.

Section 3.0 Existing Conditions Environmental Inventory

The existing conditions reports provided the basis for identifying and mapping significant natural features within the limits of the Fernbank study area. The significance of environmental features is determined in relation to the surrounding general landscape. For the Fernbank Study area, Reach 2 of the Jock River Subwatershed and the Urban Area of the City of Ottawa are used for comparison.

The environmental inventory provides an integrated summary and assessment of the natural features identified through the existing conditions investigations. Full versions of the existing conditions reports are available under separate cover.

3.1 Aquatic Features & Fish Habitat Assessments

Fish sampling was conducted with a backpack electrofisher where possible. If water depth was insufficient, dip nets were used to sample the fish community. In addition to inventorying the fish communities, the fish habitat was assessed using several parameters including channel width, wetted width, water depth, channel morphology, exposed substrate, potential blockages in fish movement, in-stream structure, stream cover and other components of the riparian corridor, following the protocols in the *Ministry of Transportation Environmental Guide for Fish and Fish Habitat* (MTO, 2006). Habitat summaries, including unique or specialized habitats for specific life stages such as spawning, rearing and foraging, were derived from the habitat information. Examples of specialized habitats include pools, riffles and in-stream structure. A thermal regime analysis in August was not completed due to the lack of water in the Monahan, Flewellyn and Faulkner catchment areas in the study area. Fish sampling locations are shown on **Figure 3.1**.

3.1.1 Carp River

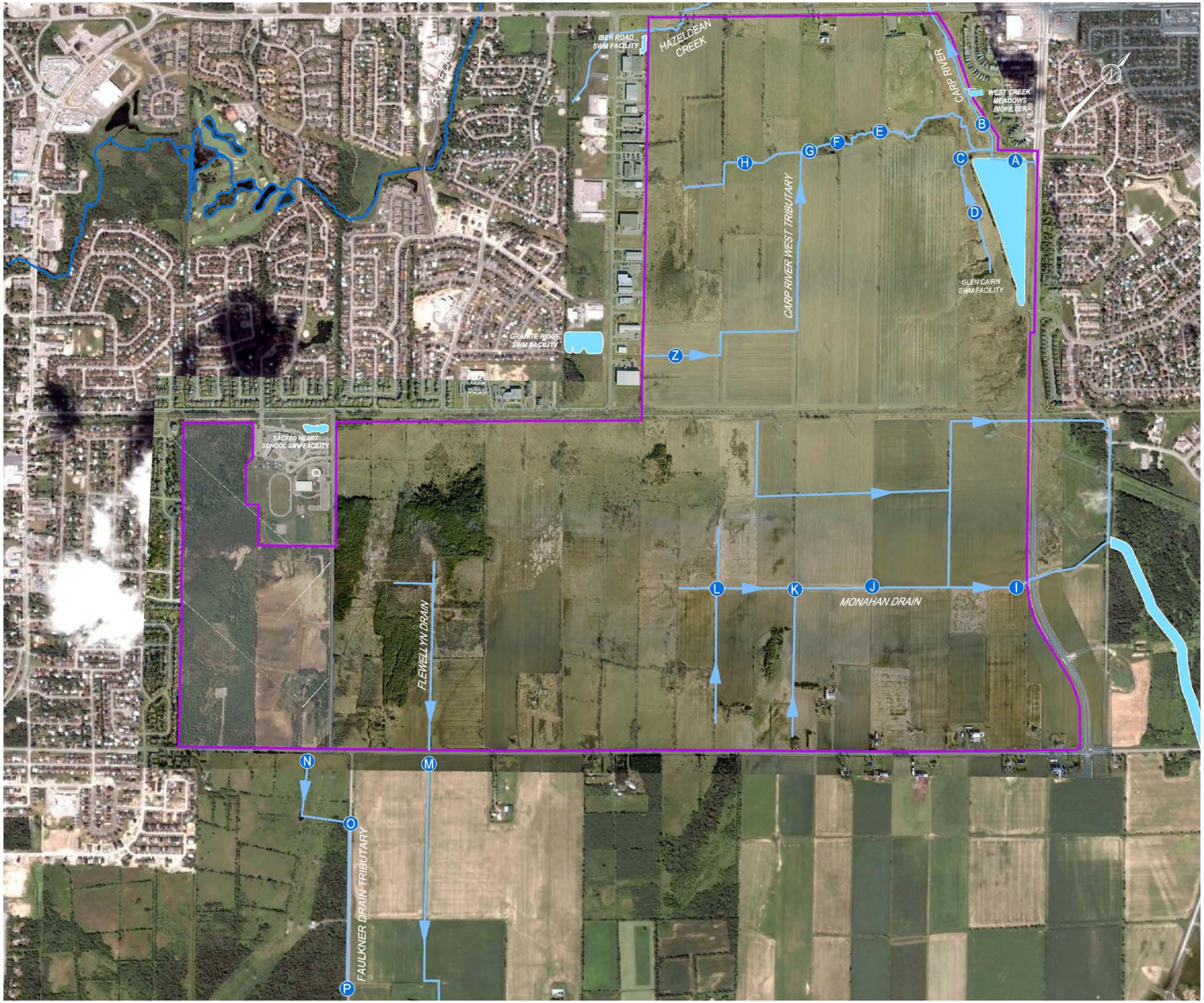
The Carp River upstream of Hazeldean Road supports a degraded warmwater fish habitat, which was considered 'Poor Quality Habitat' in the Carp River Watershed Subwatershed Study (Robinson, 2004). The existing river has been widened through channelization and historic sediment loads have created a straight, wide, shallow channel that becomes stagnant in summer and lacks suitable water depths and cover for warm water fish such as pike and sunfish (Robinson, 2004). The habitat is considered degraded due to the channelized nature of the river, lack of woody vegetation in the riparian corridor, very poor water quality, and dominance of soft substrate consisting of fine organics, silt and sand.

Aquatic vegetation and overhanging vegetation provide some in-stream structure. In-stream vegetation includes common waterweed, water plantain, duckweed, marsh purslane, hardstem bulrush, pondweeds, softstem bulrush and broad-leaved arrowhead. The riparian cover includes purple loosestrife, bulb-bearing water parsnip, rice cut grass, stinging nettle, fowl manna grass, reed canary grass and spotted jewelweed. Canopy cover along the Carp River south of Hazeldean Road is limited.

<u>Fish Sampling and Habitat Assessment</u>

Fish sampling in the Carp River was conducted in May and August of 2006 - results are summarized in **Table 3-1**. Species identified in the main Carp River channel (Stations B & C) included central mudminnow, northern redbelly dace, finescale dace, bluntnose minnow, fathead minnow, creek chub, pearl dace, golden shiner and brook stickleback. All of these species are considered common cool to warm-water fish species in eastern Ontario.

The dominant species identified during the spring fish sampling was fathead minnow. In contrast to the spring survey central mudminnow was the dominant species (fifty-nine percent of fish captured) rather than fathead minnow. Much less diversity was noted in the summer sampling with no northern redbelly dace, bluntnose minnow, creek chub or pearl dace netted.



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FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 3.1

Existing Conditions

Natural Environment Sampling Stations

STUDY AREA

DRAINAGE CHANNEL

A FISH AND BENTHIC SAMPLING STATION

SOURCE AND DATE OF AERIAL PHOTOS:
a) FERNBANK CDP LANDS: BASE MAPPING CO. (JUNE 2006)
b) BACKGROUND COMMUNITY: GOOGLE EARTH MAP (YEAR VARIES)

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet
SCALE : Not to Scale -Report

MARCH 2008

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email novainfo@novatech-eng.com

The Ontario Ministry of Natural Resources considered the Carp River as a potential spring migration corridor and/or spawning habitat for northern pike (EcoTec, 2001), however no northern pike or other large-bodied fish species were observed during several spring spawning surveys completed in the flooded vegetation along the Carp River by TSH (2005), or in the spring surveys completed in 2006 as part of this study.

Although dry in the summer, the headwaters of the Carp River west of the stormwater management pond (Station D) do provide some intermittent spring forage fish habitat.

The Carp River upstream of Richardson Side Road is classified as a tolerant warm water fish community that provides permanent fish habitat (Type 3 community).

Table 3-1: Fish Sampling Results from the Carp River

Common name	Scientific name	Trophic Class	Thermal Regime	Number Caught	Size Range (mm)
STATION B: MAIN CHANNEL ***Date: May 31, 2006*** ***Electro-Fish Shocking Time: 207 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	5	56 - 97
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	7	55 - 84
finescale dace	*Phoxinus neogaeus*	insectivore	cool	2	61 - 64
bluntnose minnow	*Pimephales notatus*	generalist feeder	warm	2	39 - 60
fathead minnow	*Pimephales promelas*	generalist feeder	warm	14	37 - 64
creek chub	*Semotilus atromaculatus*	generalist feeder	cool	2	60 - 85
pearl dace	*Margariscus margarita*	generalist feeder	cold/cool	1	84
brook stickleback	*Culaea inconstans*	water column insectivore	cool	3	23 - 50
STATION B: MAIN CHANNEL ***Date: August 4, 2006*** ***Electro-Fish Shocking Time: 288 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	22	30 - 95
golden shiner	*Notemigonus crysoleucas*	generalist feeder	cool	1	35
fathead minnow	*Pimephales promelas*	generalist feeder	warm	1	61
unknown minnows				3	15 - 40
brook stickleback	*Culaea inconstans*	water column insectivore	cool	10	15 - 45
STATION C: UPSTREAM OF GLEN CAIRN POND ***Date: August 4, 2006*** ***Electro-Fish Shocking Time: 194 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	7	30
unknown minnow				2	15
brook stickleback	*Culaea inconstans*	water column insectivore	cool	13	15-40
STATION D: CARP HEADWATERS UPSTREAM OF GLEN CAIRN POND ***Date: May 31, 2006*** ***Electro-Fish Shocking Time: 115 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	1	105

3.1.2 Carp River West Tributary

The Carp River West Tributary receives outflows from the Granite Ridge stormwater pond on the west side of Iber Road in Stittsville. The substrate was hard-packed clay, with some cobbles. Undercut banks provide some in-stream structure. There is no canopy cover along the straight channel with ninety degree bends further downstream. Corn is planted within approximately one metre of the top-of-bank. The upper reach of this channel has a typical trapezoid cross-section, while the lower reach has a more natural cross-section.The Carp River West Tributary is the only watercourse within the limits of the study area that has a near continuous baseflow component. The source of the baseflow appears to be groundwater inflow from foundation drains within the Granite Ridge Subdivision, which are routed through the Granite Ridge SWM pond prior to discharging to the West Tributary.

Fish Sampling and Habitat Assessment

Fish sampling in the Carp River West Tributary was conducted on May 9th, 2007 2006 - results are summarized in **Table 3-2**. The Carp River West Tributary supports forage fish habitat for a greater upstream range extent than previously realized due to baseflow contributions from the Granite Ridge stormwater pond. Although the fish habitat appeared degraded, a good representation of young creek chub was observed. The three fish species caught were also captured further downstream in the West Tributary in 2006. Creek chub is considered highly sensitive to sediment and turbidity for feeding and respiration, while blacknose shiner is considered to have a high sensitivity to elevated levels for respiration (MTO, 2006).

The Carp River West Tributary is classified as a tolerant warm water fish community that provides permanent fish habitat (Type 3 community). The Carp River West tributary was given award drain status under the *Ditches and Watercourses Act* and is periodically cleaned out to maintain a defined outlet for the upstream urban areas.

Table 3-2: Fish Sampling Results from the Carp River West Tributary

Common name	Scientific name	Trophic Class	Thermal Regime	Number Caught	Size Range (mm)
STATION E ***Date: May 31, 2006*** ***Electro-Fish Shocking Time: 257 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	3	40 - 96
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	1	30
blacknose shiner	*Notropis heterolepis*	benthic insectivore	cool/warm	1	53
banded killifish	*Fondulus diaphanus*	water column insectivore	cool	1	46
brook stickleback	*Culaea inconstans*	water column insectivore	cool	4	38 - 45
STATION E ***Date: August 4, 2006*** ***Electro-Fish Shocking Time: 98 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	31	26 - 50
brown bullhead	*Ameiurus nebulosus*	generalist feeder	warm	1	55
brook stickleback	*Culaea inconstans*	water column insectivore	cool	7	15 - 43
STATION F ***Date: May 8, 2006*** ***Electro-Fish Shocking Time: 239 seconds***					
fathead minnow	*Pimephales promelas*	generalist feeder	warm	4	50 - 75

Common name	Scientific name	Trophic Class	Thermal Regime	Number Caught	Size Range (mm)
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	1	60
brassy minnow	*Hybognathus hankinsoni*	generalist feeder	cool	2	35 - 50
finescale dace	*Phoxinus neogaeus*	insectivore	cool	3	25 - 35
blacknose dace	*Rhinichthys atratulus*			8	35 - 50
banded killifish	*Fondulus diaphanus*	water column insectivore	cool	7	30 - 50
brook stickleback	*Culaea inconstans*	water column insectivore	cool	4	30 - 50
STATION F ***Date: August 4, 2006*** ***Electro-Fish Shocking Time: 165 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	1	37
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	3	43 - 47
unknown minnow				3	20 - 40
banded killifish	*Fondulus diaphanus*	water column insectivore	cool	1	20
brook stickleback	*Culaea inconstans*	water column insectivore	cool	4	25 - 36
STATION G ***Date: August 4, 2006*** ***Electro-Fish Shocking Time: 50 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	3	30 - 40
unknown minnow				1	15
brook stickleback	*Culaea inconstans*	water column insectivore	cool	2	41 - 47
STATION Z ***Date: May 9, 2007*** ***Electro-Fish Shocking Time: 380 seconds***					
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	1	52
blacknose shiner	*Notropis heterolepis*	benthic insectivore	cool/warm	2	65-111
creek chub	*Fondulus diaphanus*	water column insectivore	cool	20	28-172

3.1.3 Hazeldean Tributary

The Hazeldean Tributary of the Carp River crosses Hazeldean Road in the northwest limit of the study area, east of Iber Road. The watercourse flows into the Carp River from the west between Hazeldean and Maple Grove Roads. The Hazeldean Tributary flows under Hazeldean Road in a concrete box culvert with no apparent impairments to potential fish movement. Manitoba maples trees provide greater stream cover just to the south of Hazeldean Road, while pool habitat increases the diversity of in-stream structure.

A collapsed wooden footbridge is partially blocking the channel south of Hazeldean Road and may impair fish movement during lower flow conditions. Further west towards Iber Road the channel is extensively choked with vegetation, including many non-aquatic species. Reed canary grass, broad-leaved cattail, brome grass, New England aster, hard-stem bulrush, Canada anemone, Canada goldenrod, calico aster and purple loosestrife are the common vegetation dogwood. The vegetation is growing in fine substrate with no coarse substrate observed.

Fish Sampling and Habitat Assessment

Although the Carp River Subwatershed Study (Robinson, 2004) concluded that the Hazeldean Tributary does not provide habitat for aquatic resources, recent surveys by Mississippi Valley Conservation staff indicate that the tributary supports intermittent fish habitat.

The portion of the Hazeldean Tributary adjacent to Hazeldean Road was assessed on October 20th, 2006, although no fish sampling was completed on the Hazeldean Tributary in 2006. A refuge pool, approximately 3 metres in diameter and a metre in depth, downstream (north) of Hazeldean Road contained at least 200 cyprinids (brook stickleback and at least 3 other types of cyprinid species), when reviewed by Mississippi Valley Conservation staff in early September, 2004. Brook stickleback were also observed adjacent to the Hazeldean Road culvert during June and July, 2004 surveys completed by Muncaster Environmental Planning Inc. and by EcoTec (2001) for the Hazeldean Road Design Projects.

Hazeldean Creek upstream of Hazeldean Road is classified as an intermittent watercourse that supports a tolerant warm water fish community (Type 3 community).

3.1.4 Monahan Drain

The headwaters of the Monahan Drain are situated in southeastern portion of the Fernbank CDP study area. The Monahan Drain is a municipal drain which is periodically cleaned out to maintain the design cross-section as identified in the *Engineer's Report – Monahan Creek Municipal Drain: Modifications and Improvements* (Robinson Consultants, October 2002).

The main branch of the Monahan Drain flows eastwards towards Terry Fox Drive, with several lateral branches on the north and south sides that connect with the main branch. Initial surveys of the on-site portion of the Monahan Drain (conducted in 2001) concluded that any aquatic habitat on-site is severely limited due to the general presence of non-aquatic vegetation through the cross-sections of the drainage channel, a lack of standing or flowing water and no defined low-flow channels. Non-aquatic vegetation dominated most of the channel, with exposed silt and sand at areas of erosion. Manure and cattle hoof prints were common in the channel. A large gabion basket has been installed in the channel upstream (west) of Terry Fox Drive. This new structure appears to represent a significant year-round barrier to fish movement upstream onto the site.

Fish Sampling and Habitat Assessment

Fish sampling in the Monahan Drain was conducted in May and August of 2006 - results are summarized in **Table 3-3**. Fish sampling in May 2006 along a 35m section of the watercourse between the gabion basket weir and Terry Fox Drive yielded only three fish and two species (brook stickleback and northern redbelly dace).

The fish community appeared similarly limited downstream (east) of Terry Fox Drive, with three fish captured on May 9th, 2006, representing two species (brook stickleback and banded killifish). The channel was sampled again on August 8th, 2006 with a dip net, as the water depth was insufficient for the electrofisher. Six dips provided a total of 28 fish with finescale or northern redbelly dace, banded killifish and brook stickleback observed.

Fish sampling in the Monahan Drain was also conducted further upstream of Terry Fox Drive. At 800 metres west of Terry Fox Drive, several forage fish were observed and three species captured with the electrofisher; northern red-bellied dace, brook stickleback and creek chub. At 950 metres west of Terry Fox Drive four fish were captured, representing three species (brook stickleback, bluntnose minnow and northern redbelly dace).

At the edges of the agricultural fields several smaller straight channels flow into the main east-west Monahan Drain channel. The channels had minimal flow in the early spring but do not provide any in-situ fish habitat due to their very intermittent nature and lack of defined watercourses within the overall excavated channel.

It should be noted that while the brook stickleback prefers cool temperatures, it is tolerant of warm temperatures. The Monahan Drain within the limits of the study area has been classified as an intermittent watercourse supporting indirect cool/warm water fish habitat.

Table 3-3: Fish Sampling Results from the Monahan Drain

Common name	Scientific name	Trophic Class	Thermal Regime	Number Caught	Size Range (mm)
STATION I ***Date: May 9, 2006*** ***Electro-Fish Shocking Time: 563 seconds***					
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	1	55
banded killifish	*Fondulus diaphanus*	water column insectivore	cool	1	35
brook stickleback	*Culaea inconstans*	water column insectivore	cool	4	40 -52
STATION I ***Date: August 8, 2006*** ***Dip Netting: 6 Casts***					
finescale/northern redbelly dace	*Phoxinus sp*	insectivore/generalist feeder	cool/warm	17	15-20
banded killifsih	*Fondulus diaphanus*	water column insectivore	cool	3	
brook stickleback	*Culaea inconstans*	water column insectivore	cool	8	15-20
STATION J ***Date: May 9, 2006*** ***Electro-Fish Shocking Time: 169 seconds***					
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	3	60 - 65
creek chub	*Fondulus diaphanus*	water column insectivore	cool	1	30
brook stickleback	*Culaea inconstans*	water column insectivore	cool	1	50
STATION K ***Date: May 9, 2006*** ***Electro-Fish Shocking Time: 316 seconds***					
northern redbelly dace	*Phoxinus eos*	generalist feeder	cool/warm	2	65
bluntnose minnow	*Pimephales notatus*	generalist feeder	warm	1	62
brook stickleback	*Culaea inconstans*	water column insectivore	cool	1	63

3.1.5 Flewellyn Drain

The headwaters of the Flewellyn Drain are situated in the south-central portion of the Fernbank CDP study area. The Flewellyn Drain flows south towards Fernbank Road. The Flewellyn Drain is a municipal drain and is periodically cleaned out to maintain the design cross-section as identified in the *Engineer's Report - Repair and Improvements to the Flewellyn Municipal Drain* (Novatech, August 1982).

The channel is comprised primarily of non-aquatic grass. Evidence of cattle access through the channel was common, with no electric fencing along the channel banks. The cattle access has resulted in extensive erosion. The substrate was a combination of grass and fines. In-stream structure and stream cover were lacking until further upstream in the west-central portion of the site where emergent vegetation and riparian woody vegetation are present. Rock flow check dams have been installed in the channel upstream of Fernbank Road.

Fish Sampling and Habitat Assessment

Fish sampling in the Flewellyn Drain was conducted in May of 2006 and May of 2007 - results are summarized in **Table 3-4**. A 35m reach of the channel was inventoried with a backpack electrofisher on May 9th, 2006. No fish were captured. This reach was surveyed again on May 9th 2007 and three fish were captured, representing 2 species (central mudminnow, brook stickleback).

Fish species diversity and fish abundance in the Flewellyn Drain appeared limited relative to the habitat conditions, especially in the upper (north) reaches where only two species were netted. All four species observed in the Flewellyn Drain are common cool and warmwater forage fish species. Most of the species observed are considered moderate or low sensitivity to sediment and turbidity for reproduction, feeding and respiration, however the blacknose shiner is considered to have a high sensitivity to elevated sediment/turbidity levels for respiration and the creek chub is considered highly sensitive to sediment/turbidity for feeding and respiration (MTO, 2006). It should be noted that while the brook stickleback prefers cool temperatures, it is tolerant of warm temperatures.

The Flewellyn Drain within the limits of the Fernbank Community has been classified as an intermittent watercourse supporting indirect cool/warm water fish habitat.

Table 3-4: Fish Sampling Results from the Flewellyn Drain

Common name	Scientific name	Trophic Class	Thermal Regime	Number Caught	Size Range (mm)
STATION M ***Date: May 9, 2007*** ***Electro-Fish Shocking Time: 518 seconds***					
central mudminnow	*Umbra limi*	generalist feeder	cool/warm	1	60
brook stickleback	*Culaea inconstans*	water column insectivore	cool	2	45-50

3.1.6 Faulkner Drain Tributary

The southwestern portion of the Fernbank Study area is tributary to the Faulkner Drain. Drainage for the lands west of Shea Road is provided primarily by the roadside ditches along Shea Road. There is a small low-lying area upstream (north) of Fernbank Road that is separated from the roadside ditch on Fernbank Road by an earthen berm. Runoff from this area is discharged to the roadside ditch on Fernbank Road by a small outlet pipe that passes through the berm. The area upstream of the berm was dry on May 9th 2007.

The roadside drainage crosses under Fernbank Road to a tributary of the Faulkner Drain. The tributary channel is poorly defined south of Fernbank Road among reed canary grass and no canopy cover. Areas of standing water were up to 2.5m wide but there was no continuous connection of surface water. Clay and muck are the dominant substrate.

Fish Sampling and Habitat Assessment

Fish sampling was conducted in May of 2007 at three sites on the Faulkner Drain Tributary south of Fernbank Road. No fish were observed or netted at any of the three sampling sites. Minimal water reduced the extent of fish sampling in many areas.

The Faulkner Drain Tributary can be classified as providing indirect fish habitat.

3.2 Benthic Macroinvertebrate Analysis

Benthic macroinvertebrate samples were taken with kick nets on October 12, 2006 in the Carp River, the Carp River West Tributary, the Monahan Drain and the Flewellyn Drain. Sampling locations are shown on **Figure 3.1**. Each sample is a composite of three one-minute traverses of the watercourse with the kick net, except for the Flewellyn Road sample where only enough water was present for one sample. The samples were collected by kicking in front of the dip net, washing the rocks and passing the net through aquatic vegetation. The samples were then hand picked and preserved and the remaining sediments and debris was also preserved and was sorted through in a laboratory. No evidence of contamination to the water or sediments was observed (i.e. oily substances or film).

The number of taxa generally indicates the health of the community, water quality and the diversity of available habitats. **Table 3-5** summarizes the biotic indices used analyze the benthic invertebrate data. These include:

- the Modified Hilsenhoff Index;
- percent oligochaetes (worms) and chironomids (midges); and
- and number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) taxa and their representative percentage of the total taxa.

Table 3-5: Summary of Benthic Invertebrate Data, Autumn 2006

Biotic Index	Carp River East Trib Site A	Carp River Site B	Carp River Headwaters Site D	Carp River West Trib Site E	Monahan Drain Site I	Flewellyn Drain Site M
Average Total Number of Taxa	10.7	17.3	14	23	16	13
Modified Hilsenhoff Index	6.2	6.7	6.3	6.3	6.4	5.5
% Chironomids	21.5	19	23.7	36.1	54.8	4.3
% Oligochaetes	53	55	37	28	7.6	62
EPT Index / % of Taxa	0.7/6	1/5.3	1.3/9.7	2.3/15.3	1.7/10.6	1/8

3.2.1 Results of Analysis

Modified Hilsinhoff Index

Application of the modified Hilsenhoff Biotic Index involves assigning each genus or species a value between 0 and 10. **Table 3-5** presents an average score for each site. **Table 3-6** shows how water quality is evaluated using the Biotic Index. Species with a score of 0 are intolerant of any organic and nutrient pollution while those with a score of 10 thrive in extremely polluted streams. The advantage of the modified Hilsenhoff Biotic Index is that it includes benthic invertebrates beyond just the arthropods utilized in the original Hilsenhoff Biotic Index. Sensitivity ratings were assigned to taxon such as snails, clams, worm and leeches.

Table 3-6: Hilsenhoff Biotic Index

Hilsenhoff Biotic Index	Water Quality	Degree of Organic Pollution
4.51 – 5.5	Good	Some organic pollution probable
5.51 – 6.5	Fair	Fairly significant organic pollution likely
6.51 – 7.5	Fairly Poor	Significant organic pollution likely
7.51 – 8.5	Poor	Very significant organic pollution likely

The results of the modified Hilsenhoff Biotic Index ranged in a relatively narrow band from 5.5 to 6.7, with the following definitions of water quality relevant to the results. These results generally indicate fair water quality. This is a little better than the conclusion of the benthic invertebrate data analysis by MMM (2005) that identified the upper reaches of the Monahan Drain as fairly poor water quality. None of the stations exhibited excellent, very good, poor or very poor water quality according to interpretation of this index.

Percentage of Oligochaetes and Chironomids

A higher percent of oligochaetes and chironomids in a sample is generally considered to be a reliable indicator of organic pollution. Although these pollution tolerant organisms can be in any quality of water, their dominance suggests impaired conditions. A benthic invertebrate community primarily composed of taxa highly tolerant of pollution generally indicates poor water quality and is typically associated with watercourses influenced by human activities including agriculture (MMM, 2005). Sites varied between 4 and 62 % for percent oligochaetes and chironomids individually but the sum of the percentages of chironomids and oligochaetes varied in a much narrower range between 62 and 74 %.

EPT Index

The mayflies, stoneflies and caddisflies are taxa that are considered to be very sensitive to poor water quality conditions, therefore the presence of these orders are indicators of good water quality sites. The higher the populations of these organisms, the more stable the site. The population and distribution of mayflies and caddisflies was low at all sites, with no stoneflies collected. Highest numbers were observed in the West Tributary of the Carp River.

3.2.2 Summary

The number of taxa generally indicates the health of the community, water quality and the diversity of available habitats. The diversity of aquatic invertebrates is generally low, with no stoneflies, lacewings, damselflies or fish flies and only one taxa of dragonfly and two mayfly taxa. This can be a reflection of the dominance of fine substrate, poorer nutrient enriched water quality and/or minimal in-stream structure.

Amphipods were observed only at the Carp River sites. Mayflies were observed at all sites except Flewellyn Drain, although caddisflies were observed at the Flewellyn Drain, all of the Carp River sites except the downstream site and not the Monahan Drain site. Although some water quality impairment is evident, the presence of caddisflies and amphipods suggests that water quality is not severely degraded.

3.3 Terrestrial Features & Habitat

The study area is dominated by existing and past agricultural lands, including corn crops, hay fields and pasture lands. The study area is separated into north and south parcels by a former railway line, now used as a recreational pathway, which is part of the Trans Canada Trail. An east-west steel tower hydroelectric line is parallel to and south of the Trans Canada Trail. The tower line curves to the south east of Shea Road.

Forest habitat is present west of Shea Road, with smaller wooded areas east of Shea Road. The Carp River originates north of the Trans Canada Trail and flows to the north along the east limits of the study area. Surface water flow south of the Trans Canada Trail is part of the Jock River Watershed, with most of the surface flow of the south portion of the study area picked up by a headwater ditch of the Monahan Ditch flowing west to east and crossing Terry Fox Drive south of the Trans Canada Trail.

References to natural features in the following sections are indicated by a number, i.e. (1), which are identified on **Figure 3.2**.

<u>Hydro Corridors</u>

The hydro easements for high-voltage transmission lines represent some of the more significant features within the Fernbank Community study area. The hydro corridor south of the Trans-Canada Trail is approximately 100 metres wide. The hydro corridor north of the Trans-Canada Trail is approximately 45 metres wide. The hydro corridors are generally meadow habitat with some areas of thickets. The features and functions of the hydro corridor are not generally separated from the adjacent former agricultural lands and include breeding habitat for grassland birds, feeding areas for these and other wildlife and connectivity with the other former agricultural lands east of Shea Road.

3.3.1 Carp River Watershed

Wildlife habitat in the Carp River Watershed portion of the study area is limited to an area of higher quality trees adjacent to the Carp River West Tributary (5), as well as some remnant deciduous hedgerows (6) and meadows (7). These hedgerows are only a single tree width and of limited value due to their intermittent nature and poor condition of many of the trees. The minimal width and intermittent nature, along with the adjacent development to the west, north and east greatly limit the current linkage function provided by the hedgerows. Although many of the tree species in the hedgerow are generally less desirable for preservation such as Manitoba maple and white elm, scattered bur oak, basswood, sugar maple and red ash are in the hedgerows and where an access road crosses the West Tributary (5).

3.3.2 Monahan Drain Subwatershed

Scattered clumps of mature trees (1) and deciduous hedgerows (6) also provide some localized wildlife habitat in the Monahan Drain portion of the study area. As with the hedgerows in the north portion of the study area, the minimal width and intermittent nature of the hedgerows greatly limit the ecological functions. As the balance of the land is either cultivated or used for pasture, linkage functions are also limited.

The cultural meadow habitat (7) within and adjacent to the hydro lines provides grassland habitat for several breeding birds including upland sandpiper, bobolink, field sparrow and savannah sparrow - refer to **Figure 3.2**. Eastern meadowlark was observed in 2005, but not in 2006. Many of these species, along with brown thrasher which was observed in thicket habitat, are experiencing population declines in southern Ontario as their habitat either is developed or regenerates to forests.

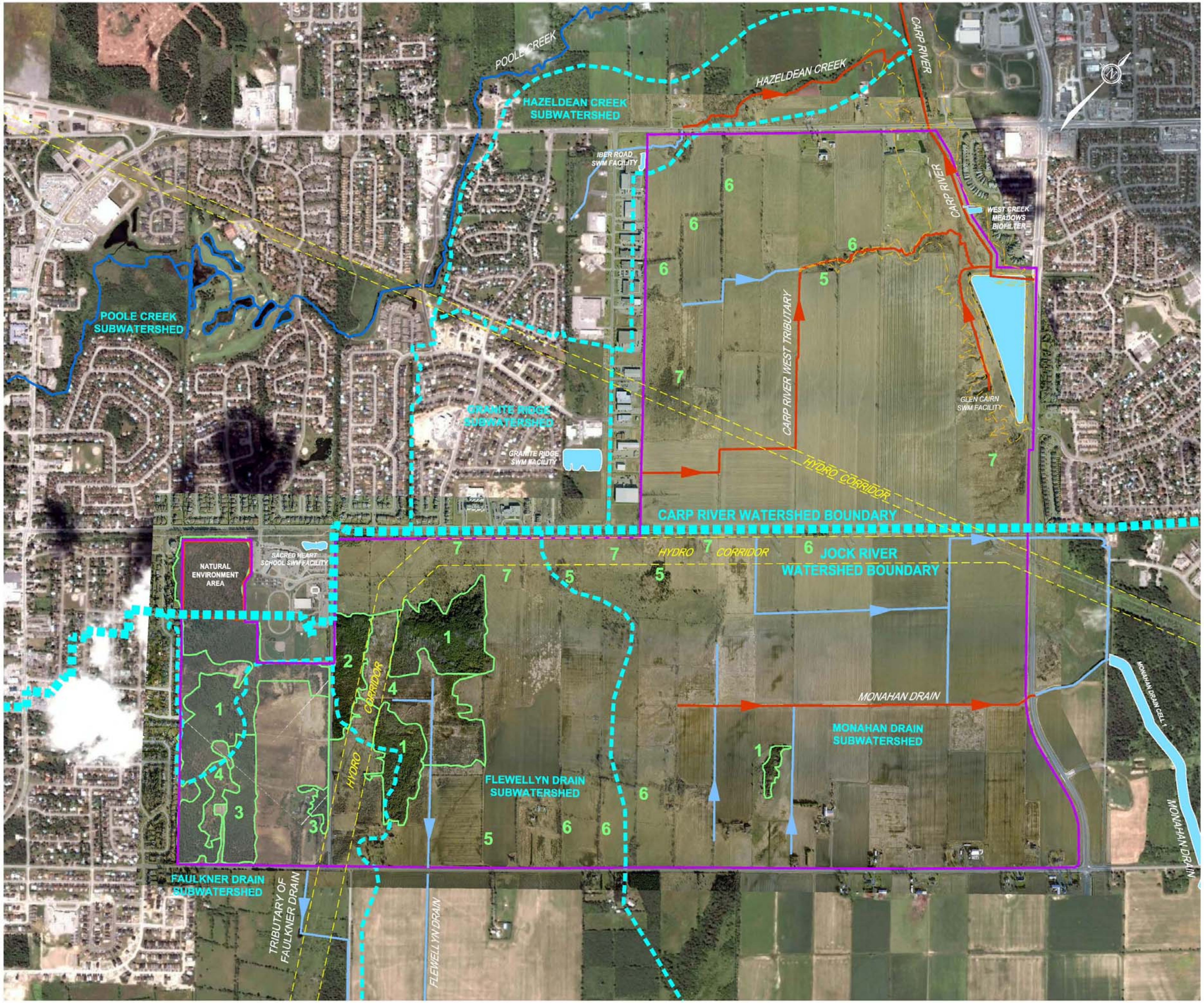

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FIGURE 3.2

Existing Conditions

Natural Environment Features

STUDY AREA

AQUATIC FEATURES

- WARM WATER FORAGE FISH HABITAT
- DRAINAGE CHANNEL

NOTE: OTHER ON-SITE CHANNELS CONTRIBUTE FLOW TO DOWNSTREAM FISH HABITAT

- CARP RIVER FLOOD PLAIN
- WATERSHED BOUNDARY

TERRESTRIAL FEATURES

- NATURAL ENVIRONMENT AREA
- AREA OF TERRESTRIAL FEATURE

1 WOODED AREA (CONIFEROUS)
2 WOODED AREA (MIXED SPECIES)
3 PINE PLANTATION
4 SCRUB AND THICKET
5 REMNANT HIGHER QUALITY TREES MAPLE, ASH and BASSWOOD
6 DECIDUOUS HEDGEROWS
7 MEADOW HABITAT USED BY FIELD SPECIES SUCH AS BOBOLINK, SAVANNAH SPARROWS, and UPLAND SANDPIPERS

SOURCE AND DATE OF AERIAL PHOTOS:
a) FERNBANK CDP LANDS: BASE MAPPING CO. (JUNE 2006)
b) BACKGROUND COMMUNITY: GOOGLE EARTH MAP (YEAR VARIES)

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet SEPTEMBER 2008
SCALE : Not to Scale -Report

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3.3.3 Flewellyn Drain Subwatershed

The cedar forests east of Shea Road (1) are young with the largest cedars in the range of 25cm diameter at breast height (dbh), but most stems are less than 15cm dbh. Some scattered trembling aspen, white birch, white spruce, bur oak and balsam poplar stems are up to 30cm dbh in the south portion of the north cedar forest. Balsam poplar is very common along the south limit of the south forest. In addition to the poplar trees, common buckthorn is well established around the periphery of the north forest. Ice storm damage is evident on some of the trees. The high density of cedars generally precludes development of ground flora. In areas of open canopy, common buckthorn, field horsetail, poison ivy, common strawberry, Virginia creeper, St. John's wort and sensitive fern are present. Spruce and cedar regeneration are good along portions of the periphery of the forests

The willow habitat east of the coniferous forest adds to the habitat diversity on the site, as does an extension of the cultural meadow habitat (7) described in the above section. Swamp sparrow and upland sandpiper are examples of the area sensitive breeding birds supported by these habitats.

3.3.4 Faulkner Drain Subwatershed

The cedar forests west of Shea Road represent the most significant natural environment feature in the study area. The portion of the forest between the Sacred Heart High School and the west study area boundary is the least disturbed. This section of the forest is designated Natural Environment Area in the City's Official Plan and will be retained in its existing condition. The white cedar trees are up to 55cm dbh. In addition to a good density of mature cedar, yellow birch, white birch, white elm and trembling aspen are common in areas, with mature birch trees up to 40cm dbh. Watermarks at bases of tree trunks in the northwest portion suggest standing water is present in the spring. The ground flora is rich in ferns including bulblet fern, lady fern, sensitive fern, marginal wood fern and cinnamon fern. Other ground flora, many indicative of rich woods, includes white trillium, foamflower, wild lily-of-the-valley, clintonia, jack-in-the pulpit, bloodroot, wild sarsaparilla, white snakeroot, wild mint and enchanter's nightshade.

The functions of the forest closer to Shea Road and south of the recreation facilities have been impacted by extensive tree removal in 2006. Pine plantations (3) were to the south of the cedar forests, north of Fernbank Road. In terms of linkages and connectivity within the Faulkner Drain Subwatershed, the area west of Shea Road is relatively isolated due to the urban residential areas to the west and north, the high school and Community Centre to the immediate north and active agricultural lands to the south. Any linkage and connectivity functions would be to the east, east of Shea Road. Such functions would be relatively minor given Shea Road and the location of the lands west of Shea Road at the west edge of the undeveloped lands to the east. On-site functions were lost as a result of the tree clearing, including wildlife habitat and mature vegetation. Many of the trees removed from the lands south of the Community Centre were mature white cedars. The density and dominance of the cedars likely precluded a diverse ground flora. The trees removed closer to Fernbank were predominantly conifer plantation with a much lower ecological features and function component.

3.4 Breeding Bird Surveys

3.4.1 Carp River Subwatershed

Wildlife observed among the fields and hedgerows north of the Trans Canada Trail included American goldfinch, yellow warbler, American robin and American crow.

3.4.2 Monahan Drain Subwatershed

Breeding birds observed in the vicinity of the cultural meadow under and adjacent to the hydro towers included several pairs of upland sandpipers west of Tower 627, field sparrow, killdeer, chipping sparrow, savannah sparrow, bobolink, brown-headed cowbird, red-winged blackbird, song sparrow, European starling, American goldfinch, least flycatcher, eastern kingbird, brown thrasher, barn swallow, Baltimore oriole, yellow warbler and chipping sparrow. In addition red-tailed hawk, northern harrier, turkey vulture and ring-billed gull were observed overhead but no indication of nesting in the study area.

3.4.3 Flewellyn Drain Subwatershed

Breeding birds were typical of common species in smaller forests, with the exception of the black-and-white warbler and white-throated sparrow, which are often considered area sensitive breeding birds. These species have been observed during the breeding season in other Ottawa locations in small forests. Additional breeding bird surveys in 2007 identified two additional species not noted in 2006, alder flycatcher and bank swallow. These birds are very common on a local and provincial scale.

The cultural meadow habitat within and adjacent to the hydro lines provides grassland habitat for several breeding birds including upland sandpiper, bobolink, field sparrow and savannah sparrow.

3.4.4 Faulkner Drain Subwatershed

Twenty-one bird species and five other wildlife species were observed on June 19th, 2007 in the remaining forests and adjacent lands west of Shea Road. Three species were not recorded in the 2006 surveys, pileated woodpecker, rose-breasted grosbeak and winter wren. All of the species are considered very common in Ontario and demonstrably secure (NHIC, 2007). A few of the bird species, pileated woodpecker, ovenbird, black-and-white warbler and winter wren, are considered area sensitive in terms of typical successful breeding habitat requirements. These species were observed in the cedar forests in the northwest portion of the study area, south of Abbott Street and west of Sacred Heart High School.

3.5 Species of Special Concern

Correspondence with the Kemptville District Office of the Ontario Ministry of Natural Resources identified several potential species of concern in the general area including ram’s head lady slipper, butternut, loggerhead shrike, milk snake, Blanding’s turtle and musk turtle. Extra search effort was made for these species in the appropriate habitats. In addition to these potential species of special concern, the list of rare species and species at risk in MMM (2005) was reviewed for additional potential species of interest in the study area. NHIC (2006), Muncaster and Brunton (2005) and Brownell and Larson (1995) were also consulted for the status of flora and fauna.

3.5.1 Narrow-Leaved Vervain

A regionally rare plant, narrow-leaved vervain, was observed in the cultural meadows adjacent to the south cedar forest on the west side of Shea Road. No other species of special concern or rare species were identified during the many surveys of the study area in 2005, 2006 and 2007 or reported in other studies.

3.5.2 NHIC Provincial Ranking (SRANK)

Provincial or subnational ranks (SRANK) are used by the Natural Heritage Information Centre to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation, needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually. SRANK scores range from S1 (extremely rare) to S5 (very common).

The Ontario SRANK of all the wildlife observed in the Fernbank Study area is S5, considered very common in Ontario and demonstrably secure, with the exception of turkey vulture and northern harrier flying over the site and bobolink and upland sandpiper, which are designated S4, common in Ontario and apparently secure, with usually more than 100 occurrences.

3.6 Urban Natural Areas Evaluation

The Urban Natural Areas Environmental Evaluation Study (UNAEES) provides a relative environmental evaluation of the remnant urban natural areas in the City of Ottawa's Urban Area (Muncaster and Brunton, 2005). Although functioning at a different scale to rural natural areas, urban areas provide natural environmental benefits as well as recreational and educational opportunities at a local, community level.

The Fernbank Community study area has been incorporated into Ottawa's Urban Area, and the natural areas within the study area were evaluated using the methodology in the UNAEES. Two urban natural areas were identified, one east of Shea Road and one west of Shea Road. These boundaries are shown on **Figure 3.3**.

There are nine separate criteria used in the UNAEES evaluation, each is rated on a scale of 1 to 5:

- Connectivity
- Regeneration
- Ecological Intensity
- Size and Shape
- Habitat Maturity
- Natural Communities
- Representative Flora and Fauna
- Significant Flora and Fauna
- Wildlife Habitat

Details of the Urban Natural Areas Environmental Evaluation Studies are provided in **Appendix C**. The results of the evaluations are summarized as follows:

3.6.1 East of Shea Road

The hydro corridor and a meadow area create breaks between the three wooded areas that comprise the UNA east of Shea Road. Consequently, the UNAEES considered each of the three wooded areas east of Shea Road separately during the evaluation.

1) A dry-fresh cedar forest (Vegetation Community '6') located east of the hydro corridor and north of the willow thickets and meadow habitat. UNAEES Rating: Moderate (score = 2.22)
2) A dry-fresh cedar forest (Vegetation Community '6') located east of the hydro corridor and south of the willow thickets and meadow habitat. UNAEES Rating: Low (score = 1.67)
3) A dry-fresh poplar mixed forest (Vegetation Community '5'), located between the hydro corridor and Shea Road. UNAEES Rating: Low (score = 1.67)

3.6.2 West of Shea Road

The fresh-moist cedar forest in the northwest corner of the study area south of Abbott Street is identified as a Natural Environment Area on Schedule A of the City *of Ottawa 2003 Official Plan* and is the most significant natural environment feature in the study area. The approximate boundary of the Natural Environment Area is identified with a red line in **Figure 3.3**. The limit of the NEA area will need to be verified as part of an EIS before any development in this area can proceed.

A cultural meadow and a willow shrub thicket create breaks between the NEA in the northwest corner of the study area and the two wooded areas to the south that comprise the UNA west of Shea Road. Consequently, the UNAEES considered the two wooded areas to the south of the NEA separately during the evaluation.

4) A dry-fresh cedar forest (Vegetation Community '6') located south of the willow shrub thicket and north of the cultural meadow habitat. UNAEES Rating: Moderate (score = 2.22)

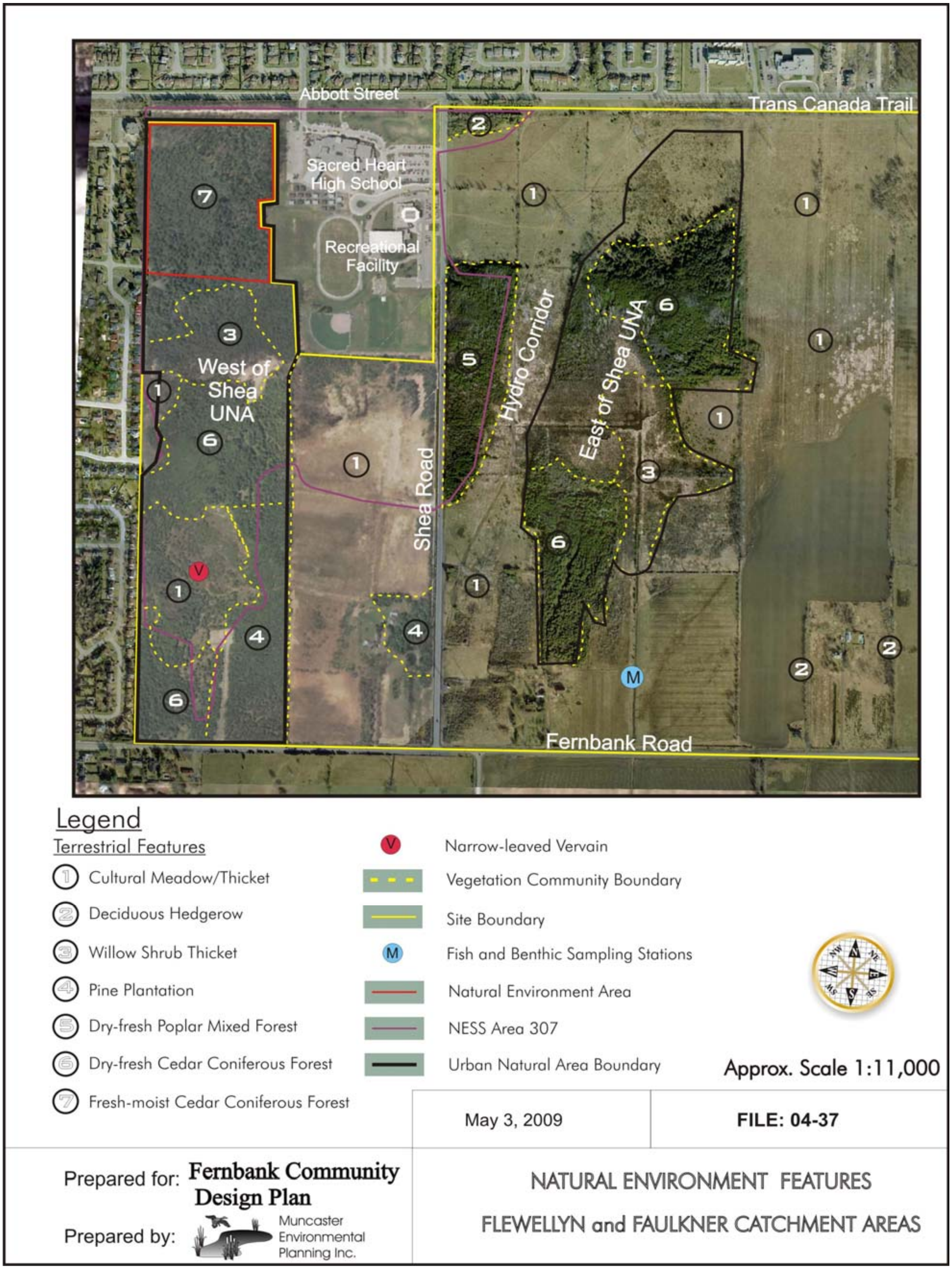
5) A dry-fresh cedar forest (Vegetation Community '6') located in the southeast corner of the study area, north of Fernbank Road.. UNAEES Rating: Low (score = 1.67)

The mature coniferous forests in the NEA are more mature, less disturbed, and have more ecological function, such as greater canopy cover, greater diversity of native flora and observations of area sensitive breeding birds, than the more open and fragmented natural area coverage in the central and south portions of the Urban Natural Area.

The portion of the forest south of the Natural Environment Area lands contains an extensive amount of ice storm damage and wind throw. The size of cedars is generally smaller and the extent of buckthorn shrubs is greater in the south portion of the forest.

Retention of the northwest forest, along with conservation through preservation or relocation, of the regionally rare flora (narrow-leaved vervain (Verbena simplex)) in the south portion of the Urban Natural Area and site-specific tree retention outside of the northwest forest will assist in retaining the significant features and functions of the Natural Area.

Figure 3.3 Existing Conditions - Urban Natural Areas



3.7 Geotechnical

A geotechnical analysis of the soils within the Fernbank Community was completed to assess soils conditions and provide preliminary guidelines with respect to slope stability, grade raise restrictions and foundation design requirements.

3.7.1 Slope Stability

The geotechnical analysis indicated that there are no slopes within the limits of the study area that are of concern from a slope stability perspective.

3.7.2 Grade Raise Restrictions & Foundation Design Requirements

A considerable portion of the Fernbank study area is underlain by deposits of sensitive silty clay of marine origin. Grade raise restrictions have been outlined for the study area, and generally range between 2-3 metres. The most severe grade raise restrictions are found adjacent to Terry Fox Drive at the eastern limit of the study area. Test pit locations, grade raise restrictions, and foundation design requirements are outlined in the Master Servicing Study.

3.7.3 Tree Planting Strategy in Areas of Sensitive Marine Clay

Figure 3.4 identifies where sensitive marine clay is present within the study area. The City of Ottawa applies restrictions for tree planting in areas where sensitive marine clay is known to exist. Tree planting strategies in these areas should be developed in accordance with the *Tree and Foundations Strategy in Areas of Sensitive Marine Clay in the City of Ottawa*.

Recommendations for tree planting strategies in sensitive marine clay are addressed in Section 11 - Environmental Management Guidelines and Recommendations.

3.8 Hydrogeology

Hydrogeologic conditions within the Fernbank Community have been identified to assist in the protection of groundwater quality and the recharge/discharge functions of the site. The characterization of the site's hydrogeology has been based on a combination of existing information and site specific information provided by the fieldwork and other analyses, including information from the environmental inventory and the geotechnical and geomorphological investigations.

3.8.1 Bedrock Geology

The bedrock which underlies the Fernbank Community area consists of generally flat-lying carbonate sedimentary rock composed of layers of limestone and limestone-like sedimentary rock. There are exposed bedrock highs in the southwestern and south-central part of the site. The overburden found in the Fernbank Community area was deposited in several stages from the last glaciation to present time. Regional mapping indicates that the finer-grained Champlain Sea marine sediments are the predominant uppermost overburden material in the area. Till is the main sediment in the uplands on the west side of the site. The till occurs as a thin and discontinuous cover over the bedrock. Till may also be found at depth beneath the clay, silty clay and silt deposits.

There is a regionally significant fault or fault zone adjacent to the eastern boundary of the site. It is the northwest/southeast trending Hazeldean Fault, two spurs of which traverse the Fernbank Community area. The faults in the Ottawa area are said to be "old and dormant" and inactive with respect to movement. The Hazeldean Fault is not known to be transmissive (i.e. water bearing) (GAL, 2003). However, differences in bedrock units and permeability across the fault lines can create certain complexities for the groundwater

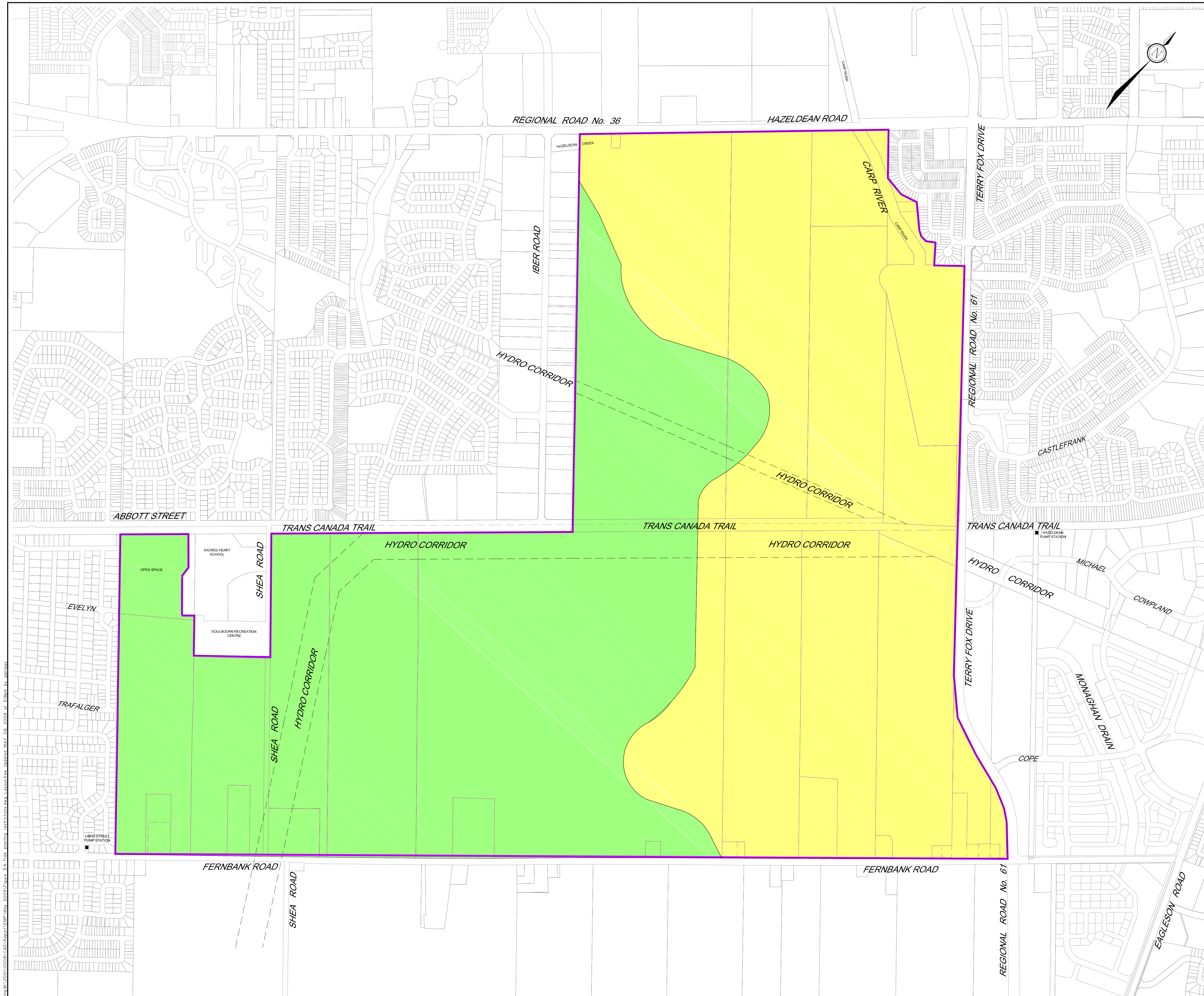


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FIGURE 3.4

Existing Conditions

Tree Planting Restrictions

STUDY AREA

NO TREE PLANTING RESTRICTIONS

TREE PLANTING RESTRICTIONS

FOR AREAS IDENTIFIED AS HAVING TREE PLANTING RESTRICTIONS, REFER TO "TREES AND FOUNDATIONS STRATEGY IN AREAS OF SENSITIVE MARINE CLAY IN THE CITY OF OTTAWA."

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet
SCALE : Not to Scale -Report

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NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

flow systems. Faulting can also cause widespread fracturing, which increases the permeability of many of the bedrock units.

3.8.2 Surficial Geology

The surficial geology of the Fernbank Community area is shown on **Figure 3.5**. The geological units mapped are the unconsolidated deposits or overburden overlying the bedrock described above. **Figure 3.5** also shows areas mapped as Paleozoic bedrock. This is because, by mapping conventions, areas covered with less than 1 metre of unconsolidated materials, such as much of the bedrock ridge in the south-central part of the site, are mapped as bedrock. Therefore, the surficial geology mapping can be used to identify the approximate location of those parts of the site which have thin to non-existent overburden cover.

The overburden found in the Fernbank Community area was deposited in several stages of geological history from the last glaciation to present time. The legend on **Figure 3.5** divides the different overburden materials into their respective depositional environments. The units listed in the legend are listed from oldest to youngest, from the bottom of the list to the top.

According to regional mapping, the total overburden thickness ranges from 25 to 50 metres at the far eastern corner of the Fernbank Community area, gradually thinning out to 2 to 0 metres thick over a bedrock high on the southwestern side of the study area, and then thickening to 2 to 3 metres at the southwestern boundary.

3.8.3 Hydrogeologic Conditions

The hydrogeologic conditions of the Fernbank Community are described in terms of infiltration potentials, groundwater recharge and discharge, and the groundwater flow systems. Infiltration rates are controlled by the nature of the surface and near-surface materials. The silty clay to clay soils have been characterized as poorly draining with a low rate of infiltration.

Both the Jock River Reach 2 and Mud Creek Subwatershed and the Carp River Subwatershed Studies have noted that sites with greater groundwater recharge potential will exist where the bedrock is close to the surface and the bedrock surface and surficial materials are relatively permeable.

For the Carp River Watershed, it has been reported that a total of 50% of the watershed's groundwater recharge is provided by 30% of the land area, and primarily by lands located in southern part of the watershed (Robinson, 2001; 2004). However, the soils within the Fernbank CDP lands tributary to the Carp River consist mainly of sensitive marine silty clay, which has a very low groundwater recharge potential. The Carp River Subwatershed Study[1] identifies the groundwater recharge potential within this area to be less than 100mm/yr.

For the Jock River Watershed, bedrock is closest to the surface in the northern, western and southern parts of the watershed. As described above, the Fernbank Community area straddles the divide between these watersheds. Being in the southern part of the Carp River watershed and in the northern part of the Jock River watershed, the study area is within those parts of both watersheds that have been identified as generally having greater recharge potential. The parts of the study area which possess the greater recharge potential characteristics are located in the southwestern / southcentral part of the study area.

The regional groundwater study identified the existence of two main groundwater flow systems: one flow system in the bedrock and another one in the overburden deposits. For the bedrock groundwater flow system, the Fernbank Community site is mapped mostly as a transitional area. Groundwater flow is

[1] Carp River Watershed/Subwatershed Study - Figure 3.4.31 - Groundwater Recharge Potential (Robinson Consultants, December 2004)

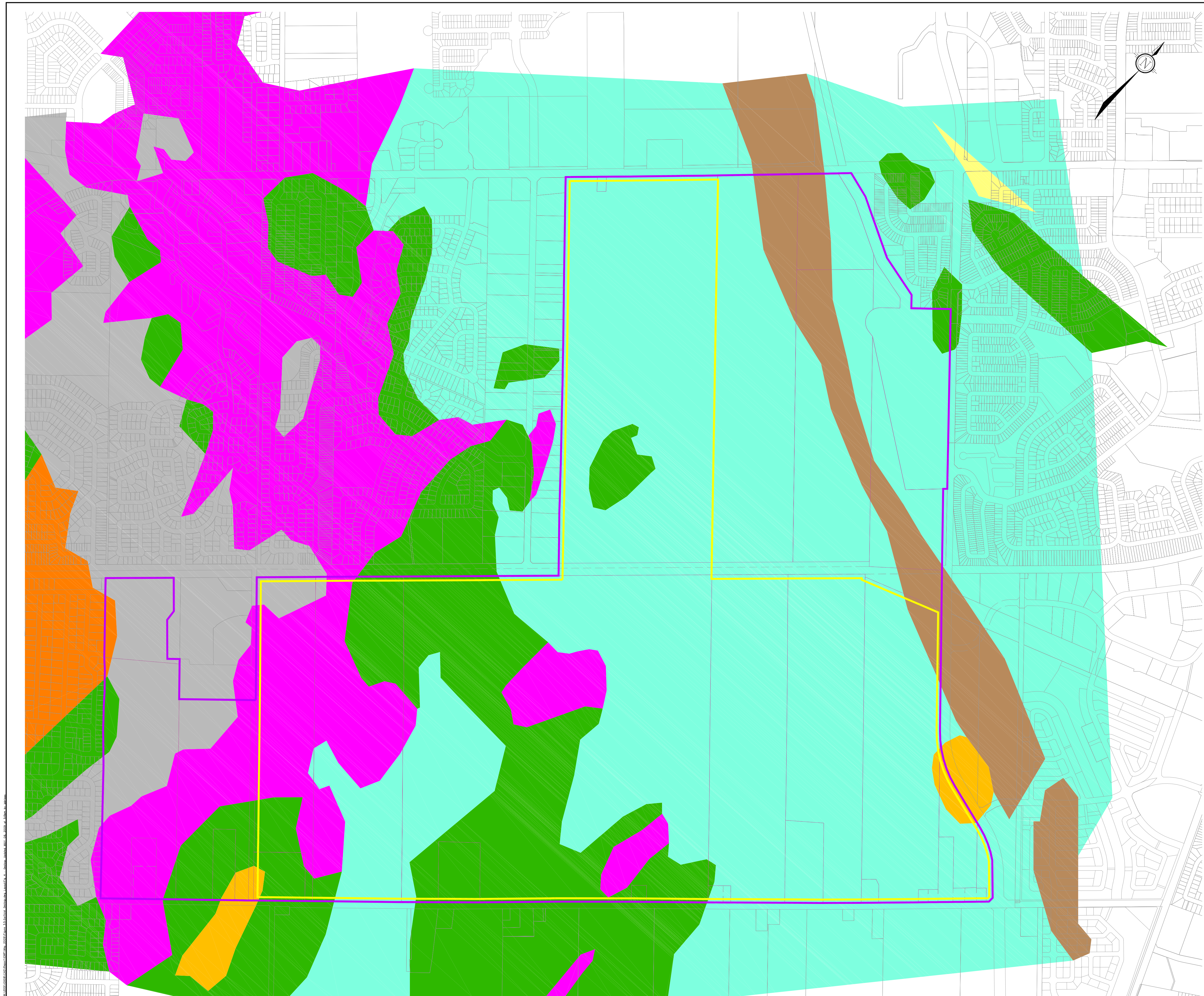

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FIGURE 3.5

Existing Conditions

Surficial Geology

STUDY AREA

DESIGNATED LANDS
LANDS OWNED BY DEL, BROOKFIELD, WESTPARK AND OTHERS. SUBJECT TO OMB ORDER No. 2092, 3352 and 1604.

Thick Organic Deposits (such as Peat)

Thin Discontinuous Organic Deposits

Beach formations, composed of sand and sand and gravel

Reworked glaciofluvial deposits of fine to medium sand

Deposits of sensitive marine silty clay

Glaciofluvial deposits of sand and gravel

Glacial Till

Paleozoic Bedrock

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet
SCALE : Not to Scale -Report

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NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

thought to be generally from west to east beneath the study area and trending north-northeastward and south-southeastward in the more northern and southern parts of the area, respectively.

3.8.4 Groundwater Discharge/Recharge

With respect to groundwater discharge, low water levels and the lack of baseflow are of concern for both of the Carp River and Jock River Watersheds' tributaries. The majority of stream reaches within the Fernbank Community area are completely dry during summer months and appear not to carry much water throughout the year. However, just beyond the far eastern corner of Fernbank Community area and downstream of the Monahan Drain's tributaries that originate in the area, colder baseflow in the Jock River system has been recorded.

The recharge associated with the flow systems supplying this groundwater discharge may be local and/or may be from more indirect recharge. If groundwater discharge is coming from geologic units at depth, including the underlying bedrock, the associated recharge areas could be through more permeable materials at a distance, such as those to the west in the Fernbank Community area. As noted above, the greater groundwater recharge potential exists where the bedrock is close to the surface and the bedrock surface and surficial materials are relatively permeable. Maintenance of baseflow in the various tributary watercourses will require preservation of both the recharge potential (e.g. promote infiltration in appropriate areas) and discharge potential (e.g. preservation/enhancement of natural channels).

3.8.5 Aquifer Vulnerability

CH2MHill and Waterloo Hydrogeologic (2001) assessed the relative vulnerability of the aquifers underlying the City of Ottawa. The land areas where the underlying groundwater resources are susceptible to contamination introduced at the ground surface were identified. The vulnerability analysis was tailored to evaluate the susceptibility of the overburden bedrock interface aquifer. This is because the study concluded that the majority of wells in the City obtain their water supply from this contact zone aquifer.

The aquifers underlying the Fernbank Community area have very low to high vulnerability to contamination from land use and materials on the surface. Generally the parts of the study area that have thicker coverage of the silty clay are rated as having low vulnerability; the parts where these fine-grained deposits are thinner or not present are rated as having medium vulnerability. The high vulnerability rating covers parts of the study area that have thin to no overburden coverage and/or coverage by more permeable materials.

The vulnerability study reported that in the former Goulbourn Township and adjacent areas, the vulnerability is strongly controlled by the shallow depth to water table. As well, the bedrock aquifers are closer to ground surface than in other areas of the City. The vulnerability is further increased in areas of higher recharge potential. As noted in the vulnerability study report a limitation of the approach used is that it did not account for other factors that determine how a potential contaminant source may be introduced to the environment. The example given is the role well and septic system construction play in the actual risk of contamination being introduced to the aquifer or environment. Poor well construction, poor well maintenance and improperly abandoned wells can lead to direct connections between the ground surface and the aquifer. These direct connections "short circuit" the protection afforded the aquifer by the overlying overburden. Poorly constructed and/or maintained, or improperly abandoned systems pose a greater threat of contamination than those systems and wells that have been properly constructed, maintained and properly abandoned.

3.8.6 Water Supply Wells

The rural dwellings and farms in and adjacent to the Fernbank Community lands have their own private water supply wells. Ontario's provincial well record system was established in the 1940's. It is quite likely that farm homesteads were established in the Fernbank Community area before that time, and there could be wells within the study area for which there may be no record on file. A review of historical photos was conducted as part of the hydrogeologic investigation to locate the sites of old homesteads within the area and the potential sites of old wells. A map showing the locations of wells from MOE records, as well as old homesteads that may have had water supply wells is provided as **Figure 3.6**.

The logs from local wells indicated that there are potentially three aquifers that supply the wells of the Fernbank Community area and vicinity:

- Paleozoic Bedrock Aquifer –The groundwater is stored in and flows through the pore space provided by bedrock bedding planes, fractures and joints. Wells drawing on this aquifer are completed in the bedrock.
- Overburden and Paleozoic Bedrock Interface Aquifer – The groundwater is stored in and flows through the pore space provided by pores within the overburden material and the fractured upper strata of the underlying bedrock, which are all overlain by more than 10 metres of clay. Wells drawing on this aquifer are completed into the bedrock and are open to the bedrock / overburden contact zone.
- Lower Overburden Aquifer – Groundwater is stored in sand, gravel and potentially coarse-grained till deposits found at depth below more than 10 metres of clay. The groundwater has accumulated in and flows through the pore space of these buried unconsolidated deposits. Wells drawing on this aquifer are completed in the overburden.

Most of the wells within the Fernbank Community are developed in the Paleozoic Bedrock Aquifer. Of the fourteen wells recorded in the provincial Water Well Information System, eight are Paleozoic bedrock aquifer wells, one and possibly two are Overburden and Paleozoic Bedrock Interface Aquifer wells, and four are Lower Overburden Aquifer wells.

Well records for the water supply wells within the Fernbank Community and adjacent areas (former Goulbourn Township, Conc. X/XI, and Lots 26-30/28) are available in the existing conditions hydrogeology report (J.F. Sabourin, September 2007).

3.8.7 Tile Drains

Parts of the Fernbank study area have tile drainage systems installed to provide improved drainage for agricultural purposes. Discharge from tile drainage systems is typically more turbid than natural system groundwater discharge. The tile drainage systems typically lower the water table in the drained areas, and tend to alter the baseflow characteristics in the outlet watercourses. Tile drainage systems provide a preferential pathway for storm runoff to enter the receiving watercourse, thereby decreasing the response time to a storm event. Tile drains also tend to reduce the duration of baseflow by quickly reducing the soil water content. When the water table is already lower than the tile drainage, the drainage systems would augment interflow (the lateral drainage of groundwater in the unsaturated zone) and its discharge to local water courses.

The Fernbank Community is located at the headwaters of the Monahan, Carp, Flewellyn and Faulkner Subwatersheds, and there is no upstream tile drainage entering the Fernbank Community lands.

GIS data has been used to identify the known locations of tile drains within the vicinity of the Fernbank Community. The tile drain locations are shown on **Figure 3.7**. There may be additional tile drains within the study area which are not in the GIS database.

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FIGURE 3.6

Existing Conditions

Water Supply Wells

STUDY AREA

DESIGNATED LANDS

1932 HOMESTEADS

1963 HOMESTEADS

1996 HOMESTEADS

LOCATION OF WELLS FROM MOE WELL RECORDS

1502930
Date: 1949
Formations: Blue Clay 0020
Grey Limestone 0068
Elevation 330 feet
UTM: 428700 / 5014710

1502811
Date: 1949
Formations: Blue Clay 0020
Clay Boulder 0025, Limestone 0054
Elevation 355 feet
UTM: 429930 / 5012320

1502815
Date: 1949
Formations: Clay 0115
Gravel 0122, MSND 0123
Elevation 320 feet
UTM: 431230 / 5014070

1511614
Date: 1971
Formations: Brown Clay Boulder 0019,
Grey Limestone 0080
Elevation: 320 feet
UTM: 429980 / 5012320

1502813
Date: 1967
Formations: Red Loam 0015
Grey Limestone 0080
Elevation 350 feet
UTM: 430140 / 5012640

1522587
Date: 1988
Formations: Brown Clay Boulder packed 0016, Grey Sand loose Boulder 0020,
Grey Limestone Gravel Forced 0027,
Grey Limestone LYRD MGRD 0065
Elevation: N/A
UTM: 431184 / 5013941

1502814
Date: 1949
Formations: Clay 0115
Gravel 0122, MSND 0123
Elevation 320 feet
UTM: 431510 / 5013720

NOTE: SMALL LAND HOLDINGS ARE NOT LABELLED ON THIS PLAN.

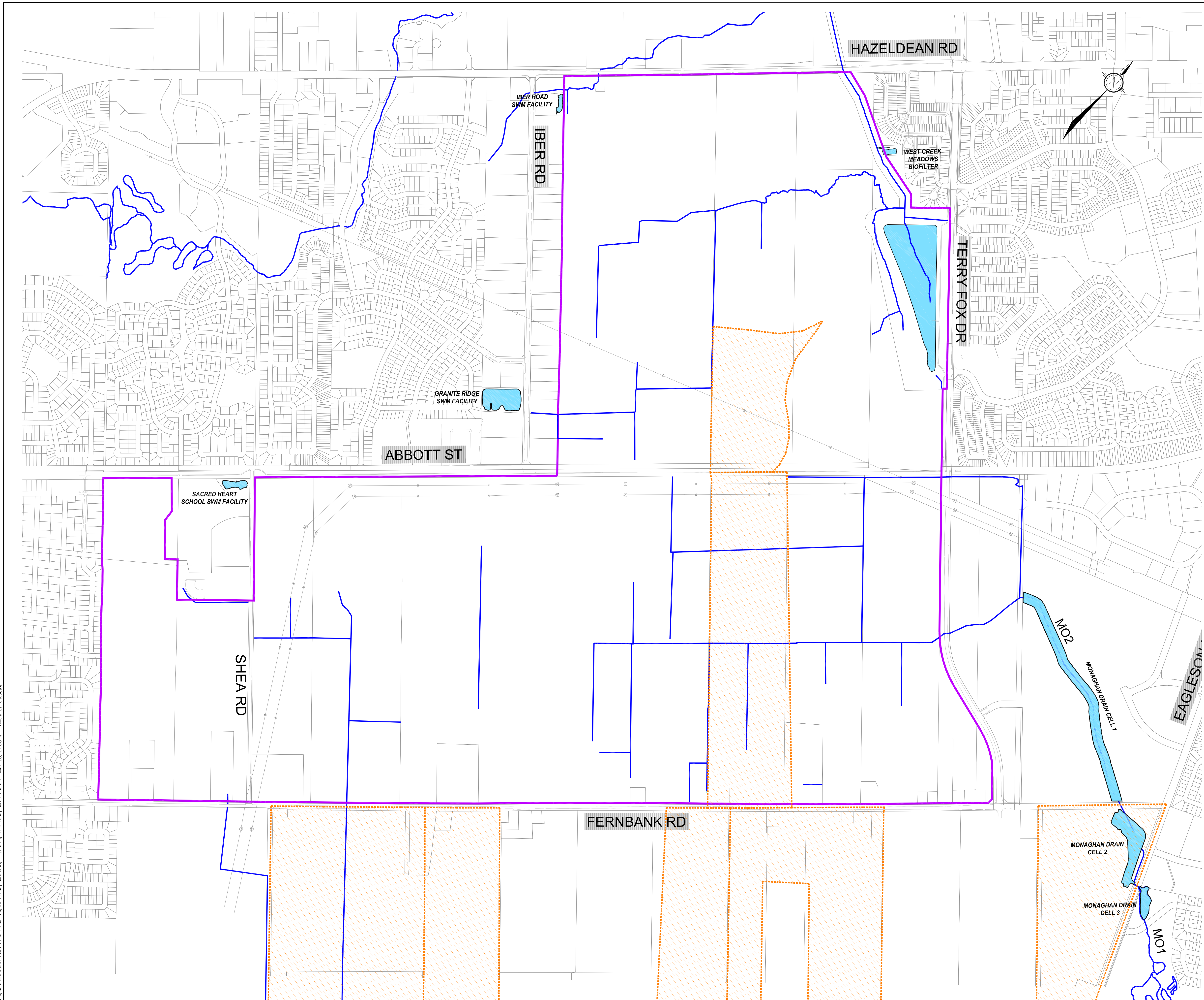
SOURCE AND DATE OF AERIAL PHOTOS:
a) FERNBANK CDP LANDS: BASE MAPPING CO. (JUNE 2006)
b) BACKGROUND COMMUNITY: GOOGLE EARTH MAP (YEAR VARIES)

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet
SCALE : Not to Scale -Report

SEPTEMBER 2008

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email novainfo@novatech-eng.com



FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 3.7

Existing Conditions

AGRICULTURAL TILE DRAINS

STUDY AREA

STREAMS

TILE DRAIN AREAS

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet

SCALE : Not to Scale -Report

MARCH 2008

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

3.9 Fluvial Geomorphology

The geomorphology analysis has been used to define cumulative headwater functions within the Fernbank Community; identify linkage with local and regional hydrology; develop recommendations for stream corridors; and to identify opportunities with respect to stream restoration and ultimately in the development of restoration concepts.

Reach boundaries have been identified based on channel morphometrics and natural controls (geology and hydrology) which alter the form and function of most drainage basins. Local geology influences the drainage pattern, the spatial distribution of water and sediment inputs (i.e. quantity and type). The drainage basin hydrology controls the amount and rate of water entering the channel network. These natural controls are modified by human activity. Channels are modified directly (e.g. channel straightening, realignment and constriction) and indirectly through land use changes, which in turn influence the hydrologic cycle and sediment inputs (e.g. clearing of land, increased urbanization and impermeable surfaces). These controls are discussed in detail, providing the background information for the geomorphic analysis presented in this section.

A map of stream reaches and reach breaks for watercourses included in the fluvial geomorphology analysis is provided as **Figure 3.8**.

3.9.1 Historical Assessment

Historical aerial photographs were used to determine changes in channel flow path and land use in the area. Aerial photographs from 1953, 1978, and 2002 were used in this analysis. The land use of the study area itself has remained predominantly agricultural over the last 50 years. The south-west corner of the study area was predominantly forested. However, land use surrounding the study area has changed. Residential developments appeared between 1953 and 1978 north-east and south-west of the study area. Between 1978 and 2002 a school was built in the south-west corner off of Shea Road. Development further increased between 1978 and 2002. The reaches containing natural sinuous channel were surrounded by trees and therefore migration rates could not be determined. The straightened channels were not visible in the aerial photographs and therefore no change could be observed. While there has been urban development surrounding the study area, this does not appear to have impacted the study area itself, which has remained primarily agricultural. The straightened reaches appear to have been straightened for agricultural purposes.

3.9.2 Field Reconnaissance

Field walks were undertaken along the channels identified in **Figure 3.8** in order to provide a characterization of existing geomorphic conditions. In order to provide a holistic evaluation of the potential impacts of development, field investigations were undertaken for both on-site channels and channels outside of the study area that could potentially be impacted by the proposed land use change. This robust data set offers the benefits of not only informing any restoration efforts, but also provides for the development of performance targets for sections of channel which will be receiving flows from the developed lands.

This field reconnaissance determined the majority of the reaches in the study area to be drains and geomorphically stable (RGA scores of Stable). Based on the RGA and RSAT results, detailed sites were chosen based on sensitivity analysis from the RGA and RSAT walks. In total, eight reaches were subjected to detailed analysis:

- Five of the sites (J5, J37, C12, C13, and C35) were located within the limits of the Fernbank Community study area.
- The three remaining sites (FA1, FL4, MO2) were located outside of the study area in locations that could potentially be impacted by the proposed change in land use.

FERNBANK COMMUNITY DESIGN PLAN

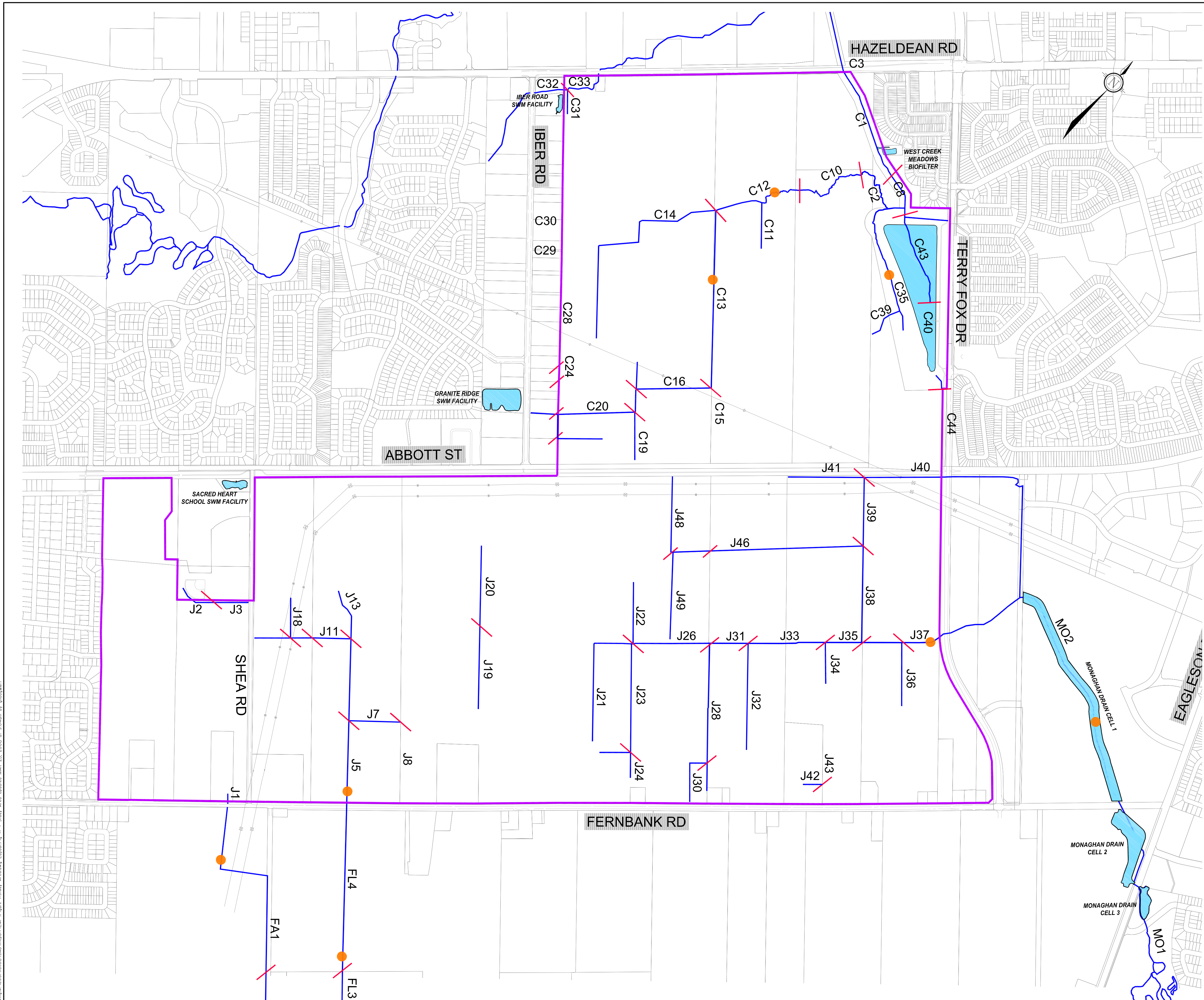
City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 3.8

Existing Conditions

Fluvial Geomorphology Stream Reaches



STUDY AREA

REACH BREAK

STREAMS

DETAILED MONITORING SITE

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet

SCALE : Not to Scale -Report

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3.9.3 Erosion Thresholds

The erosion threshold represents the discharge at which sustained flows will tend to entrain and transport sediment. Selection of an appropriate threshold was dictated, in part, by indicators of active geomorphic processes identified through the rapid assessment phase, as well as convergence within the erosion assessment models; the underlying assumptions upon which the models are based; and whether these assumptions can be deemed applicable to the particular site. The erosion threshold analysis ultimately involved the determination of a critical discharge based on the entrainment of the D_{50} or median grain size, which is the general practice.

In all cases, a comparison between the critical discharge and bankfull flow was made to determine whether the bed is fully mobilized around bankfull flows. This implies that sediment can be entrained below bankfull flows and that any increase in discharge within these systems will lead to increased sediment transport and would likely exacerbate channel erosion. The resultant threshold values represent performance targets that must be considered when developing a stormwater management plan for the study area. Since they are based on the most sensitive portions of the drainage system, they are inherently conservative and are meant to ensure that channel erosion processes are not exacerbated in the post-development phase.

It should be noted that erosion is a natural process that must occur within a channel in order to maintain a state of equilibrium. As such, the threshold is meant to be exceeded. The overall goal is to ensure that post-development conditions do not see a substantial increase in the frequency or duration of flow events which are in excess of the established thresholds from pre-development conditions. This will ensure that the receiving channels do not experience higher than normal rates of erosion. Erosion thresholds can also be used to inform any rehabilitation measures being undertaken as part of the development process by providing insight into the design of enhancement features and the ultimate channel configuration.

The critical and bankfull discharges derived for the detailed field sites are as listed in **Table 3-7**.

Table 3-7: Average Bankfull and Erosion Threshold Parameters

Reach ID	Location	Critical Discharge[1] (m^3/s)	Bankfull Discharge[2] (m^3/s)
C12	Carp River Tributary - Lower Reach	1.70	4.67
C13	Carp River Tributary - Upper Reach	2.90	3.58
C35	Carp River Tributary adjacent to Glen Cairn Pond	0.24	1.40
J37	Monahan Drain U/S of Terry Fox Drive	1.60	6.80
MO2	Monahan Drain D/S of Terry Fox Drive	0.10	2.10
J5	Flewellyn Drain U/S of Fernbank Road	7.60	1.72
FL4	Flewellyn Drain D/S of Fernbank Road [3]	0.20	0.43
FA1	Faulkner Tributary D/S of Fernbank Road	0.83	1.91

1 Critical discharge is defined as the flow associated with insipient motion of the D_{50} (median grain size).

2 Bankfull discharge is defined as the channel-forming stage, generally associated with a 1.5 to 2-year return period.

3 The critical discharge values given for the Flewellyn Drain represent the values for the most sensitive reach between Fernbank Road and Flewellyn Road.

These bankfull and critical flow thresholds have been used in conjunction with continuous hydrologic modeling to evaluate the existing channels and to ensure that the performance targets being established are appropriate, given local flow conditions. Details of the continuous hydrologic modeling analysis are provided in Section 8.3.

3.9.4 Monitoring

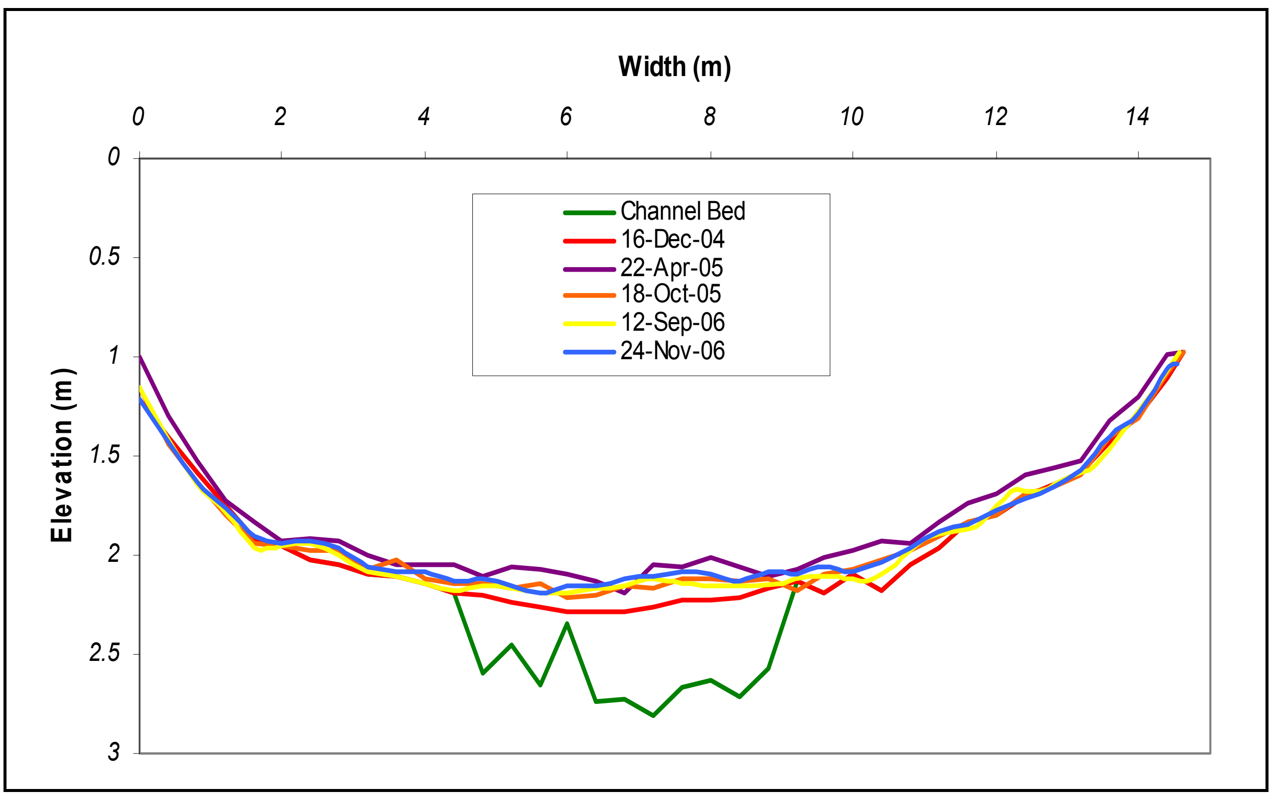
Monitoring cross-sections are frequently installed to assess the long-term stability of streams and watercourses. If they are set up at an appropriate time, they can provide a baseline for channel evolution when there has been disturbance upstream.

Work had been done on the main branch of the Carp River in 2004, at which time a monitoring cross-section was installed as part of that project (CR-1). As part of the fluvial geomorphological assessment, this cross-section was re-monitored when the preliminary field reconnaissance was completed as well as when detailed field work was done. Four additional monitoring sites have been established within the study area (C12, C13, J5, J37). Monitoring locations are identified on **Figure 3.8**.

Carp River U/S of Hazeldean Road - Monitoring Site CR-1

Figure 3.9 shows the monitoring cross-section established on the Carp River upstream of Hazeldean Road (Site CR-1). In December 2004, the channel bed (green line) was surveyed, in addition to the top of unconsolidated sediment (red line). Over the two years of monitoring, the extent of this unconsolidated sediment has varied, indicating alternating periods of aggradation and erosion over time. Specifically, the channel appears to have experienced aggradation between December 2004 and April 2005, followed by a period of erosion in October of 2005, and subsequent accumulation over 2006.

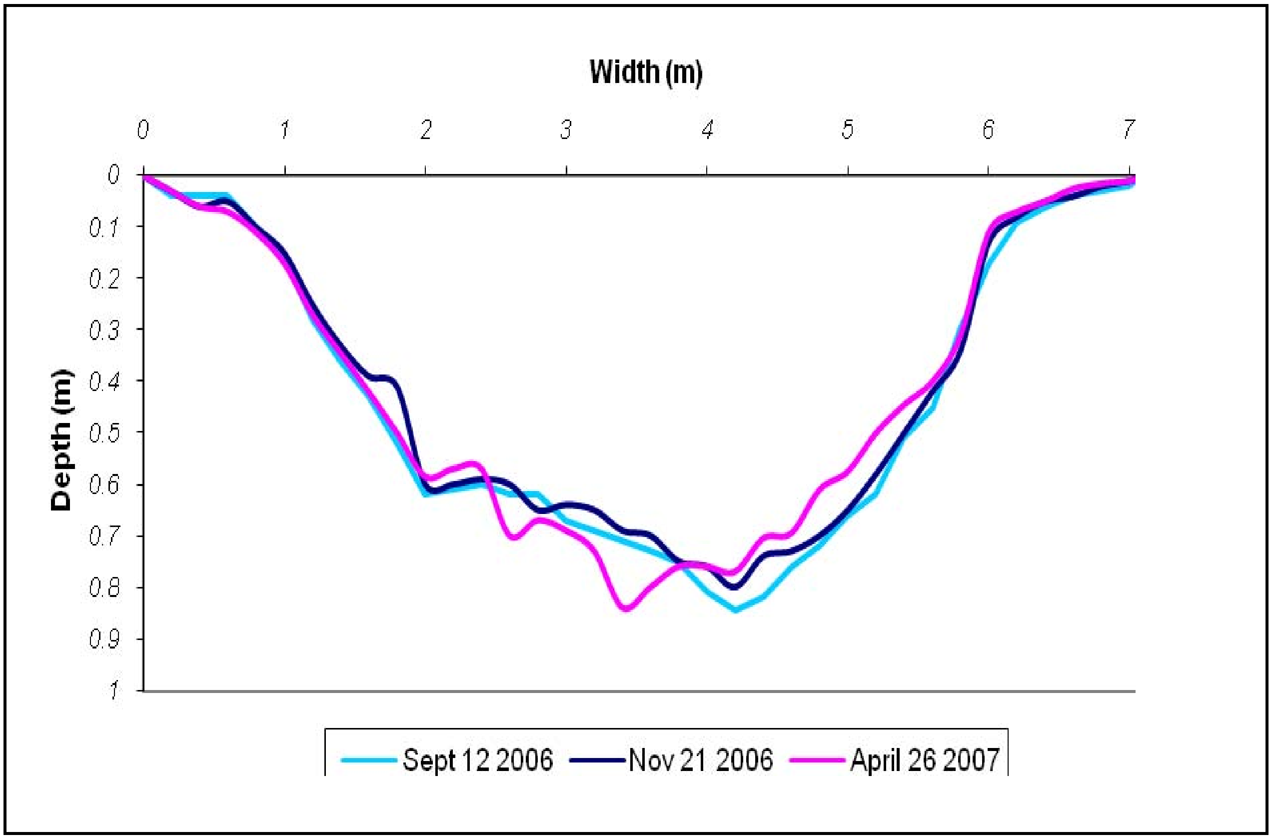
Figure 3.9 Monitoring Cross-Section CR-1



Carp River West Tributary Lower Reach - Monitoring Site C12

Figure 3.10 shows the monitoring cross-section established on the lower reach of the Carp River West Tributary (Site C12) in September 2006. Although the first monitoring interval was only two months, there appears to have been some accumulation of sediment on the river bed, particularly in the deepest part of the channel (thalweg). The second monitoring interval was 5 months later following the spring freshet and shows the re-establishment of a thalweg along the center of the channel, along with the re-working of sediment deposits along the channel margins. Overall, the channel cross-sectional area decreased over the entire monitoring period by 3.6%. Erosion pin monitoring results at the cross-section indicated an average bank erosion rate of 7.6 cm/year.

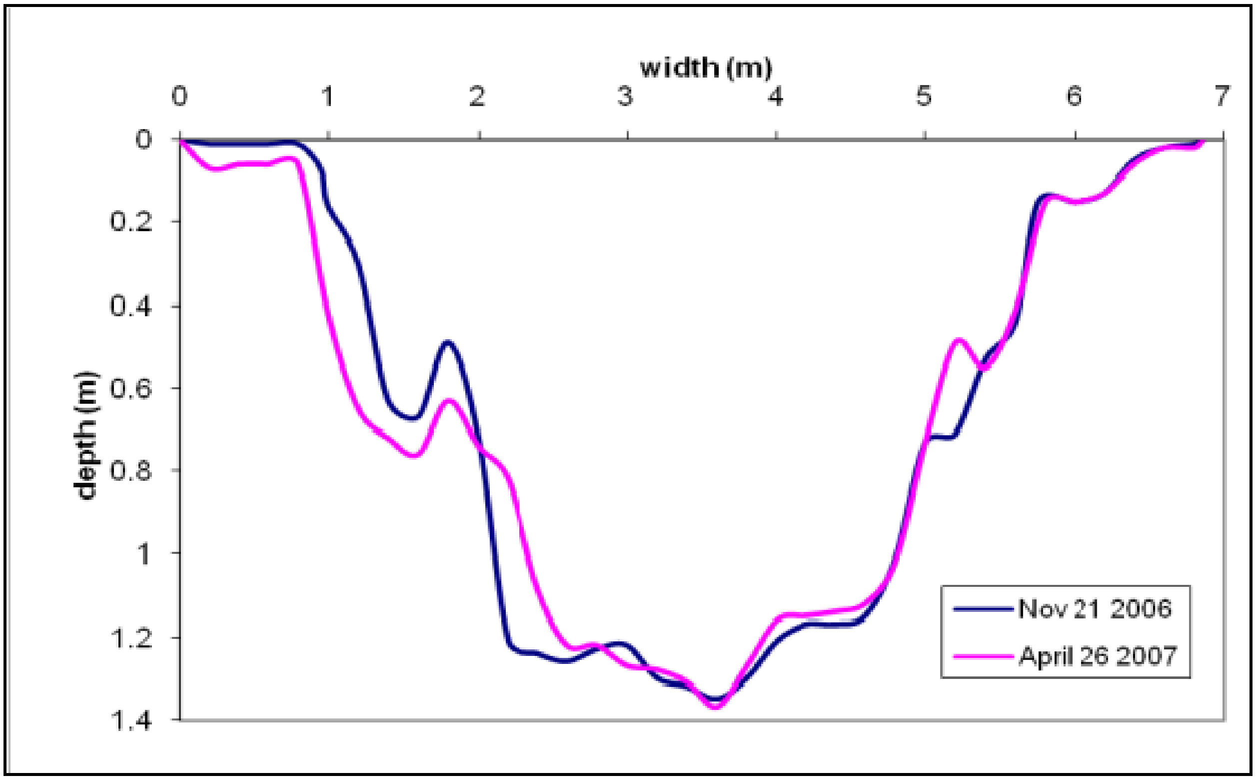
Figure 3.10 Monitoring Cross-Section C12



Carp River West Tributary Upper Reach - Monitoring Site C13

Figure 3.11 shows the monitoring cross-section established on the upper reach of the Carp River West Tributary (Site C13) in November 2006 and the subsequent re-monitoring in April 2007. The upper portion of the left bank appears to have experienced erosion and slumping over this period of time. Minimal erosion and deposition occurred elsewhere in the monitoring cross-section. Cross-sectional area increased by 1.3% over the 5 month monitoring interval. Erosion pin monitoring results, meanwhile, indicated average bank erosion rates of 5.9 cm/year on the left bank and 1.3 cm/yr along the right bank.

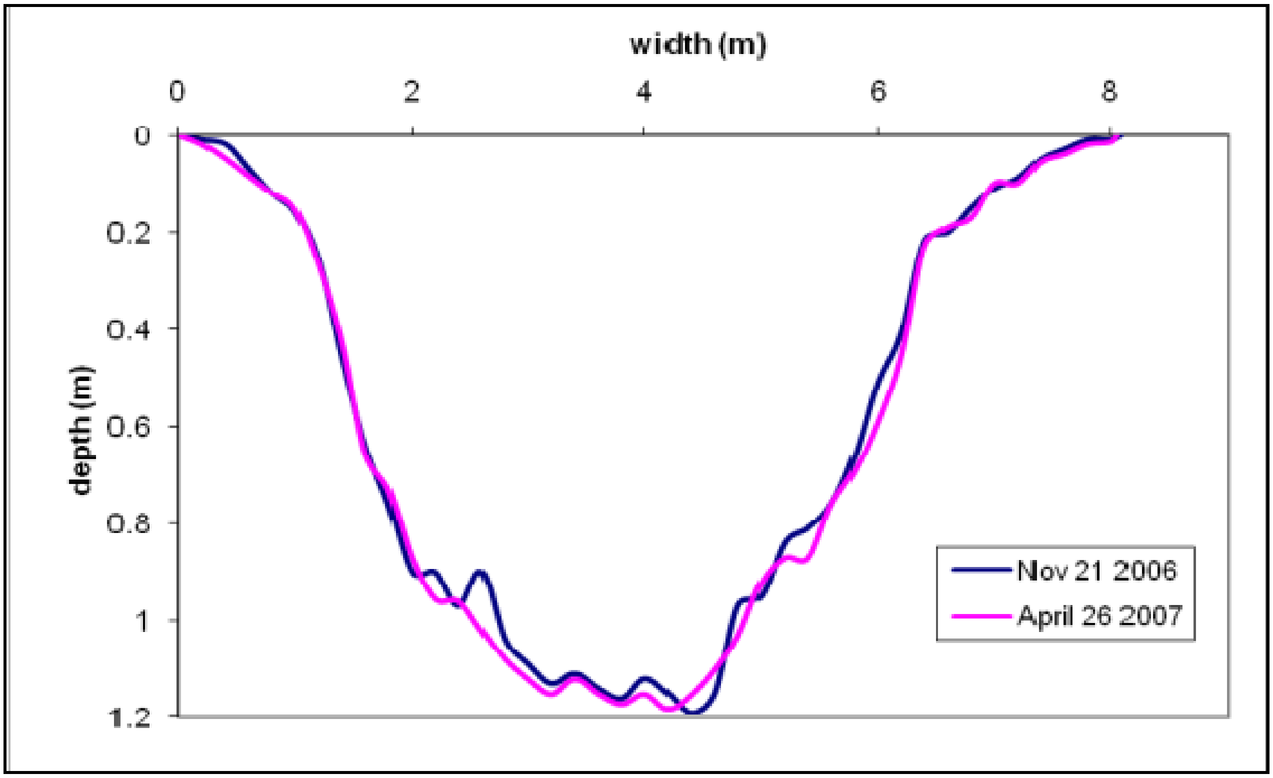
Figure 3.11 Monitoring Cross-Section C13



Flewellyn Drain U/S of Fernbank Road - Monitoring Site J5

Figure 3.12 shows the monitoring cross-section established in the Flewellyn Drain upstream of Fernbank Road (Site J5) in November 2006 and the subsequent remonitoring in 2007. The cross-section showed minimal changes to the cross-sectional area, although there was some minor scour and deposition evident on the bed. Cross-sectional area increased by 2.3% over the 5 month monitoring interval. The erosion pin on the left bank indicated erosion rates of 2.5 cm/year while that on the right bank indicated rates of 0.4 cm/year.

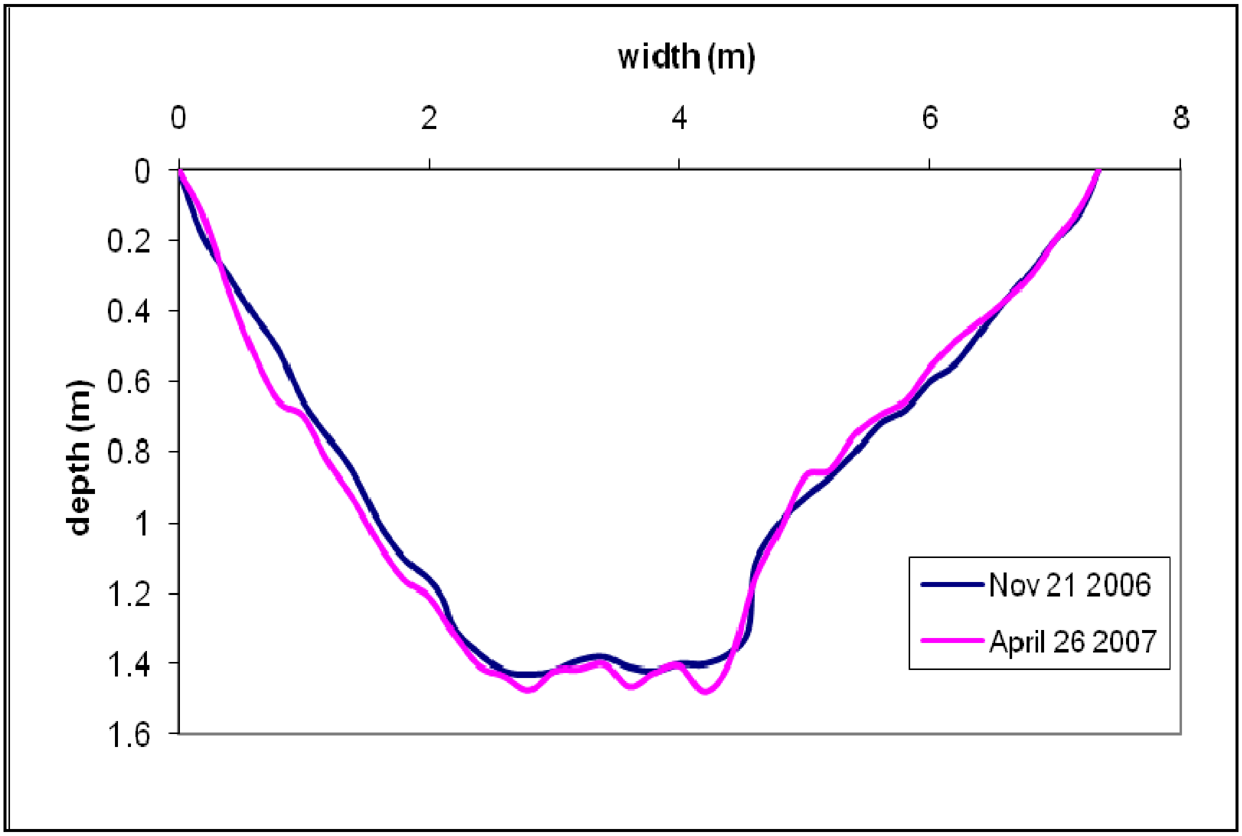
Figure 3.12 Monitoring Cross-Section J5



Monahan Drain U/S of Terry Fox Drive - Monitoring Site J37

Figure 3.13 shows the monitoring cross-section established in the Monahan Drain upstream of Terry Fox Drive (Site J37) in November 2006 along with the subsequent remonitoring in April 2007. The cross-section showed small amounts of erosion of the left bank and the river bed. Cross-sectional area increased by 1.9% over the 5 month monitoring interval. The erosion pin on the left bank indicated deposition rates of 2.5 cm/year while that on the right bank indicated deposition rates of 4.2 cm/year.

Figure 3.13 Monitoring Cross-Section J37



3.9.5 Summary

Overall, the general stability of the reaches in the study area was good. However, the majority of the reaches were heavily vegetated drains. At the time of the RGA and RSAT walks, many of the drains were completely dry. The detailed sites revealed that reaches J5 and J7 were very uniform and trapezoidal in shape. There was slightly more variability in C13, however the channel cross-section remained trapezoidal. Reach C12 displayed the greatest variability in cross-section as it was the only natural and sinuous channel in the study area. Overall, critical discharges for the area were found to be fairly high, which is expected with a heavily vegetated system that is not overly sensitive to fluctuations in flow. If storm water runoff is managed effectively once development begins, and if sufficient riparian vegetation is left to buffer the reaches, the study area should remain fairly stable.

3.10 Riparian Corridors

3.10.1 Official Plan Policy

Section 4.7.3 of the City of Ottawa Official Plan outlines the policies for Erosion Prevention and Protection of Surface Water:

1. *Except as otherwise provided for in this section, Council will establish minimum setbacks from rivers, lakes, streams and other watercourses in watershed, subwatershed and environmental management plans in these plans identify any additional studies needed to revise the setback through the development review process as well as any site specific measures needed to protect the setback [OMB decision # 1754, May 10, 2006]*

2. *Where a Council-approved watershed, subwatershed, or environmental management plan does not exist, the minimum setback will be the greater of the following:*
   a. *Development limits as established by the regulatory flood line (see Section 4.8.1);*
   b. *Development limits as established by the geotechnical limit of the hazard lands;*
   c. *30 metres from the normal high water mark of rivers, lakes and stream, as determined in consultation with the Conservation Authority; or*
   d. *15 metres from the existing top of bank, where there is a defined bank. [OMB decision # 1754, May 10, 2006]*

Carp River Subwatershed Study

Section 8.4.2 of the Carp River Subwatershed Study provides the minimum the aquatic setback requirement for watercourses within the Carp River portion of the study area:

Based on the discussion in Section 8.2.3.1, the riparian corridor width and restoration target for aquatic habitat protection in the subwatershed are as follows:

- *Type 1 fish community – Poole Creek & Feedmill Creek: 30 metre setback on each side of the watercourse; revegetating up to 75% of the total stream length with native, woody, riparian vegetation (representing 50% of the replanted area)*
- *Type 2 and 3 fish community – Carp River and Glen Cairn Tributary: 15 metre setback on each side of the watercourse; revegating up to 50% of the total stream length with native, woody, riparian vegetation (representing 50% of the replanted area)*
- *Intermittent watercourses including Hazeldean tributary: 15 metre setback on each side of the watercourse; revegating up to 50% of the total stream length with native, woody, riparian vegetation (representing 50% of the replanted area)*

All tributary watercourses within the Carp River Subwatershed portion of the Fernbank Community have been classified in the CRSWS as either Type 2 or 3 fish communities, or as intermittent watercourses. Therefore, the aquatic setback requirements have been established based on a minimum 15 metre setback from the top of bank on each side of the watercourse, as per the recommendations of the Carp River Subwatershed Study.

The Monahan Drain is an intermittent watercourse that provides indirect fish habitat. A 15 metre setback requirement has been established for the Monahan Drain based on the same criteria as those for watercourses within the Carp River portion of the Fernbank Study area.

3.10.2 Riparian Corridor Evaluation

The watercourses within the limits of the Fernbank Community study area have been evaluated and watercourses to be preserved and/or enhanced have been selected through evaluation and discussions with the approval agencies. Riparian corridor widths for these corridors have been established based on the sensitivity of the fish habitat and geomorphic characteristics determined as part of the field investigations.

Watercourses identified for protection and restoration are: The lower reach of the Carp River West Tributary; Hazeldean Creek; and the main branch of the Monahan Drain.

The determination of the minimum riparian corridor width to support stream functions is dependent upon the following:

- aquatic buffers / aquatic habitat setback;
- meander belt widths; and
- floodplain limits;

<u>Aquatic Habitat Setback</u>

Since aquatic buffers are applied to the edge of channel, they are independent but often accommodated by the meander belt width. The aquatic buffers for watercourses to be preserved within the limits of the Fernbank Community have been established with the objective of protecting and encouraging enhancement of the fish and aquatic habitats. For all watercourses within the Fernbank community, the aquatic habitat buffer has been established as a 15 metre setback from the top of bank on each side of the watercourse.

<u>Meander Belt Width</u>

The meander belt width is defined as the corridor in which a river or channel migrates laterally. The meander belt width provides a measure of the area in which river processes occur and are likely to occur in the future, and is used as a tool for managing risk from river erosion and protecting the long-term integrity of a watercourse.

For the lower reach of the Carp River tributary, the existing reach has been maintained with a natural planform and the meander belt width has been determined accordingly.

Due to the extensive degree of channel alteration for the remainder of channels within the study area, surrogate or reference reaches were used to provide the basis for determining appropriate meander belt width dimensions within the Fernbank Community study area. Meander belt widths were then assigned on a reach basis according to the surrogate values. From a geomorphic perspective, a 10% factor of safety was applied to each side of the meander belt width (for a total of 20%) to account for any future adjustments in stream planform due to meander migration and/or channel widening.

Reaches with a 15 meter meander belt width had an additional aquatic setback to be incorporated into the corridor width. This setback was calculated to be 12 meters (15 meter aquatic buffer minus the 3 meter factor of safety associated with the meander belt width). It should be noted that these setbacks are meant to be distributed equally across the meander axis, but will never be less than 15 m from the top of bank.

Floodplain Limits

The floodplain limits are defined by regulatory authorities (RVCA / MVC). The regulatory floodline will represent the limits of the defined riparian corridors if it is greater than the aquatic habitat setback and the meander belt width. Any requirements for setbacks from the regulatory floodline should be reviewed and confirmed by the Conservation Authorities at the permit stage.

3.10.3 Riparian Corridor Widths

Table 3-8 lists the riparian corridor widths for channels recommended for retention (Lower Reach of the Carp River West Tributary, Hazeldean Creek, and the main branch of the Monahan Drain). The channel reaches are identified on **Figure 3.8**. The riparian corridor widths have been based on the greater of either:

- the aquatic habitat setback (from top of bank); or
- the meander belt width plus a 20% factor of safety.

Table 3-8: Riparian Corridor Widths for Channels Recommended for Retention

Reach	Riparian Corridor determined from Meander Belt Width				Riparian Corridor determined from Aquatic Setback		
	Meander Belt Width	**20% Factor of Safety**	**Aquatic Setback**	**Corridor Width**	**Aquatic Buffer**	**Bankfull Width**	**Corridor Width**
Carp River West Tributary (Lower Reach)							
C12	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
C10	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
Hazeldean Creek							
C32	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
C33	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
Monahan Drain (Main Branch)							
J26	15 m	3 m	12 m	**30**	15m + 15m	>10m	**40**
J31	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
J33	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
J35	30 m	6 m	--	**36**	15m + 15m	>10m	**40**
J37	30 m	6 m	--	**36**	15m + 15m	>10m	**40**

Overall, channels are dynamic; hence, setback should be a total corridor value. A riparian corridor width of 40 metres is recommended for all watercourses within the Fernbank Community study area. The proposed riparian corridor widths are supported by the fluvial geomorphic assessment and are in accordance with the recommendations of the Carp River Subwatershed Study.

The proposed riparian corridors are able to accommodate the provision of a multi-use recreational pathway. Pathways should be set above the 1:10 year flood elevations and outside the meander belt width, but can be located within the limits of the established riparian corridors (i.e. an additional setback for the pathways is not required).

Section 4.0 Existing Storm Drainage Conditions

4.1 Climate

Warm summers, relatively cold winters, a moderate growing season, and usually reliable rainfall characterize the local climate. Annual precipitation (rain + snow) in the City of Ottawa is approximately 944 mm/yr.

The study area is located at the headwaters of several different watersheds, and the hydrologic response is relatively rapid. Consequently, short-term climatic events, such as thunderstorms or extended hot-dry periods tend to exert greater influence on the hydrologic characteristics of the study area than long-term averages. An understanding of the hydrologic response of the study area depends on a detailed analysis of the topography, geology, and land use. The existing conditions studies completed for the Fernbank CDP have provided the information that has been used in the development of the hydrologic models.

4.2 Storm Drainage Areas

Detailed topographic mapping and aerial photography was used to refine the drainage areas used in the existing conditions hydrologic analysis of the Fernbank Community. The subcatchment areas used in the existing conditions analysis are shown on **Figure 4.1**.

Carp River Subwatershed

4.2.1 Carp River West Tributary

The Carp River West Tributary serves as the drainage outlet for an area of approximately 88.6 ha of land within the limits of the proposed Fernbank Community (Area 101-2). The Carp River West Tributary also serves as the outlet for the Granite Ridge SWM Facility and receives storm runoff from an upstream drainage area of approximately 74.3 ha within the Stittsville urban boundary (Area 101-3).

4.2.2 North of the Carp River West Tributary

The lands north of the West Tributary generally slope from west to east towards the Carp River, comprising an area of approximately 56.7 hectares (Area 101-1). There is no defined watercourse for this area. Storm runoff either sheet drains directly to the Carp River, or is captured by the roadside ditch on the south side of Hazeldean Road prior to outletting to the Carp River.

4.2.3 South of the Carp River West Tributary

The lands south of the Carp River Tributary generally slope from west to east towards the headwater reach of the Carp River, comprising an area of approximately 77.9 hectares (Area 500). The headwaters of the Carp River are located adjacent to the Glen Cairn SWM Facility.

4.2.4 Hazeldean Creek

Hazeldean Creek passes through the northwest corner of the site, just east of Iber Road. This watercourse receives storm runoff from an existing SWM facility within the Stittsville urban boundary and has an drainage area of approximately 62.17 ha upstream of Hazeldean Road (Area 100-1), comprised mainly of residential development. Hazeldean Creek passes under Hazeldean Road through a concrete box culvert and flows into the Carp River south of Maple Grove Road. Only a small portion of the subject lands in the northeast corner of the site are tributary to Hazeldean Creek.

FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

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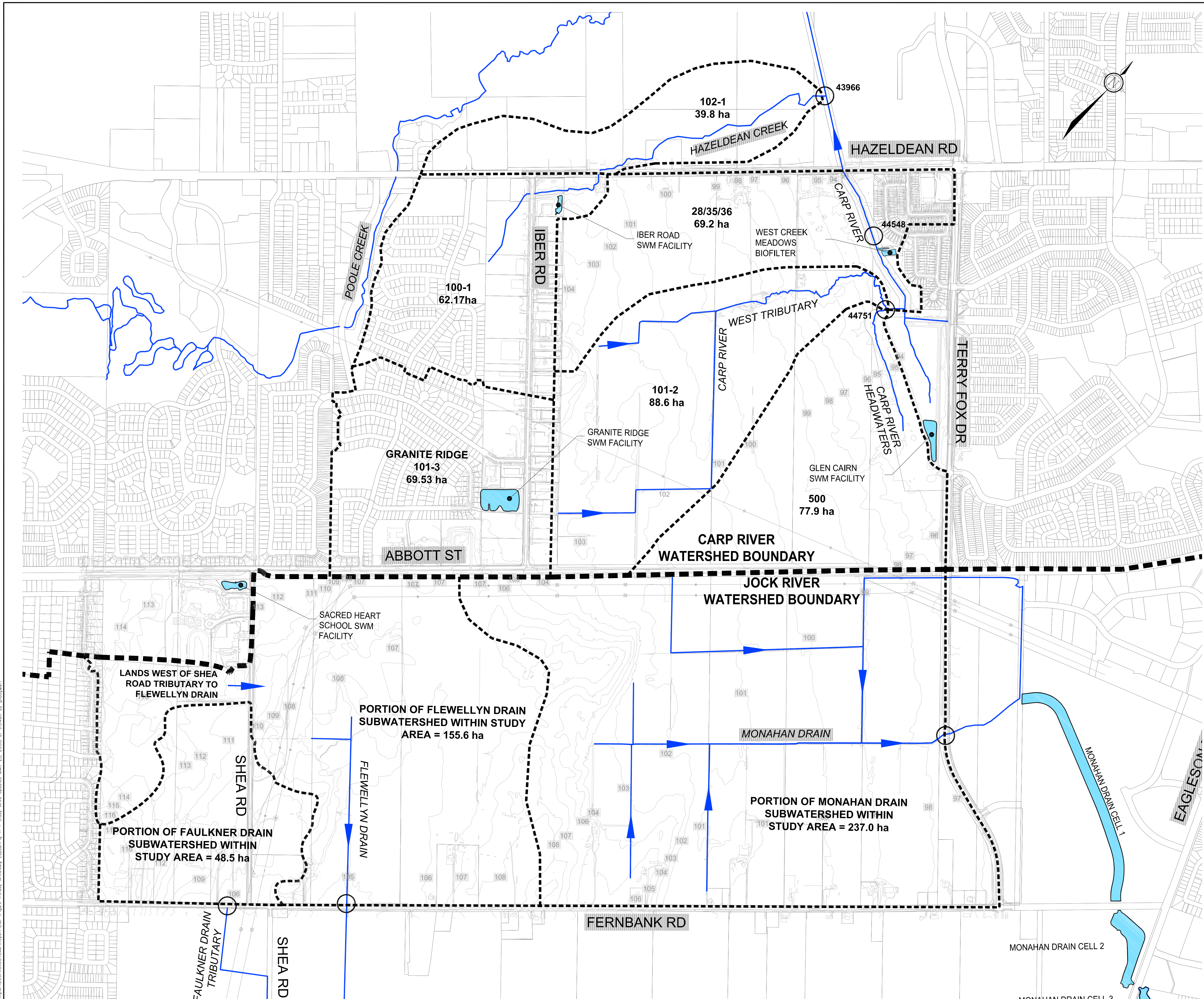
FIGURE 4.1

Existing Conditions

Storm Drainage Subcatchments



○ HYDROGRAPH LOCATIONS

44751 HEC-RAS INFLOW NODE ID (CARP RIVER ONLY)

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet NOVEMBER 2008

SCALE : Not to Scale -Report

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

Jock River Subwatershed

4.2.5 Faulkner Drain

Approximately 48.5 hectares of land in the southwest portion of the study area are tributary to the Faulkner municipal drain. Storm runoff from this area is conveyed overland in a southerly direction, through a culvert crossing Fernbank Road, to a tributary of the Faulkner Drain. The Faulkner Drain tributary starts on the south side of Fernbank Road, just west of Shea Road, and flows in a southerly direction, then turns east and outlets to the roadside ditch on the west side of Shea Road. The Shea Road ditch flows into the main branch of the Faulkner Drain at Flewellyn Road, which ultimately outlets to the Jock River at the village of Richmond.

4.2.6 Flewellyn Drain

Approximately 155.6 hectares of land in the southern portion of the study area are tributary to the Flewellyn municipal drain. The Flewellyn Drain starts approximately 280 m north of Fernbank Road, and flows in a southerly direction to Fallowfield Road, where it turns east and outlets to the Monahan Drain. The Flewellyn Drain has been straightened, and serves as a drainage outlet for the surrounding agricultural lands and as a roadside ditch on the north side of Fallowfield Road.

4.2.7 Monahan Drain

Approximately 237.0 hectares of land in the southeast portion of the study area are tributary to the Monahan municipal drain. The main branch of the Monahan Drain runs through the site in an easterly direction towards Terry Fox Drive. There are a number of smaller branch drains which connect to the main branch within the limits of the study area. All branches of the Monahan Drain within the limits of the study area have been straightened to follow the perimeter of the agricultural fields.

4.3 Hydrology

The existing conditions hydrologic analysis of the Fernbank community has been completed using the SWMHYMO hydrologic model. The existing conditions analysis is comprised of both event-based modeling (2-100yr), and continuous modeling using long-term rainfall data for the City of Ottawa.

The impact of development within the Fernbank Community on the receiving waters is a critical aspect in the development of a recommended stormwater management strategy for the study area. A detailed hydrologic analysis of existing conditions was completed to provide a benchmark for comparison and evaluation of post-development conditions. The existing conditions analysis includes:

- Identification of storm drainage subcatchments and drainage features within the study area;
- Development of hydrologic models for the Fernbank Community;
- Assessment of the hydrologic response of the various subcatchments;
- Comparison of the existing conditions models to approved hydrologic models.

4.3.1 Hydrologic Modeling - Jock River Subwatershed

Modeling parameters for lands within the Jock River subwatershed were initially taken from the OTTHYMO model developed for the *Monahan Drain Constructed Wetlands Final Design Report* (J.L. Richards, December 1993). This model has subsequently been updated to account for recent development upstream of the Monahan Drain Constructed Wetlands, as outlined in the *Monahan Drain Constructed Wetlands Phase 2 Final Design Report* (Novatech, October 2006).

The Phase 2 design for the Monahan Drain Constructed Wetlands (completed in 2006) took into account future development of both the SOHO West and Fernbank communities in sizing of Cells 1 and 2 of the constructed wetlands and the determination of peak flows and flood elevations through the facility and downstream. The 2006 design report for the Constructed Wetlands used the following assumptions for the Fernbank Lands:

- Development of the Fernbank Lands would retain the main branch of the Monahan Drain upstream of Terry Fox Drive;
- Fernbank lands tributary to the Monahan Drain would be serviced by 3 SWM facilities:
    - One SWM facility at the headwaters of the Monahan Drain;
    - Two SWM facilities on each side of the Monahan Drain immediately upstream of Terry Fox Drive.
- The proposed SWM facilities would control post-development peak flows to pre-development levels for all storms up to the 100-year event;
- The total drainage area tributary to the Monahan Drain upstream of Terry Fox Drive was assumed at approximately 296 hectares with an average imperviousness of 46%.

Provided that proposed development within the Fernbank Community conforms to the above, there will be no adverse impact on the design and operation of the Constructed Wetlands and no additional analysis of the downstream SWM facility will be required.

The RVCA published the *Jock River Flood Risk Mapping - Hydrology* Report in July 2004. This report outlines key hydrologic parameters and flood flows for various return periods for the Jock River and its major tributaries within the City of Ottawa. The RVCA model of the Jock River was calibrated using single station frequency analysis where streamflow gauging data was available. The Monahan, Flewellyn and Faulkner Drains are all tributary to the lower reach of the Jock River, defined in the context of the Flood Risk Mapping Study as the reach between Richmond and the Rideau River.

The RVCA hydrologic model for the lower reach of the Jock River has been calibrated using 34 years of flow data from the WSC gauge at Moodie Drive, and the model is considered to provide a good estimate of the 100-year flow.

The SWMHYMO model of the Monahan, Flewellyn and Faulkner Drains used in the Fernbank CDP study is much more discretized than the model used in the RVCA Jock River Flood Risk Study:

- The Jock River study models the entire Monahan Drain subwatershed as a single catchment, which includes both the Monahan Drain and Flewellyn Drains.
- The Fernbank CDP model has subdivided the Monahan Drain subwatershed into more than 20 catchment areas.

The existing conditions SWMHYMO model is based on the approved hydrologic model completed by Novatech as part of the *Monahan Drain Constructed Wetlands - Phase 2 Final Design Report* (Novatech, 2006). The only adjustment to the existing conditions model was the discretization of the Flewellyn Drain catchment area into several smaller subcatchments to allow for a detailed hydraulic analysis of the drain.

Monahan Drain/Flewellyn Drain

The Jock *River Flood Risk Mapping - Hydrology* Report provides a summary of modeled peak flows for return periods of 2 - 100 years at various hydrologic reference points along the Jock River. A comparison of the peak flows between the 1993 J.L. Richards model, the RVCA model and the Novatech model created for the Fernbank CDP is provided in **Table 4-1**.

Table 4-1: Hydrologic Model Comparison - Monahan Drain at Jock River

Model	**Area (ha)**	**Summer Event - 24 hr SCS** Peak Flow (m3/s)						**Spring Event - 10 day Runoff** Peak Flow (m3/s) *Runoff Volume (ha.m)*					
		Return Period (years)						**Return Period (years)**					
		2	**5**	**10**	**25**	**50**	**100**	**2**	**5**	**10**	**25**	**50**	**100**
JLR* (1993)	2,737	9.5	15.5	19.9	26.1	31.2	36.3	5.1	9.0	11.9	15.7	18.6	21.7
RVCA (2004)	2,737	11	18	22	29	34	40	10 *9*	13 *13*	15 *16*	17 *20*	20 *24*	21 *27*
NECL (2007)	2,713	11.3	17.7	22.7	28.6	34.1	41.8	4.0 *4.0*	7.5 *8.0*	10.2 *11.2*	13.7 *16.1*	16.9 *20.1*	20.1 *26.1*

* Spring event peak flows from the J.L. Richards Model are based on a 24-hour rain-on-snow event as opposed to 10-day event.

A comparison plot for the existing conditions models at the Jock River showing the hydrographs from the updated Novatech model and the RVCA model for the 100-year event is shown on **Figure 4.2**.

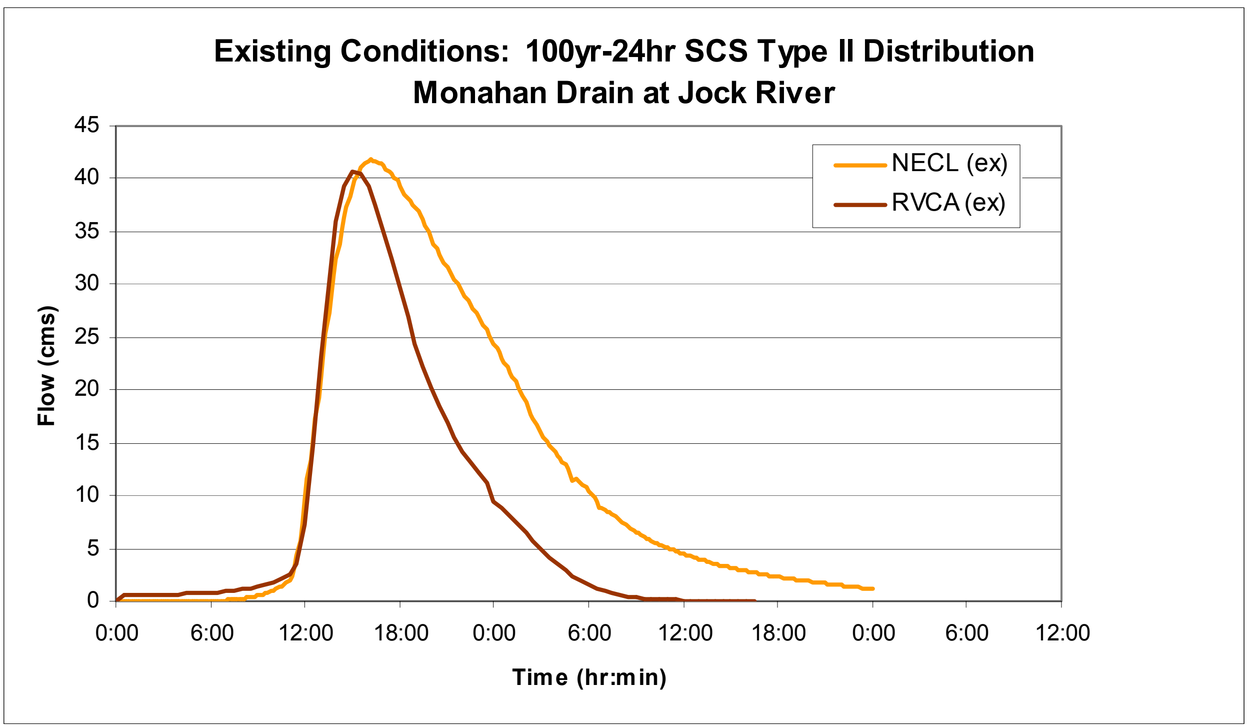


Figure 4.2 Existing Conditions - Monahan Drain 100yr Hydrograph at Jock River

Monahan Drain Modeling Results - Summer Event

For the summer event (24-hr SCS distribution), the Fernbank CDP model provides a very close correlation to the RVCA model. The greatest difference in peak flow occurs for the 100-year event: The 100-year peak flow is 41.8 m^3/s for the Fernbank CDP model vs. 40.0 m^3/s for the RVCA model, a difference of approximately 4.5%.

Modeled peak flows from both the RVCA (2004) and Novatech (2007) simulations are both slightly higher than the peak flows modeled by J.L. Richards in 1993. The primary reason for the increase in flows is that J.L. Richards used IDF data from the former City of Kanata in their analysis, which generate slightly smaller runoff volumes than the current City of Ottawa IDF parameters.

Monahan Drain Modeling Results - Spring Event

The model results for the J.L. Richards spring event have been included in **Table 4-1** for comparison purposes, but it should be noted that the 1993 analysis only considered a 24-hour rain-on-snow event and not a 10-day event.

There is a good correlation between the RVCA and Novatech 100-year peak flows for the spring event (10-day Rain+Snow). The 100-year peak flow is 20.1 m3/s for the Fernbank CDP model vs. 21.0 m^3/s for the RVCA model, a difference of approximately 4.5%. The spring peak flows do not correlate as closely for the more frequent return periods. The primary reason for the difference in peak flows is likely due to the influence of the Monahan Drain Constructed Wetlands: The wetlands are modeled as a discrete element in the Fernbank CDP model, while the RVCA model does not specifically account for storage and routing through the wetlands. The wetlands do significantly attenuate peak flows for smaller storm events, but the attenuation effect is reduced for larger storm events.

It should be noted that the Jock River Flood Risk Mapping - Hydrology Report states "…the calibration/validation effort concentrated on the simulation of high flows for the purpose of flood risk mapping, and that the estimates of more frequent Return Period Flows, such as the 2 year and 5 year, should be used with caution."

The Fernbank CDP SWMHYMO model provides a good correlation of peak flows to the RVCA model for the full range of summer events (24-hr SCS distribution), and good correlation to the RVCA model for the 100-year spring event. Therefore, the Fernbank CDP model of the Monahan Drain will provide a good benchmark for the analysis of impacts resulting from development of the Fernbank CDP on the downstream Monahan and Flewellyn Drains.

Faulkner Drain

The Fernbank CDP lands situated northwest of Shea Road are tributary to the Faulkner Drain, which is in turn tributary to Flowing Creek. The lands within the Fernbank Community represent only 48.5 hectares of the 4945 hectare area comprising the Flowing Creek Watershed (approximately 1%), and any meaningful comparison to the Flowing Creek Subwatershed model used in the Jock River Hydrology Study is not possible for this area.

Existing conditions for the Fernbank CDP lands tributary to the Faulkner Drain have instead been modeled based on the physical characteristics of the watershed. Modeling parameters were derived as follows:

- The soil types (and corresponding CN values) have been verified through test pit data;
- The drainage area has been verified based on detailed topographic mapping;
- The time to peak (t_p) has been calculated based on the average slope, length and land use within the catchment.

4.3.2 Hydrologic Modeling - Carp River Subwatershed

Modeling parameters for lands within the Carp River subwatershed were initially taken from the XP-SWMM hydrologic model developed for the upper reach of the Carp River (CH2MHill, 2009). The drainage areas and modeling parameters from the CH2MHill model for areas in and upstream of the Fernbank Study area were refined based on detailed topographic mapping, aerial photography and previous design reports. Refinements to the drainage areas and modeling parameters in the vicinity of the Fernbank study area have been reviewed and discussed with City staff (refer to correspondence in **Appendix B**).

Drainage Area Revisions

The catchment areas used in the Novatech model have been based on detailed topographic mapping of the study area. The revised drainage areas are based on the inflow hydrgraph locations used in the HEC-RAS model of the Carp River and are summarized as follows:

HEC-RAS Inflow Location	NECL	CH2MHill
Station 44751	236.0	255.7
Station 44546	69.2	21.4
Station 43966	102.0	125.1
Total	407.2	402.2

The total difference in drainage areas between these three inflow locations is 5.0 ha (approximate difference of 1%). However, the revised subcatchment areas represent a significant increase in drainage area to the Carp River upstream of Hazeldean Road and a corresponding reduction in drainage area to Hazeldean Creek, which enters the Carp River downstream of Hazeldean Road.

A comparison of the existing conditions 100-year hydrographs from the Novatech analysis (generated using SWMHYMO) vs. the existing conditions hydrographs from the CH2MHill analysis (generated using the XP-SWMM hydrologic/hydraulic model) is provided for each of the three inflow hydrograph locations on **Figures 4.3-4.5**.

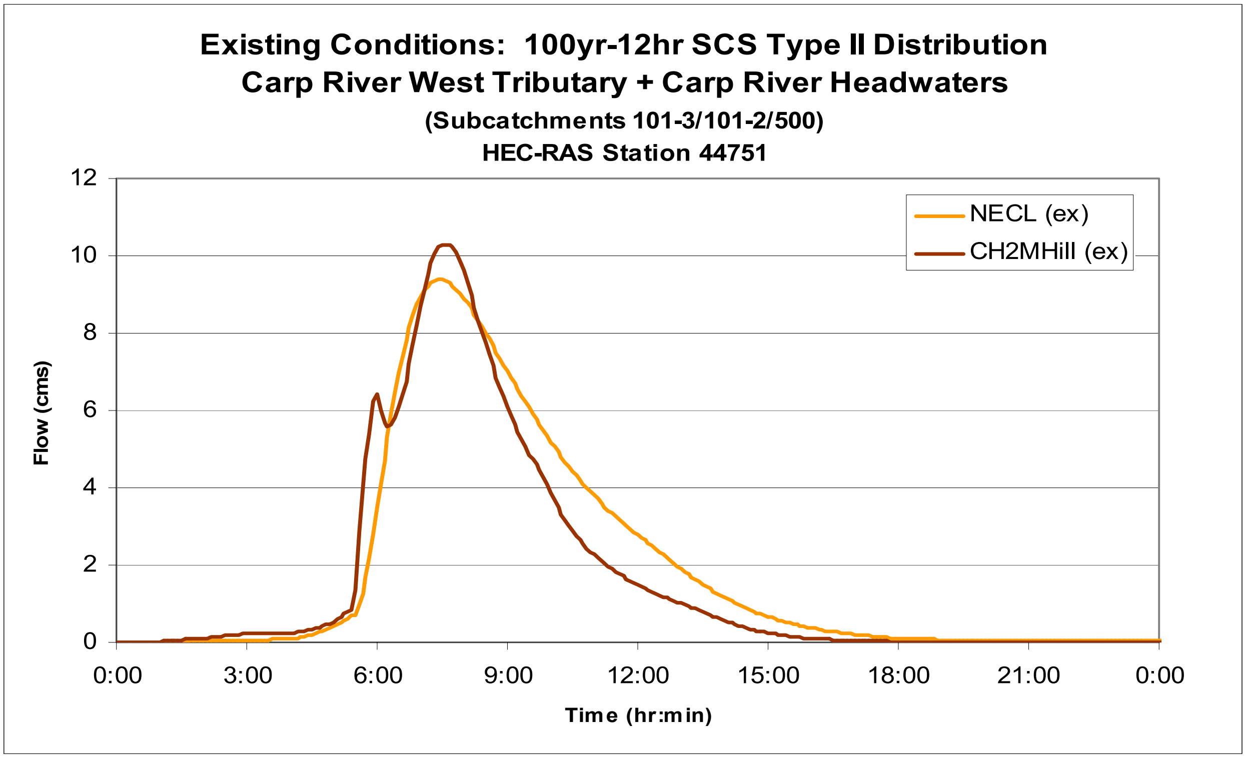


Figure 4.3 Existing Conditions - 100yr Inflow Hydrograph (HEC-RAS Station 44751)

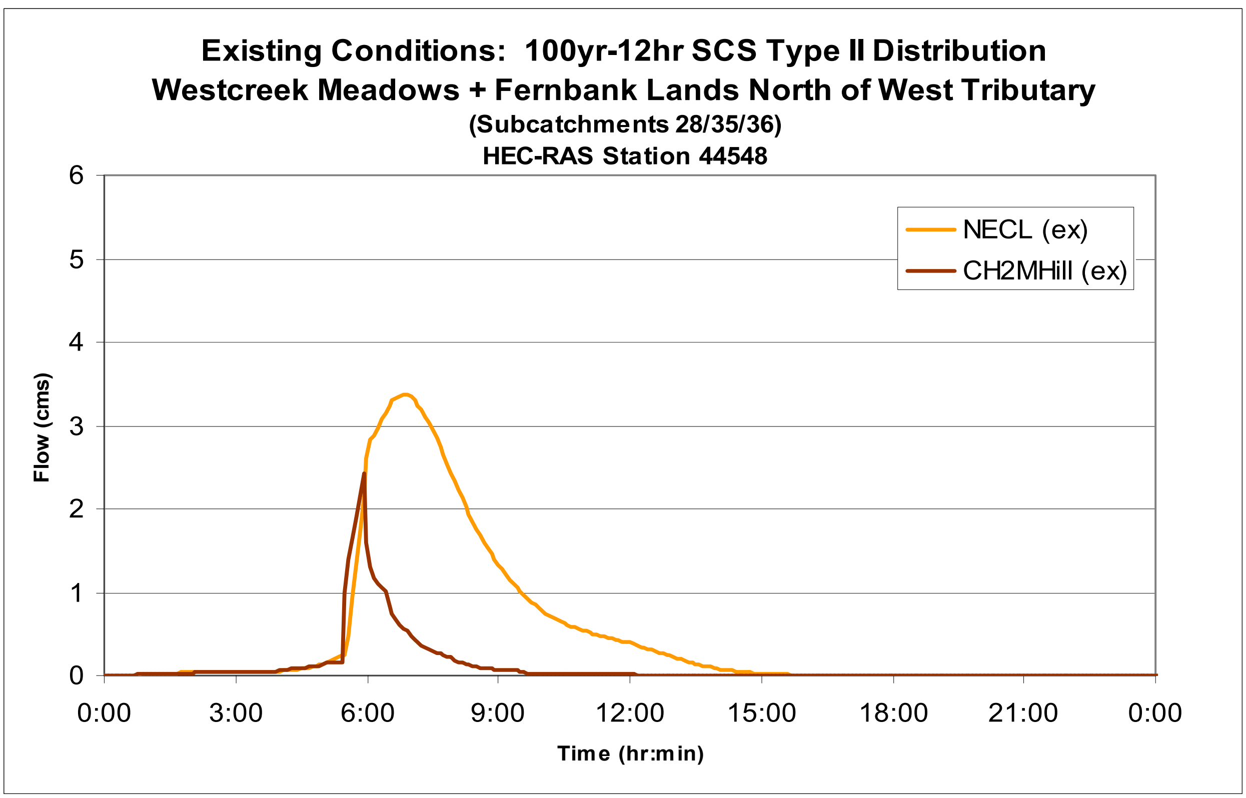


Figure 4.4 Existing Conditions - 100yr Inflow Hydrograph (HEC-RAS Station 44548)

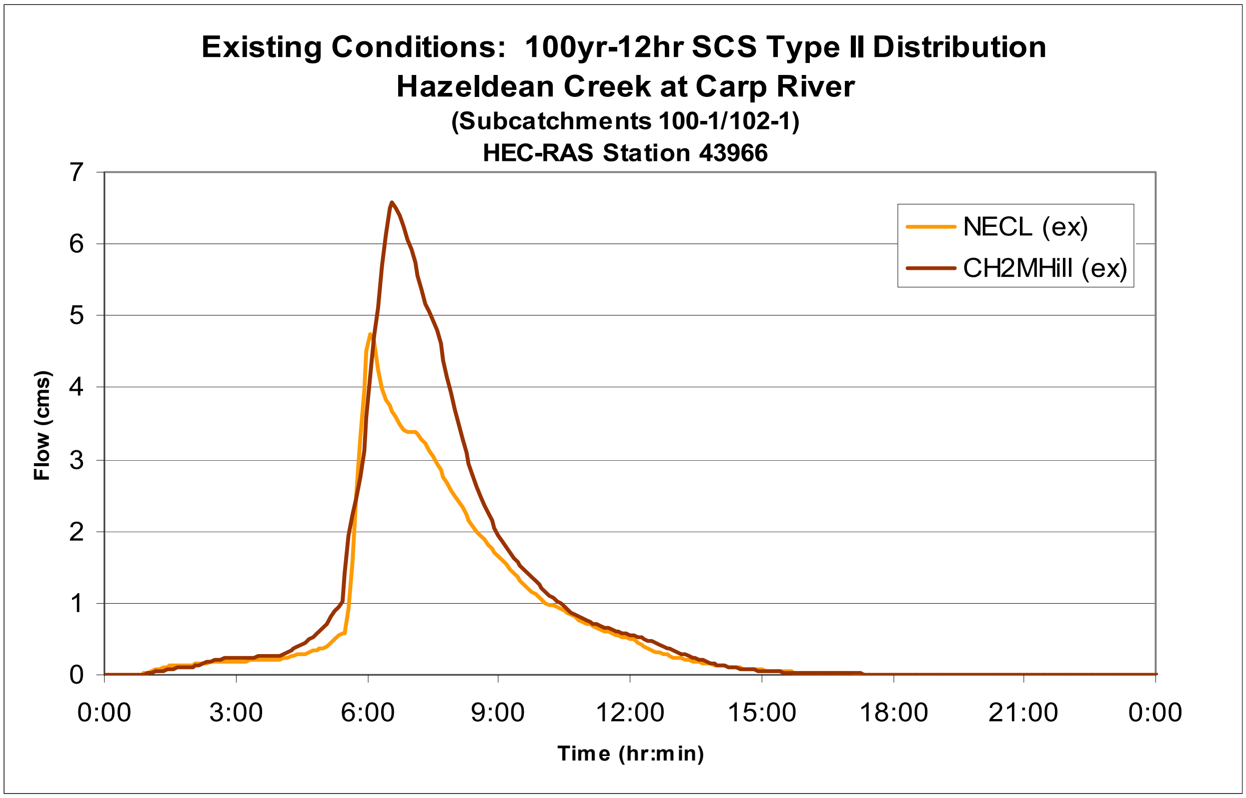


Figure 4.5 Existing Conditions - 100yr Inflow Hydrograph (HEC-RAS Station 43966)

4.3.3 Results of Existing Conditions Hydrologic Analysis

The results of the existing conditions hydrologic models have been used to establish design criteria for stormwater management for the Fernbank Community and to evaluate the performance of the proposed stormwater management strategy.

Event Based Modeling

Event-based existing conditions modeling was completed using three different storm distributions:

- 12-hr AES 30% distribution
- 12-hr SCS Type II distribution
- 24-hr SCS Type II distribution

Modeled peak flows for each of the tributary drainage areas are summarized in **Table 4-2** and in **Figure 4.6**. Event-Based SWMHYMO modeling files are provided in **Appendix D**.

Table 4-2: Existing Conditions Peak Flows

	Peak Flow (m^3/s)						
	Distribution	**2yr**	**5yr**	**10yr**	**25yr**	**50yr**	**100yr**
Carp Subwatershed							
Carp Headwaters +	12hr AES	2.53	3.92	4.86	6.08	6.93	7.79
Carp River West Tributary	12hr SCS	2.76	**4.46**	**5.62**	**7.27**	**8.20**	**9.39**
HEC-RAS Station 44751	24hr SCS	**2.91**	4.45	5.52	6.84	7.92	9.38
Fernbank Lands north of West	12hr AES	0.65	1.05	1.33	1.74	2.04	2.36
Tributary + Westcreek Meadows	12hr SCS	0.84	**1.46**	**1.90**	**2.53**	**2.90**	**3.37**
HEC-RAS Station 44548	24hr SCS	**0.89**	1.46	1.86	2.37	2.76	3.34
Hazeldean Creek @	12hr AES	0.91	1.38	1.72	2.19	2.53	2.94
Carp River	12hr SCS	**1.82**	**2.65**	**3.28**	**4.42**	**4.74**	**5.45**
HEC-RAS Station 43966	24hr SCS	1.49	2.16	2.68	3.40	3.98	4.83
Jock Subwatershed							
Monahan Drain @	12hr AES	**1.21**	**1.99**	**2.54**	**3.24**	**3.74**	4.24
Terry Fox Drive	12hr SCS	1.13	1.87	2.39	3.13	3.55	4.10
	24hr SCS	1.21	1.92	2.42	3.05	3.57	**4.28**
Flewellyn Drain @	12hr AES	1.12	**1.83**	**2.33**	**2.97**	**3.42**	3.88
Fernbank Road	12hr SCS	1.05	1.76	2.25	2.97	3.37	3.90
	24hr SCS	**1.13**	1.81	2.28	2.88	3.37	**4.05**
Faulkner Tributary @	12hr AES	0.46	0.74	0.94	1.19	1.37	1.55
Fernbank Road	12hr SCS	0.48	0.82	1.05	1.39	1.58	1.83
	24hr SCS	**0.51**	**0.83**	**1.05**	**1.32**	**1.55**	**1.85**

Critical Storm Distributions

The 12-hour SCS distribution appears to be the critical storm distribution for lands in the Carp River subwatershed. This is consistent with the 12-hour SCS distribution used in the Carp River XP-SWMM hydrologic modeling (CH2MHill, MVC).

The 12 hour AES distribution generates higher peak flows for the more frequent return periods on both the Monahan Drain and the Flewellyn Drain. However, the 24hr SCS distribution generates the highest 100-year peak flows for all three catchment areas in the Jock River subwatershed. The 24-hour distribution was used in the Jock River Flood Risk Mapping analysis (PSR Group, RVCA).

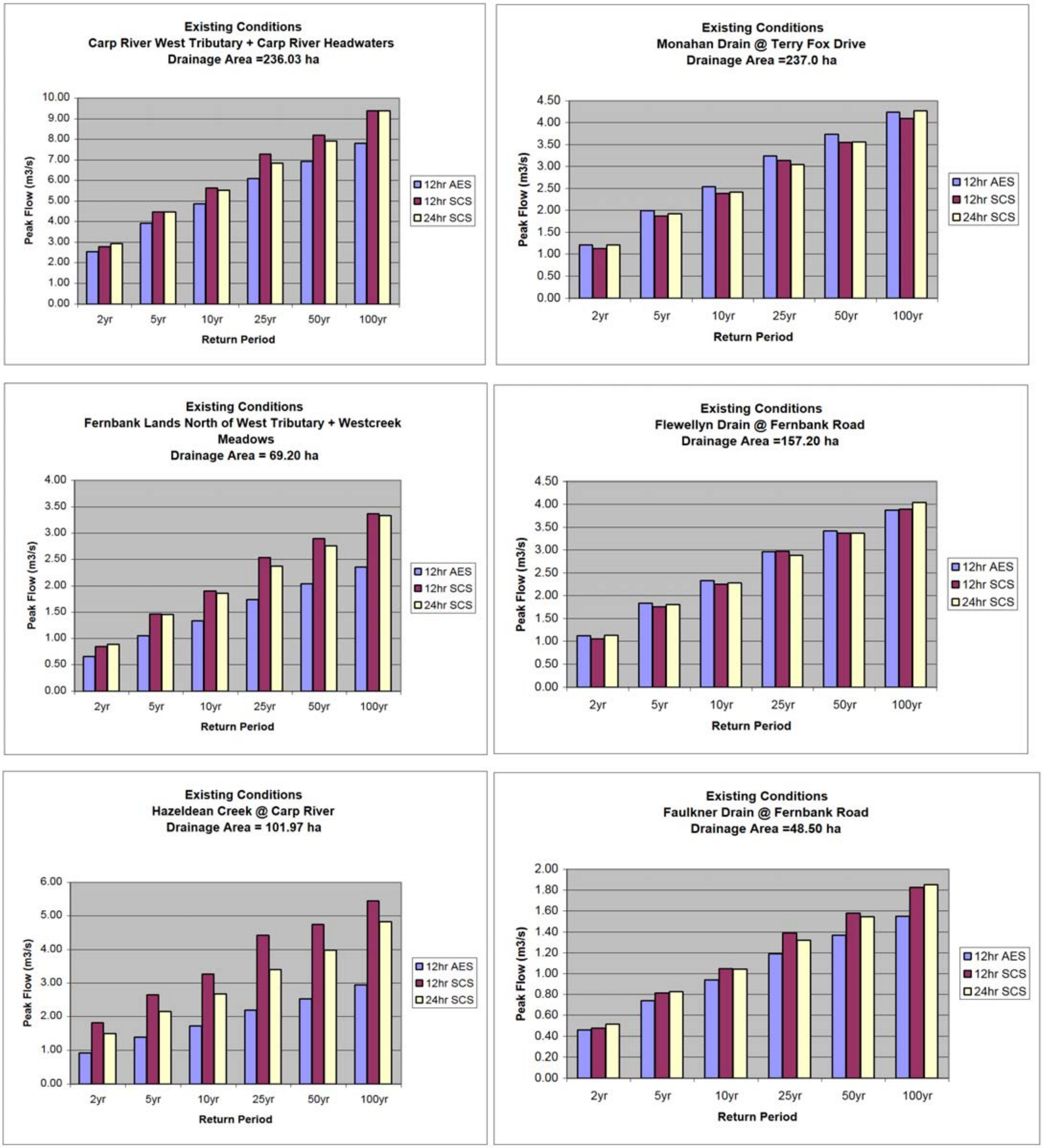


Figure 4.6 Existing Conditions Peak Flows

Section 5.0 Environmental Constraints & Opportunities

The natural features identified and evaluated as part of the existing conditions inventory are shown on the Constraints and Opportunities Plan provided as **Figure 5.1**.

The evaluation process was an ongoing process, with input taken from:

- The authors of the existing conditions reports;
- City staff & regulatory agencies, through regular project team meetings; and
- The public, through open houses.

Initial evaluations of environmental features were completed as part of the existing conditions reports. From the existing conditions reports, significant features were identified and selected for further evaluation. This information has been incorporated into the proposed development plans for the Fernbank Community, with consideration given to whether protection of a particular feature is warranted.

The following sections provide additional information on the features identified on the opportunities and constraints plan.

5.1 Existing SWM Facilities

There are several existing SWM facilities in the vicinity of the Fernbank Community. Consideration must be given to these facilities, even though they may be situated outside the limits of the study area. Drainage outlets must be provided for upstream SWM facilities, and the impact of proposed development on downstream facilities must be evaluated.

5.1.1 Glen Cairn SWM Facility

The Glen Cairn SWM Facility is located at the eastern limit of the site, adjacent to Terry Fox Drive. This SWM facility represents the headwaters of the Carp River and provides water quality and quantity control for the existing residential development east of Terry Fox Drive. MVC has indicated that this pond is operating at capacity, and no additional lands should be directed to this facility.

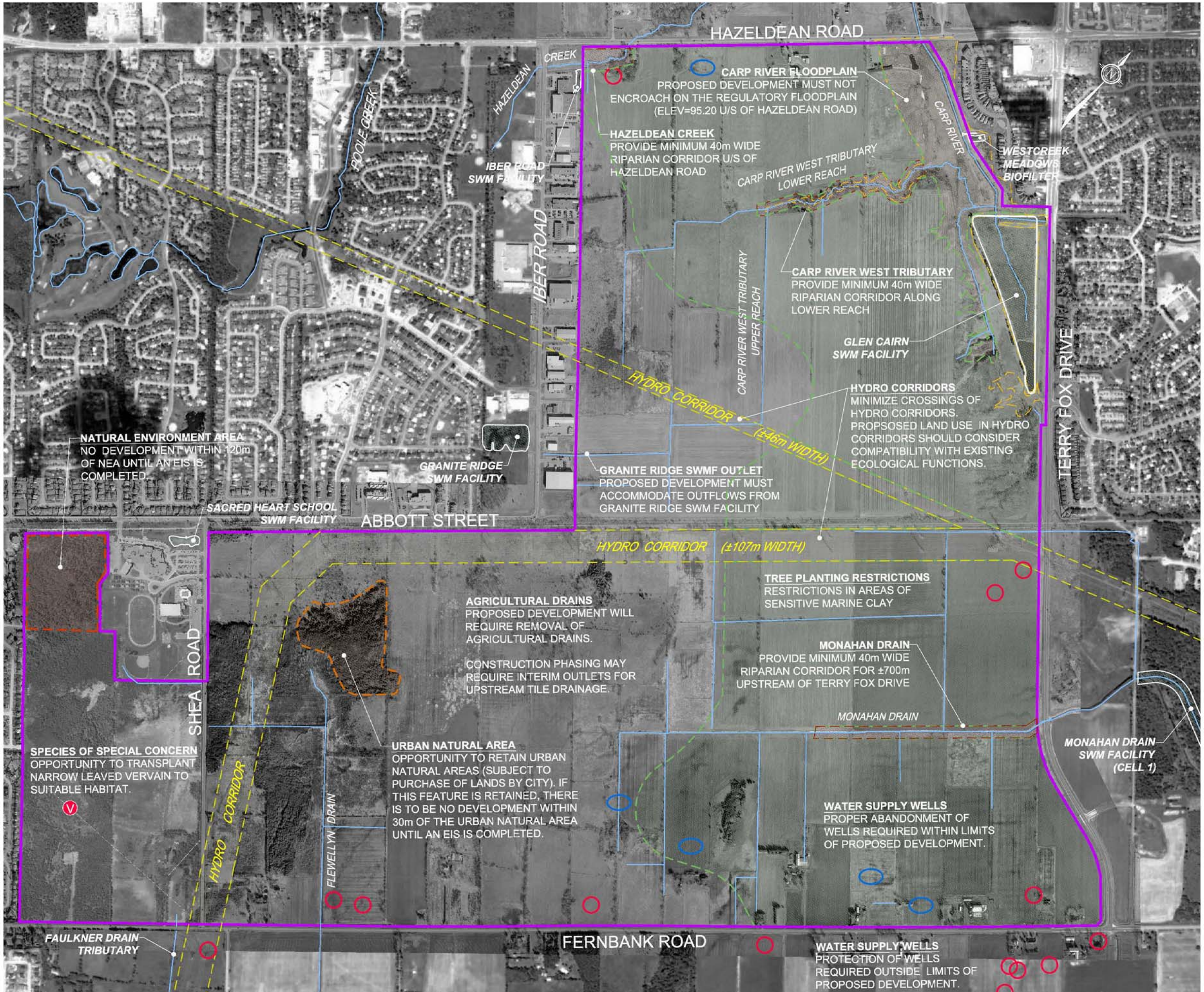
5.1.2 Monahan Drain Constructed Wetlands

The Monahan Drain Constructed Wetlands is an inline SWM facility consisting of a series of interconnected storage cells between Terry Fox Drive and Hope Side Road. This facility has been designed to provide water quality and quantity control for a tributary drainage area of approximately 900 hectares.

At the time that this facility was originally designed in 1993, it was assumed that the Fernbank Community lands would remain undeveloped. Updated hydrologic and hydraulic modeling of this facility has recently be completed in support of development applications for lands east of Terry Fox Drive (SOHO West & Bridlewood Trails Subdivisions). The revised modeling, completed in 2006, has taken development impacts of the Fernbank Community Lands into consideration and demonstrated that development of the Fernbank Community lands will not be problematic, provided that appropriate stormwater management controls are provided that will mitigate any adverse impact on peak flows, flood elevations or storage requirements downstream.

5.1.3 Granite Ridge SWM Facility

The Granite Ridge SWM facility is located on the west side of Iber Road in Stittsville. This facility provides water quality and quantity control for the Granite Ridge subdivision. Outflows from the Granite Ridge SWM facility are directed to the Carp River West Tributary, which conveys the outflows through



FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 5.1

Constraints & Opportunities

- STUDY AREA
- DRAINAGE CHANNEL
- REGULATORY FLOODPLAIN
- EXISTING SWM FACILITY
- HYDRO CORRIDOR
- URBAN NATURAL AREA
- NATURAL ENVIRONMENT AREA
- TREE PLANTING RESTRICTIONS
- HISTORIC HOMESTEAD LOCATION (POTENTIAL WELL LOCATION)
- WATER SUPPLY WELL LOCATION (FROM MOE WELL RECORDS)
- NARROW-LEAVED VERVAIN (POSITION APPROXIMATE)

SOURCE AND DATE OF AERIAL PHOTOS:
a) FERNBANK CDP LANDS: BASE MAPPING CO. (JUNE 2008)
b) BACKGROUND COMMUNITY: GOOGLE EARTH MAP (YEAR VARIES)

0 50 100 250 500 metres

SCALE : 1:5000 -B1 Sheet SEPTEMBER 2008
SCALE : Not to Scale -Report

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the Fernbank study area to the Carp River. The proposed development plan for the Fernbank Community must maintain a storm outlet for the 69.53 hectare upstream drainage area.

5.1.4 Westcreek Meadows Biofilter

The Westcreek Meadows biofilter provides water quality control for the Westcreek Meadows residential development located on the southwest corner of Hazeldean Road and Terry Fox Drive. The proposed development of the Fernbank Community is not expected to have any impact on the performance of this facility.

5.1.5 Iber Road SWM Facility

The Iber Road SWM Facility provides water quality and quantity control for a portion of the Iber Road Business Park in Stittsville. Outflows from the Iber Road SWM facility are directed to Hazeldean Creek, which flows through the northwest corner of the study area.

A 40 metre wide riparian corridor is recommended for Hazeldean Creek within the limits of the Fernbank Community stud area. This riparian corridor will maintain the outlet for the 62.17 hectare drainage area upstream of the Fernbank Community.

5.1.6 Sacred Heart School SWM Facility

The Sacred Heart School SWM Facility is located at the southwest corner of Shea Road and Abbott Street, and provides water quality control for the school and the adjacent community Centre. This facility is located within the Poole Creek subwatershed, and the proposed development of the Fernbank Community is not expected to have any impact on the performance of this facility.

5.2 Riparian Corridors

Based on aquatic habitat setbacks, meander belt widths, and hydraulic analysis of floodplain limits, protected riparian corridors have been identified for the following watercourses:

- 40 metre Corridor: Carp River West Tributary (Lower Reach);
- 40 metre Corridor: Hazeldean Creek;
- 40 metre Corridor: Monahan Drain (Main Branch), extending approximately 700m upstream of Terry Fox Drive.

5.3 Natural Environment Area

The NEA lands are to remain undisturbed in their existing condition. The southern boundary of the NEA will need to be determined as part of an EIS for this area. There is to be no development within 120 m (as per OP policy) of the Natural Environment Feature until the EIS is completed.

5.4 Urban Natural Area

The City have expressed potential interest in purchasing one of the Urban Natural Areas identified using the UNAEES criteria. This area is shown on the Constraints and Opportunities Plan. At the Draft Plan stage, the City will have option to purchase this UNA at market value. If the City exercises their option to purchase these lands, there is to be no development within 30 m (as per OP policy) until an EIS is completed for this area. No EIS is required if the City does not purchase these lands.

Grade raise conditions for a balanced subdivision preclude the large-scale preservation of trees outside the natural areas. Individual trees and clusters of woody vegetation can be saved on a case-by-case basis as permitted along the edge conditions, in neighborhood parks and school sites where possible. The identification of individual trees and/or vegetation clusters suitable for retention is outside the scope of the

EMP, and will need to be evaluated at the Plan of Subdivision stage based on proposed road layouts and grading/servicing requirements.

5.5 Species of Special Concern

A regionally rare plant, narrow-leaved vervain, was observed in the cultural meadows adjacent to the south cedar forest. There is an opportunity to retain this species through transplanting or seed planting, provided the transplant site has similar physical and biological properties (full sun, dry fields, limited soils).

Recommended transplant and seed planting locations include residential or municipal gardens, parks, or open space corridors. The most suitable open space transplant locations are within the Hydro Corridor west of Shea Road, between Fernbank Road and the proposed North/South Arterial Road.

5.6 Open Space / Hydro Corridors

The existing hydro corridors for high-voltage transmission lines must be maintained through the development lands. The hydro corridors provide grassland habitat for several breeding birds, and preservation of the existing natural features within the hydro corridors will help to preserve their ecological function. Consideration should be given to minimizing the number of road crossings of open space corridors, while still meeting the transportation requirements of the proposed development.

Hydro corridor lands are privately owned with an easement agreement in favour of Hydro One. The easement agreement does not permit specific development uses, but rather a request can be submitted to Hydro One for consideration on a case-by-case basis.

5.7 Water Supply Wells

Unused and unmaintained wells within the study area must be properly abandoned. Proper abandonment of these systems will reduce the potential for direct contamination of the underlying groundwater resources.

Private water supply wells in lands adjacent to the study area must be taken into consideration during construction. Any required bedrock blasting in the vicinity of the wells should include mitigation techniques for minimizing the potential for adverse impacts.

5.8 Tile Drains

Agricultural tile drains were encountered in some of the test pits. Any tile drains encountered within the house excavations could be a source of significant volumes of water, which could impact on the basements of the houses. Tile drains will need to be removed during construction. Development phasing will need to provide consideration for maintaining tile drainage outlets where there are significant upstream areas serviced by tile drains.

5.9 Areas of Sensitive Marine Clay

A considerable portion of the Fernbank study area is underlain by deposits of sensitive silty clay of marine origin.

- Grade-raise restrictions in these areas are outlined in the Master Servicing Study.
- Development plans in these areas will need to conform to the *Tree and Foundations Strategy in Areas of Sensitive Marine Clay in the City of Ottawa*.

Section 6.0 Stormwater Management Criteria

A key objective of the Environmental Management Plan is to establish stormwater management criteria for the Fernbank community that can be implemented through stormwater site management plans. In establishing stormwater management targets for the study area, it is important to consider the overall ultimate land uses within the subject watersheds. As the study area is located at the headwaters of several different watersheds, the stormwater management targets for the Fernbank Community lands must take into account the effects of development on the downstream areas.

The SWM criteria have been established on the basis of aquatic habitat protection and the sensitivity of the downstream erosion regime. Quality control objectives have been developed based on the recommendations of the Carp River and Jock River Subwatershed Studies. Quantity control objectives have been developed to ensure there is no adverse impact on the downstream watercourses resulting from the proposed development.

6.1 Regulatory Agencies

Stormwater Management Criteria were established with input from various agencies that have regulatory approval for works within a waterbody including:

- MVC and RVCA, Section 28 of the Conservation Authorities Act – Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses
- CAs and DFO, Section 35 of the Federal Fisheries Act – Fish Habitat
- OMAFRA, Drainage Act
- MOE, Ontario Water Resources Act

6.2 Monitoring / Adaptive Management

Long-term performance monitoring of the outlet watercourses will be required to ensure that they will not be affected by future changes in channel morphology resulting from the proposed development of the Fernbank Lands. The recommended monitoring program should consist of:

- Top-of-bank benchmarked cross-sections will be installed at representative areas at each of the outlet watercourses;
- Periodic measurements of erosion pins. A series of erosion pins will be installed horizontally into the face of several banks in strategic locations including outside banks of pools and other areas of anticipated erosion and in riffle areas where no erosion is expected (control). Rates of adjustment will be calculated on an annual basis.
- Total station survey every year. The details of the survey will include tops, crests and ends of riffles, upper, middle and lower pool depths as well as any breaks in slope, etc;
- A series of photographs at each cross-section location will be included with the monitoring data package – does not supplant photographic records from other disciplines
- Annual monitoring reports summarizing results.

Based on the monitoring results, several groups of geomorphic and related indicators will be used to assess the evolution of the stream channels. If the assessment indicates that any of the outlet watercourses have been adversely impacted, an appropriate solution will be determined. This will entail the integration of professionals from various disciplines, geomorphic, aquatic habitat, hydraulic, hydrologic and geotechnical conditions to assess the ultimate solution. This may entail adjusting SWM discharge rates because channel is aggrading or remedial work of the channel that may includes bank protection or minor channel re-alignment.

The developer would be responsible for initiation of any monitoring programs and the associated costs until such time as the City accepts ownership of the associated SWM facilities and/or watercourses. Continuation of the monitoring program would then become the responsibility of the City. It is anticipated that monitoring would be an open-ended program as part of an ongoing adaptive management strategy.

6.3 SWM Criteria - Carp River Subwatershed

Stormwater management criteria for the Fernbank Community lands tributary to the Carp River subwatershed have been developed based on the recommendations of the Carp River Subwatershed Study, the recommendations of the Carp River 3rd Party Review, and input from MVC:

- The proposed stormwater management strategy will need to adhere to all applicable policies and guidelines of Mississippi Valley Conservation; the City of Ottawa, MOE, and other approvals agencies.

Quality Control / Fish Habitat

- Level 2 - Normal protection for lands tributary to the Carp River (70% long term TSS removal);
- End-of-pipe SWM facilities are to provide extended detention storage for both baseflow enhancement and water quality control;
- The proposed development must have no adverse impacts on downstream fish habitat;
- The Carp River and the West Tributary have been classified as tolerant warmwater fish communities (Type 3 Communities), based on classifications from the *Carp River Watershed / Subwatershed Study*. Temperature mitigation measures are to be incorporated into all proposed SWM facilities, with the goal of ensuring that the temperature of discharged stormwater does not exceed the following target values:
    - Maximum Discharge Temperature = 25ºC
    - Preferred Discharge Temperature = 22ºC

Quantity Control

- Increases in runoff volume resulting from development are not to exceed an additional 40,000 m^3 above existing conditions for the 100-year event;
- All development within the Fernbank Community tributary to the Carp River accommodate a per hectare share of the 85,600 m3 deficit volume identified in the Third Party Review until data is available to confirm the model.
- The proposed development must not result in any increase in downstream flood risk in the Carp River. Any proposed increases in flood elevations will need to be reviewed to ensure that they do not represent an increase in flood risk. Provided this criterion is met, the following design criteria are to be applied to proposed SWM facilities:
    - For SWM Facilities outletting directly to the Carp River, peak flow control is not required for major storm events (> 10 year event).
    - For SWM facilities outletting to tributaries of the Carp River, peak flow control is required for all storms up to the 100-year event.
    - **Pre-Development Peak Flow targets are listed in Table 4-2.**

Erosion control / Fluvial Geomorphology

- Continuous hydrologic modeling should be used to demonstrate that the proposed development will not result in an adverse change to the geomorphology of the Carp River West Tributary. The number of exceedences of the erosion thresholds established by the fluvial geomorphic analysis should not increase under post-development conditions.
    - **Critical flow (Erosion) targets for watercourses are listed in Table 3-7.**

6.4 SWM Criteria - Jock River Subwatershed

Stormwater management criteria for the Fernbank Community lands tributary to the Jock River subwatershed have been developed based on the recommendations of the Jock River Reach 2 River Subwatershed Study and input from RVCA:

- The proposed stormwater management strategy will need to adhere to all applicable policies and guidelines of the Rideau Valley Conservation Authority; the City of Ottawa, MOE, and other approvals agencies.

<u>Quality Control / Fish Habitat</u>

- Level 1 - Enhanced protection for lands tributary to the Jock River (80% long term TSS removal);
- End-of-pipe facilities will be designed to provide extended detention storage for both baseflow enhancement and water quality control.
- The proposed development must have no adverse impacts on downstream fish habitat.
- The Monahan Drain, Flewellyn and Faulkner Drains have been classified as intermittent watercourses that provide indirect habitat supporting tolerant warm/cool water fish communities. Temperature mitigation measures are to be incorporated into all proposed SWM facilities tributary to the Jock River, with the goal of ensuring that the temperature of discharged stormwater does not exceed the following target values:
    - Maximum Discharge Temperature = 25ºC
    - Preferred Discharge Temperature = 22ºC

<u>Quantity Control</u>

- Ensure the proposed SWM infrastructure will not result in any adverse impacts on flood elevations or increase the extent of flooding in downstream watercourses.
- Ensure the Monahan Drain ponds are designed to have no adverse impacts the function of the Monahan Drain Constructed Wetlands SWM Facility. No additional analysis of the Constructed Wetlands will be required provided that the proposed development conforms to the following:
    - The main branch of the Monahan Drain is retained upstream of Terry Fox Drive;
    - Fernbank lands tributary to the Monahan Drain to be serviced by 3 SWM facilities:
        - One SWM facility at the headwaters of the Monahan Drain;
        - Two SWM facilities on each side of the Monahan Drain upstream of Terry Fox Drive.
    - The design of the Constructed Wetlands assumed a total drainage area tributary to the Monahan Drain upstream of Terry Fox Drive of approximately 296 hectares with an average imperviousness of 46%.
- Post-development peak flows are not to exceed pre-development levels for all storms up to the 100-year event.
    - **Pre-Development Peak Flow targets are listed in Table 4-2.**

<u>Erosion control / Fluvial Geomorphology</u>

- Continuous hydrologic modeling should be used to demonstrate that the proposed development will not result in an adverse change to the geomorphology of the outlet watercourses. The number of exceedences of the erosion thresholds established by the fluvial geomorphic analysis should not increase under post-development conditions.
    - **Critical flow (Erosion) targets for watercourses are listed in Table 3-7.**

Section 7.0 Evaluation of SWM Alternatives

As part of the integrated EA process, several storm drainage and stormwater management options were considered for each watershed within the Fernbank Community. The development of a preferred stormwater management strategy for the Fernbank Community included the assessment of several storm drainage and stormwater management alternatives.

Alternatives for stormwater management were developed using a two stage process. The first stage was the development of preliminary alternatives and a coarse screening process. The second stage was the selection of a preferred alternative, and refinement of that alternative to generate more detailed solutions.

7.1 Preliminary Alternatives

"Alternative Solutions" are defined as feasible alternative ways of solving an identified problem or addressing an opportunity. In this case, the "problem and/or opportunity" is to develop a stormwater management strategy for the Fernbank Community that meets all applicable design criteria and meets all targets required for approval by regulatory agencies.

The preliminary alternatives considered for the Fernbank CDP lands included the following:

- Do Nothing / Limit Growth
- No Stormwater Management
- Lot-level & conveyance controls only
- End-of-Pipe SWM Facilities

The Do Nothing / Limit Growth alternative is not considered a viable option as it does not meet the development targets established for the study area, nor does it provide any opportunity for enhancement of existing features.

Development of the study area with no stormwater management would result in an unacceptable increase in storm runoff, and a degradation of water quality.

Lot level and conveyance controls are considered an important part of an integrated treatment train approach to stormwater management, and will form an important component in ensuring that post-development conditions do not see a substantial increase in the frequency or duration of flow events in excess of established thresholds.

The surficial geology over a significant portion of the Fernbank Community study area is not conducive to infiltration (clay & silty clay soils, shallow depths to bedrock), and it would be extremely difficult to meet the required water quality and quantity control targets using lot level and conveyance controls only. Consequently, end-of-pipe stormwater management facilities will be required in addition to lot level and conveyance controls in order to provide the requisite levels of stormwater treatment and detention.

The results of the preliminary alternatives evaluation was presented at a public open house. Meeting details, Public Notices, and Presentation Materials are contained in a separate report entitled *Fernbank Community Design Plan – Public Consultation Report* along with the comments and inputs received.

7.2 Refinement of Preferred Alternative

For large drainage areas, wet ponds represent the most viable option to provide baseflow enhancement, erosion control, water quality control and peak flow control. The assessment of stormwater management alternatives for the Fernbank Community was refined to focus primarily on the locations of the proposed SWM facilities.

Alternative locations for the proposed SWM facilities for each subwatershed were comparatively evaluated to determine which alternative best met the SWM objectives for each services area, including:

- Servicing: Does the option service the entire upstream area?
- Environment: Is the option complimentary to the environmental objectives?
- Economic: Does the option represent the most cost-effective solution?
- Approvals: Does the option meet all applicable regulatory requirements?

The evaluation of the SWM servicing alternatives and the selection of the preferred alternative for each subwatershed were presented at a public open house in September 2007. Meeting details, Public Notices, and Presentation Materials are contained in a separate report entitled *Fernbank Community Design Plan – Public Consultation Report* along with the comments and inputs received.

7.2.1 Carp River

The Fernbank CDP lands tributary to the Carp River have an overall catchment area of approximately 195 ha. The Glen Cairn SWM Facility is located at the eastern limit of the site and forms the headwaters of the Carp River. Outflows from the pond are discharged to the Carp River, which flows north under Hazeldean Road. The majority of drainage channels within this drainage area are agricultural drainage ditches that have been straightened and have no appreciable baseflow.

The Carp River West Tributary serves as the outlet for the Granite Ridge SWM facility, and does have a baseflow component. The lower reach of this tributary has good riparian cover consisting of mature trees and has been identified for preservation by DFO and MVC, as it provides good quality fish habitat.

Four different SWM servicing options were considered for the Fernbank CDP lands tributary to the Carp River (refer to **Figure 7.1**).

<u>Option 1</u>

- A single pond located adjacent to the Carp River

Pros:

- Can service entire drainage area with a single facility
- Lowest capital cost & operation/maintenance costs.

Cons:

- Eliminates the Carp River West Tributary. MVC and DFO have identified the lower reach of the Carp River West Tributary as fish habitat that is to be preserved.
- Conveyance of major system drainage becomes an issue for very large drainage areas.
- Elimination of Carp River West Tributary will not meet regulatory requirements.

As this option would eliminate the lower reach of the Carp River West Tributary, it does not adhere to the regulatory requirements identified for this area and would not be approved.

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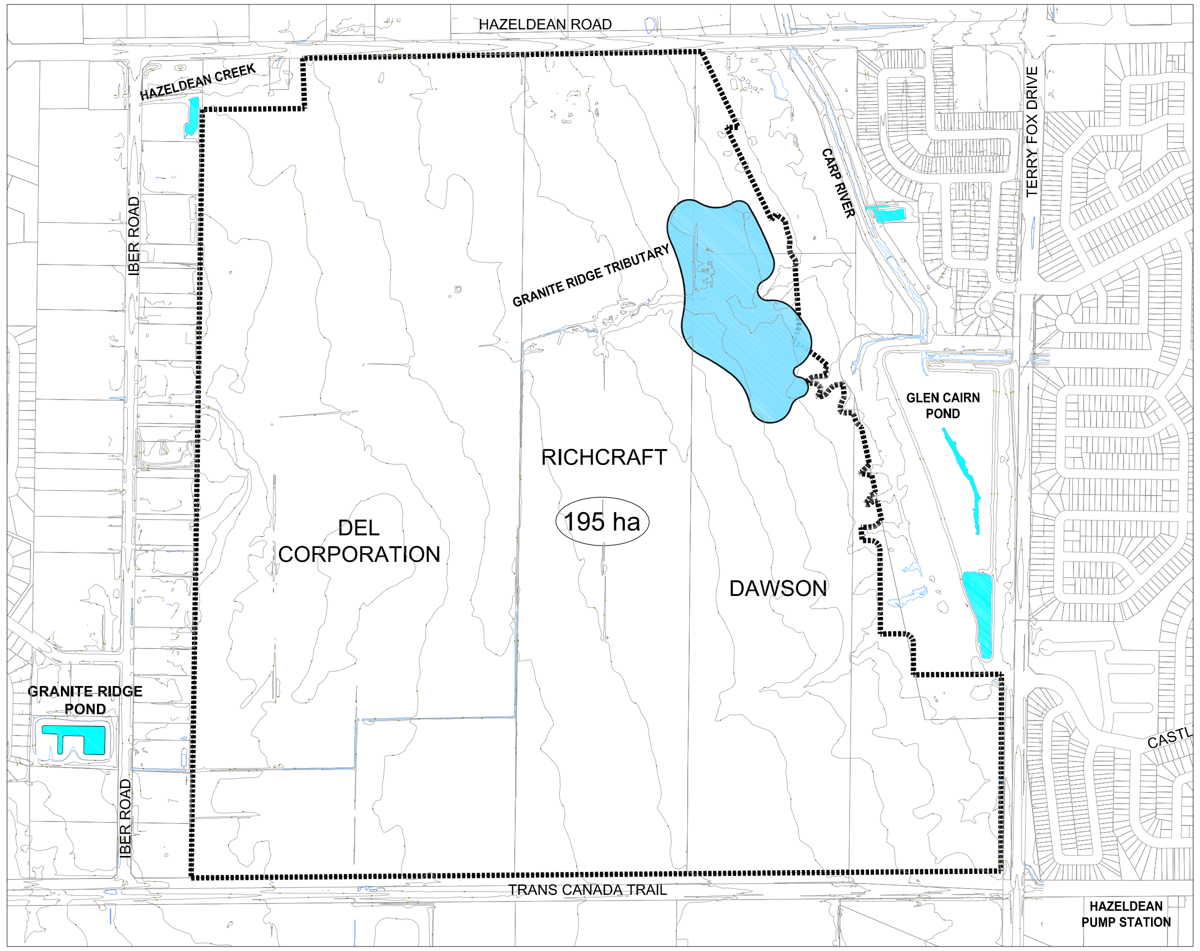
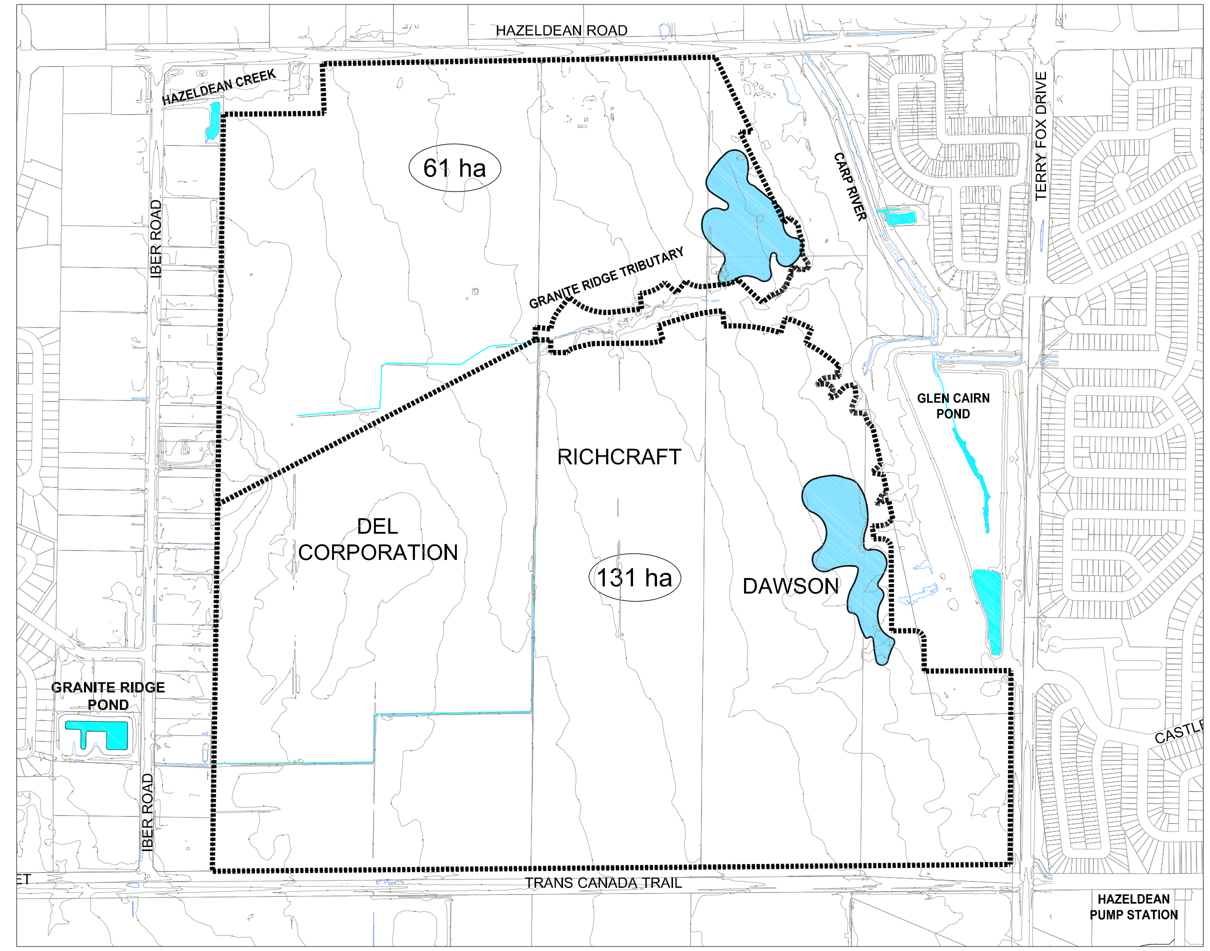
FIGURE 7.1

SWMF Alternatives

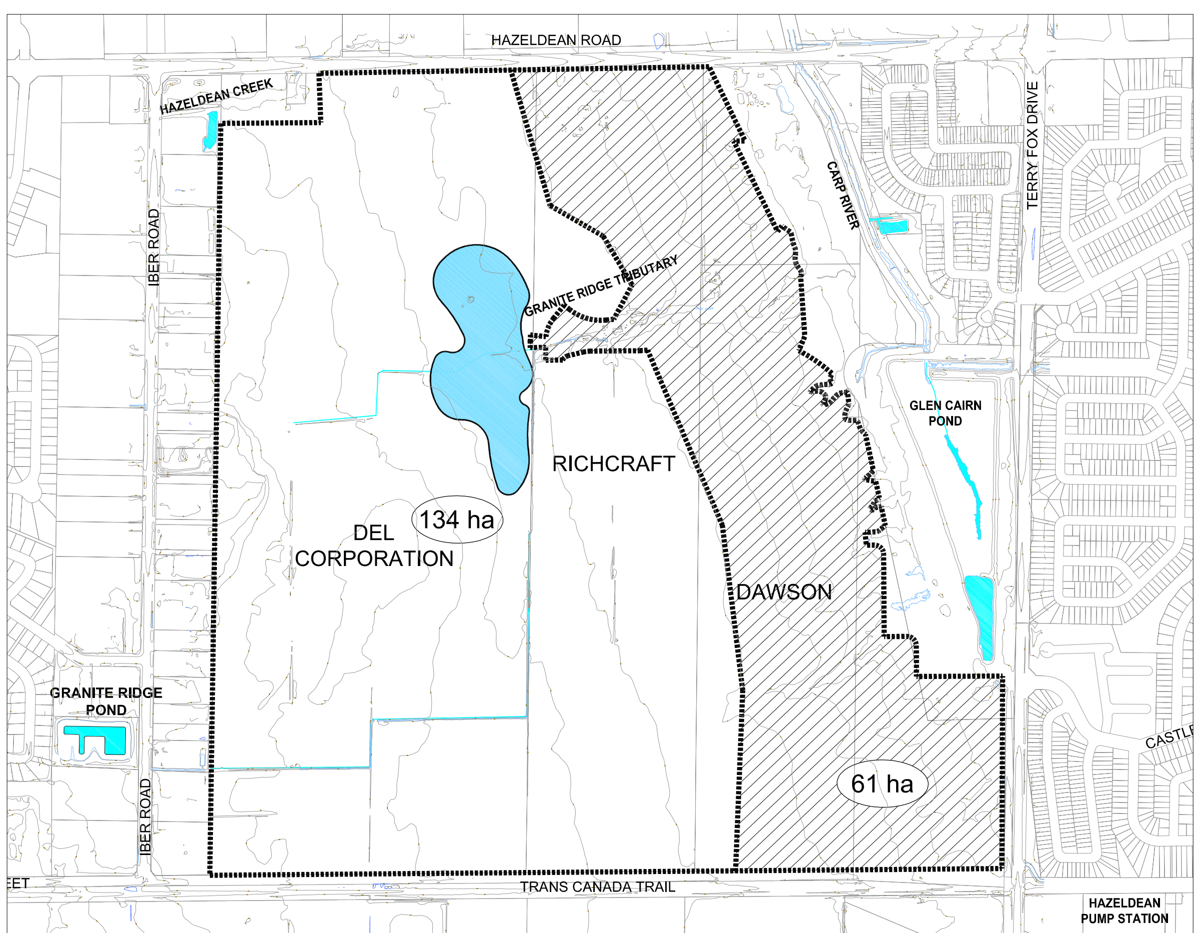
Carp River



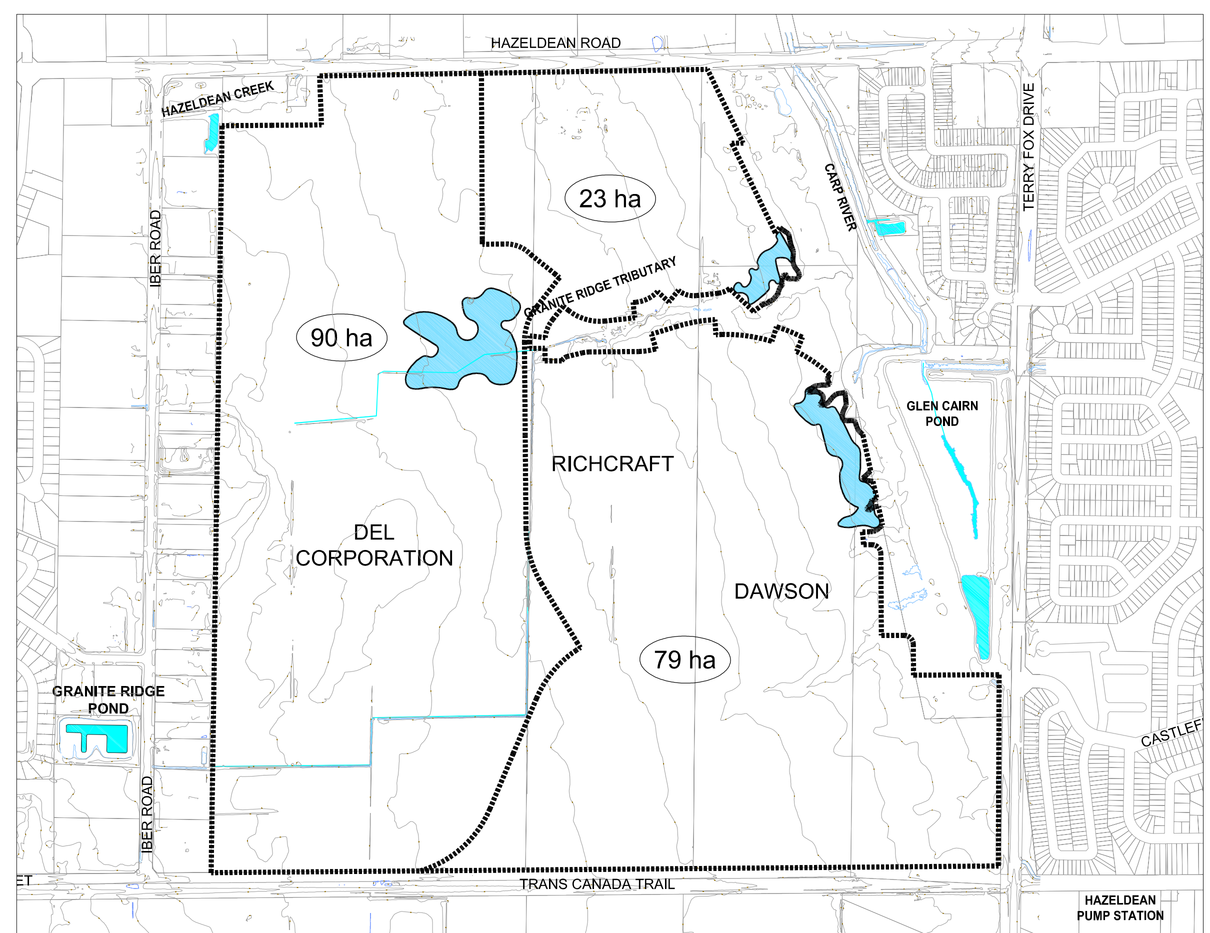
OPTION 1: ONE POND ADJACENT TO CARP RIVER



OPTION 3: TWO PONDS LOCATED ON EITHER SIDE OF THE GRANITE RIDGE TRIBUTARY



OPTION 2: ONE POND AT UPSTREAM LIMIT OF NATURAL CHANNEL ALONG GRANITE RIDGE TRIBUTARY



OPTION 4: ONE POND AT EASTERN LIMIT OF DEL PROPERTY
TWO PONDS ON EITHER SIDE OF GRANITE RIDGE TRIBUTARY (PREFERRED)

Lands Unserviceable by SWM Option

SCALE : Not to Scale

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ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email novainfo@novatech-eng.com

Option 2

- A single pond located upstream of natural reach of Carp River West Tributary

Pros:

- Low capital cost & operation/maintenance costs.
- Preserves the lower reach of the Carp River West Tributary.
- Pond will be located adjacent to North/South arterial road and Transit Corridor, and can provide storage of major system flows from upstream drainage area.
- Provides opportunity for preservation and enhancement of the lower reach of the Carp River West Tributary (baseflow enhancement, creation of additional fish habitat).

Cons:

- Topographic constraints and grade raise restrictions will result in a large portion of the site (±60 ha) being unserviceable by this facility.
- Alternate SWM measures would be required to provide quality and quantity control for the eastern portion of the site.

This option does not provide a feasible SWM servicing strategy for the Craig/Dawson Lands. Lands to the east of this facility would require additional quality and quantity control measures to be implemented. On-site controls are not practical for the proposed land use.

Option 3

- Two ponds adjacent to the Carp River on either side of the Carp River West Tributary

Pros:

- Services entire drainage area.
- Preserves the lower reach of the Carp River West Tributary.

Cons:

- Eliminates a significant portion of the drainage area to the lower reach of the Carp River West Tributary and will result in a reduction in baseflow.
- Major system flows will need to be conveyed across North/South Arterial and Transitway, or storage will need to be provided upstream.

While this option does retain the lower portion of the Carp River West Tributary, the redirection of storm runoff from the Del Lands (±90 ha) will result in a considerable reduction in baseflow, which is not compatible with the objective of enhancing fish habitat within this reach.

Option 4 (Preferred)

- One pond upstream of naturalized reach of Carp River West Tributary.
- Two ponds adjacent to the Carp River on either side of the Carp River West Tributary.

Pros:

- Services entire drainage area.
- Preserves the lower reach of the Carp River West Tributary.
- Provides opportunity for preservation and enhancement of the lower reach of the Carp River West Tributary (baseflow enhancement, creation of additional fish habitat).

Cons:

- Highest capital cost & operation/maintenance costs.
- Small drainage area to SWM facility on north side of Carp River West Tributary.

Option 4 achieves the objectives of providing a feasible SWM servicing option for the entire drainage area while providing an opportunity for preservation and enhancement of the lower reach of the Carp River West Tributary, as well as providing a solution for storage of major system flows upstream of the transitway & north/south arterial road.

7.2.2 Monahan Drain

The Fernbank CDP lands tributary to the Monahan Drain have an overall catchment area of approximately 220 ha. The catchment area is bounded by the Trans Canada Trail to the north, Terry Fox Drive to the east, and Fernbank Road to the South. The western limit of this drainage area is a ridge that represents the watershed boundary between the Monahan and Flewellyn Drains.

The Monahan Drain runs west to east through the central portion of the site and crosses under Terry Fox Drive. There are a number of north/south branch drains that outlet to the Monahan Drain.

RVCA have identified the Monahan Drain and the various branch drains as intermittent watercourses providing indirect habitat. The main branch of the Monahan Drain is to be preserved and enhanced to provide mitigation for loss of fish habitat that will result from the elimination of the branch drains.

Three different SWM servicing options were considered for the Fernbank CDP lands tributary to the Monahan Drain (refer to **Figure 7.2**).

<u>Option 1</u>

- A single pond located at Terry Fox Drive

Pros:

- Can service entire drainage area with a single facility
- Low capital cost & operation/maintenance costs.

Cons:

- Eliminates the Monahan Drain upstream of Terry Fox Drive.
- Conveyance of major system drainage becomes an issue for very large drainage areas.
- Elimination of Monahan Drain will not meet regulatory requirements.

This option would eliminate the Monahan Drain upstream of Terry Fox drive, which does not meet the objective of preserving and enhancing fish habitat within this reach. It does not adhere to the regulatory requirements identified for this area and would not be approved.

<u>Option 2</u>

- One pond located at the headwaters of the Monahan Drain.
- A second inline pond located at Terry Fox Drive.

Pros:

- Services entire drainage area.
- The use of multiple ponds will allow for easier management of major system flows.
- Preserves the Monahan Drain upstream of Terry Fox Drive.

Cons:

- Inline ponds will not be approved in areas identified as fish habitat.

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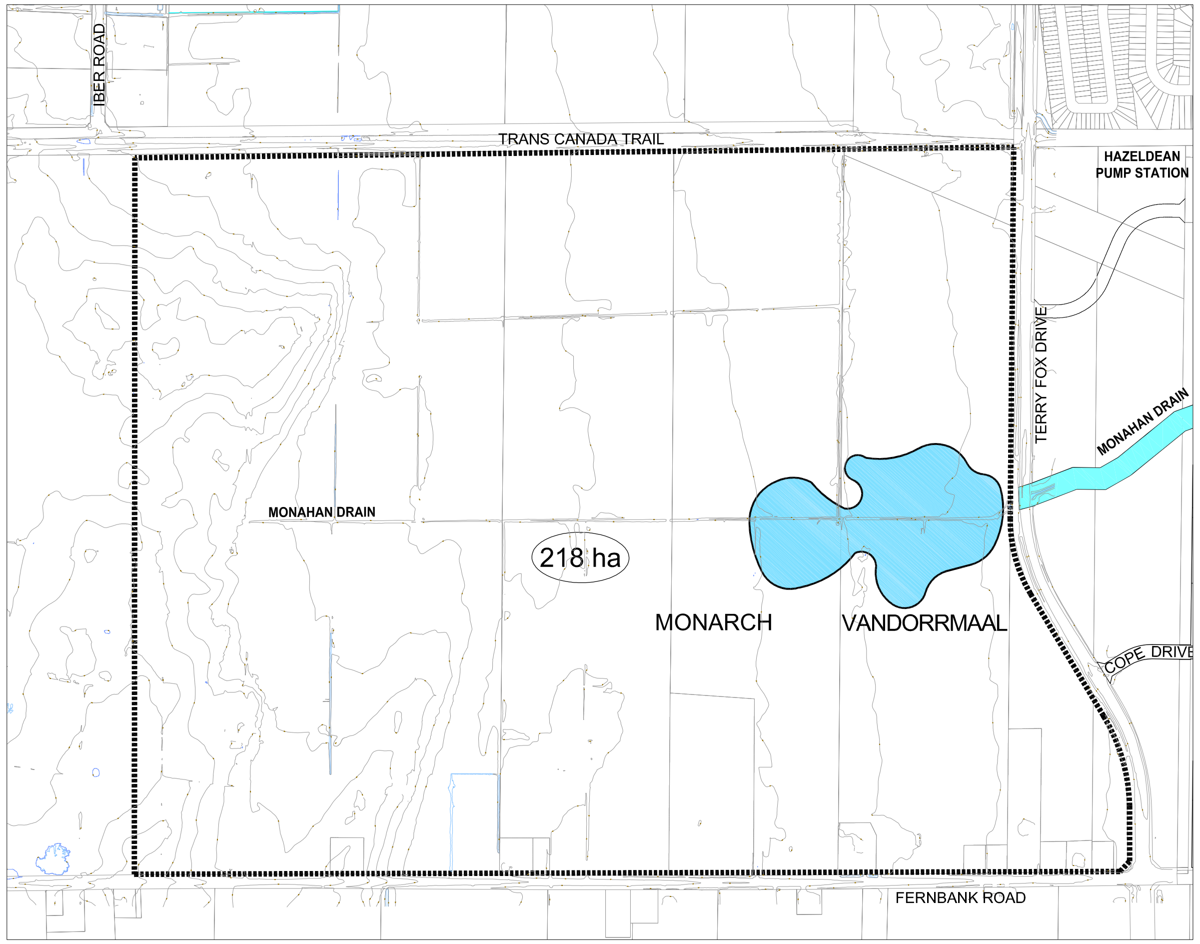
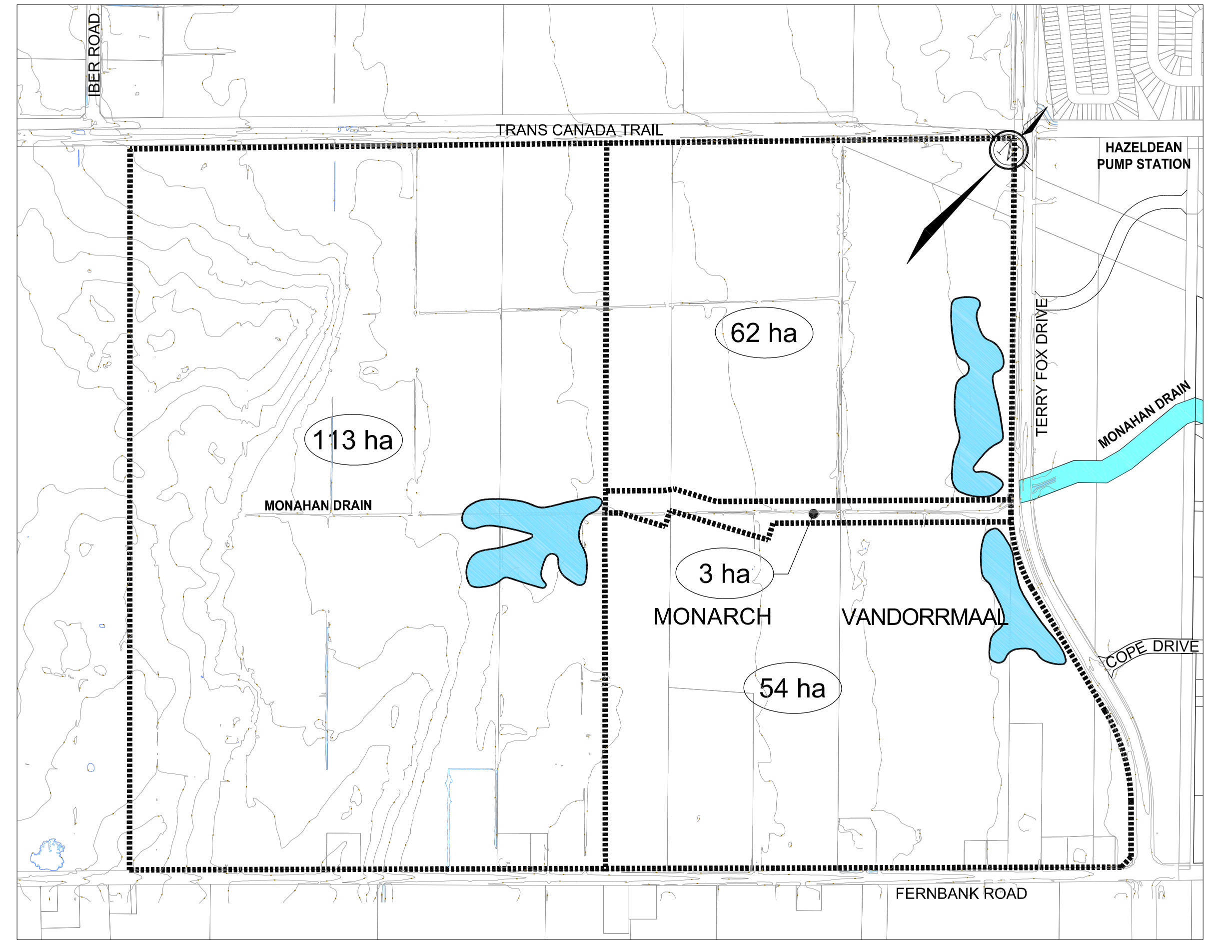
FIGURE 7.

SWMF Alternative

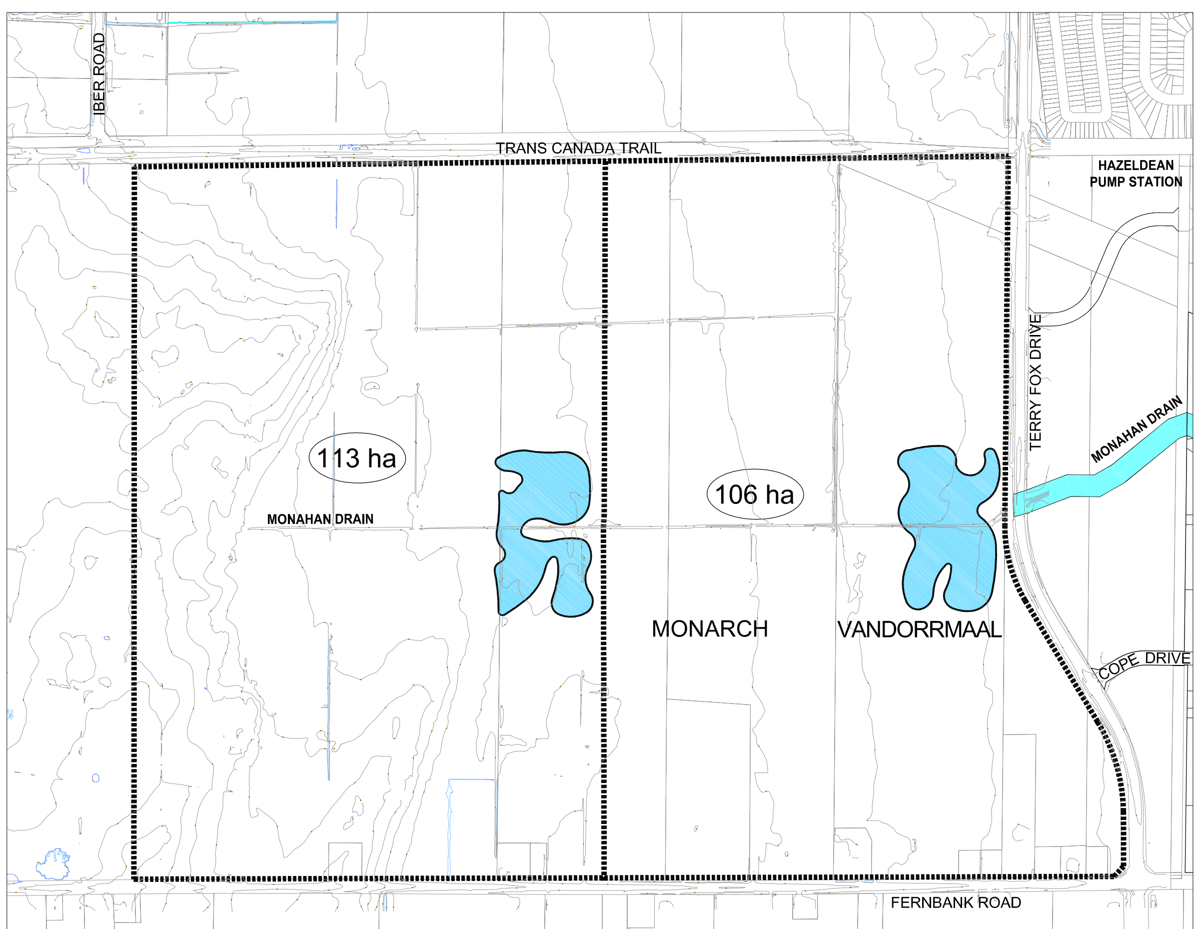
Monahan Drai



OPTION 1: ONE POND FOR MONAHAN DRAIN



OPTION 3: ONE POND AT HEADWATERS OF MONAHAN DRAIN
TWO OFF-LINE PONDS UPSTREAM OF TERRY FOX DRIVE (PREFERRED)



OPTION 2: ONE POND AT HEADWATERS OF MONAHAN DRAIN; ONE POND UPSTREAM OF TERRY FOX DRIVE

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ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

The use of an inline pond would create a barrier to fish passage and would not be approved in an area identified as fish habitat. The use of inline ponds is generally discouraged unless it can be demonstrated that they present the most viable option for SWM servicing.

Option 3 (Preferred)

- One pond located at the headwaters of the Monahan Drain.
- Two ponds located on either side of the Monahan Drain at Terry Fox Drive.

Pros:

- Services entire drainage area.
- Preserves the main branch of the Monahan Drain.
- The use of multiple ponds will allow for easier management of major system flows.
- Provides opportunity for preservation and enhancement of the Monahan Drain (baseflow enhancement, creation of additional fish habitat).

Cons:

- Highest capital cost & operation/maintenance costs due to multiple facilities.

This option achieves the objectives of providing a feasible SWM servicing option for the entire drainage area, while providing an opportunity for preservation and enhancement of the main branch of the Monahan Drain. The location of the facilities will also allow for easier management of major system flows within the site.

7.2.3 Flewellyn & Faulkner Drains

The Fernbank CDP lands tributary to the Flewellyn and Faulkner Drains have an overall catchment area of approximately 206 ha. The catchment area is bounded by the Trans Canada Trail to the north, Fernbank Road to the South, and urban development in Stittsville to the West. The eastern limit of this drainage area is a ridge that represents the watershed boundary between the Monahan and Flewellyn Drains.

The Flewellyn Drain runs southwards through the site, crossing under Fernbank Road and ultimately outletting to the Monahan Drain. The Flewellyn drain is a poorly defined channel within the limits of the site, and does not provide any fish habitat.

Lands west of Shea Road outlet to a drainage ditch that is tributary to the Faulkner Drain. There is no defined drainage channel within the limits of the site.

Four different SWM servicing options have been considered for the Fernbank CDP lands tributary to the Flewellyn and Faulkner Drains (refer to **Figure 7.3**).

Option 1

- A single pond located at Fernbank Road outletting to the Flewellyn Drain

Pros:

- Can service entire drainage area with a single facility
- Low capital cost & operation/maintenance costs.

Cons:

- Will result in the redirection of approximately 56 ha from the Faulkner subwatershed to the Flewellyn subwatershed.
- Eliminates Flewellyn Drain upstream of Fernbank Road.
- Conveyance of major system drainage becomes an issue for very large drainage areas.

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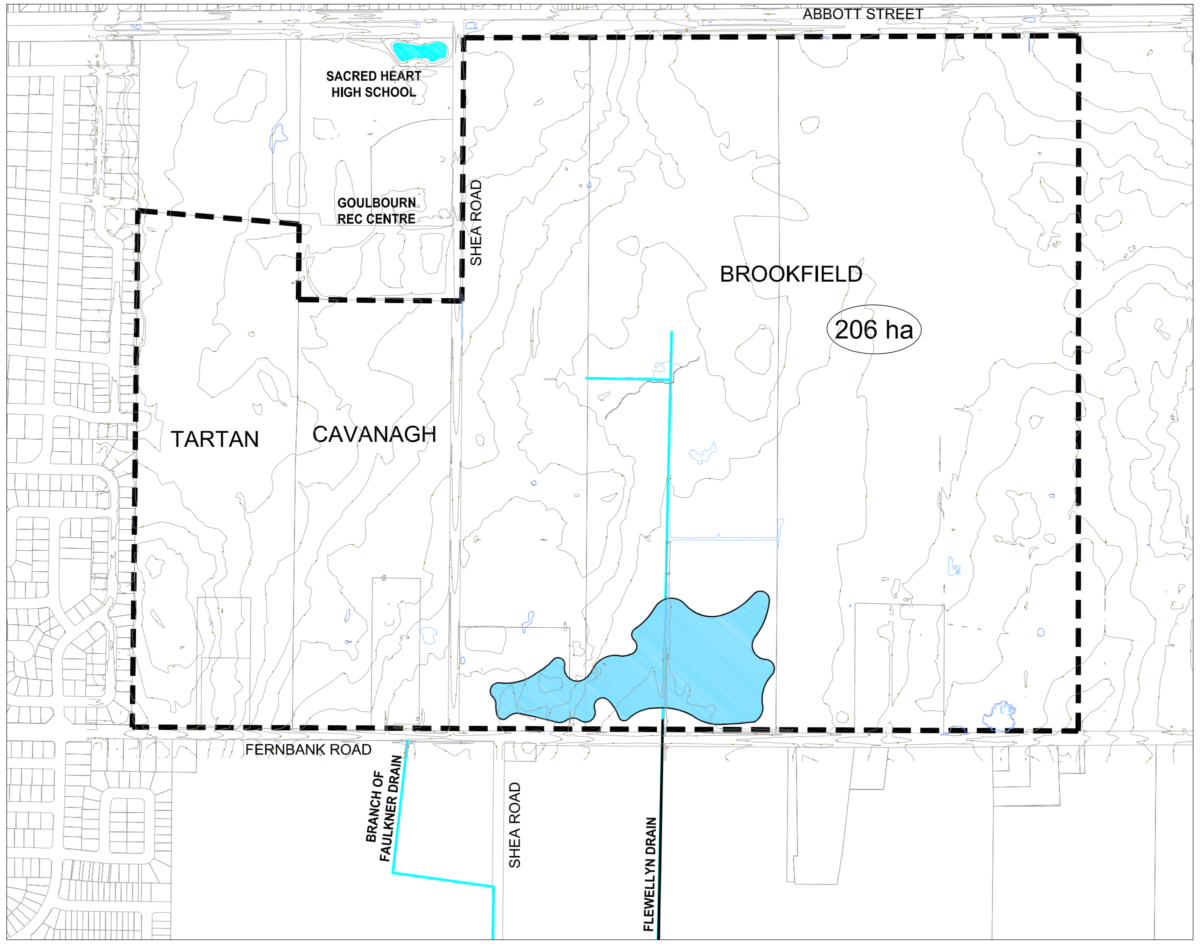
FIGURE 7.3

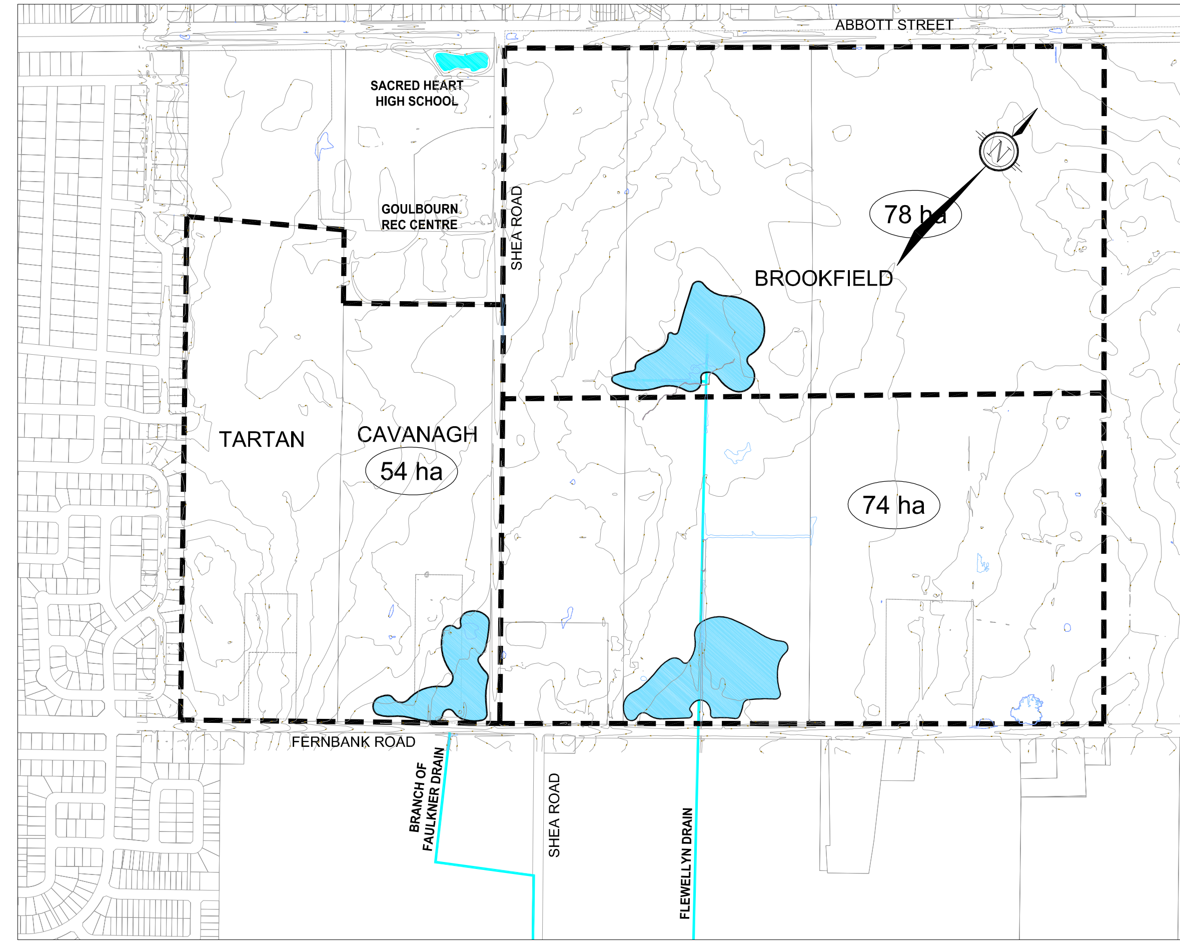
SWMF Alternatives

Flewellyn & Faulkner Drains

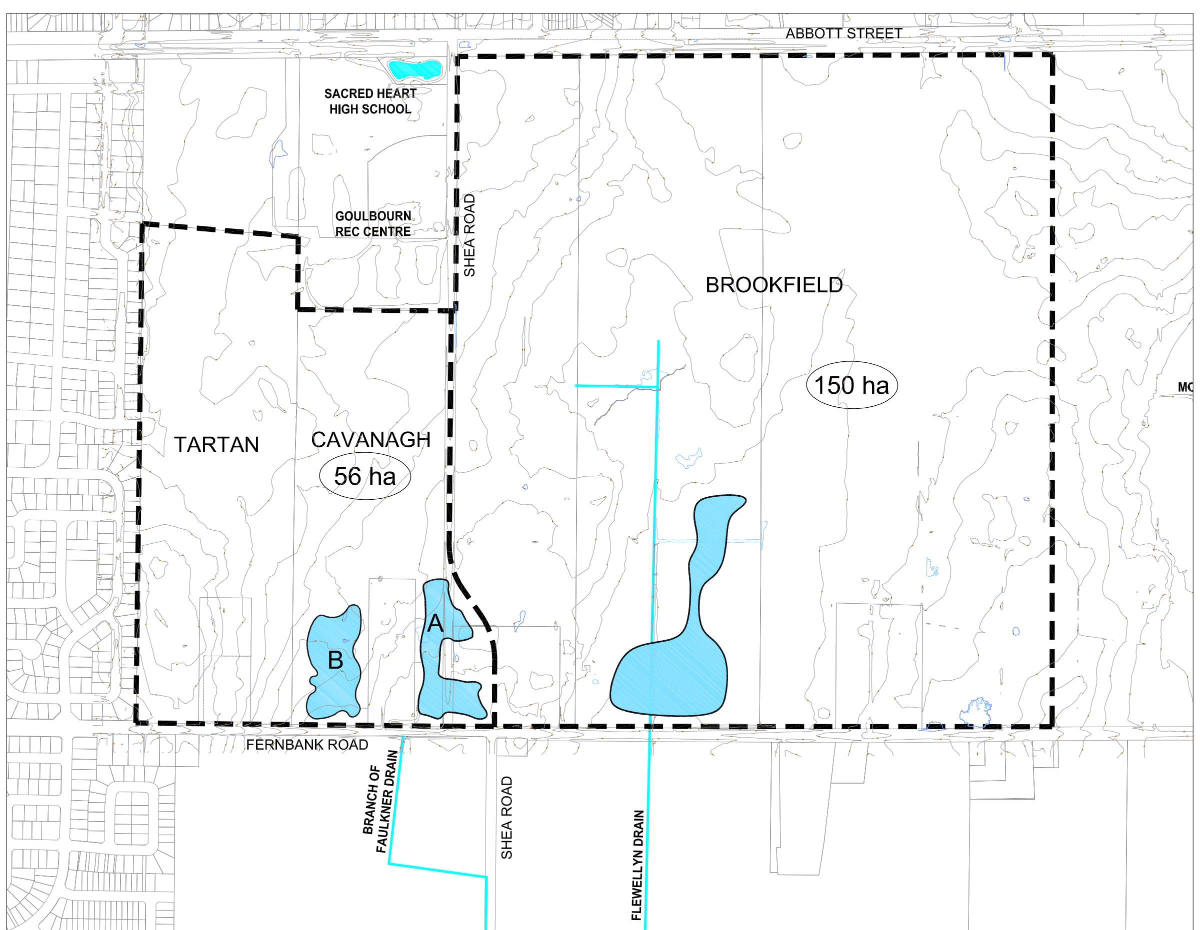
Lands Unserviceable by SWM Option



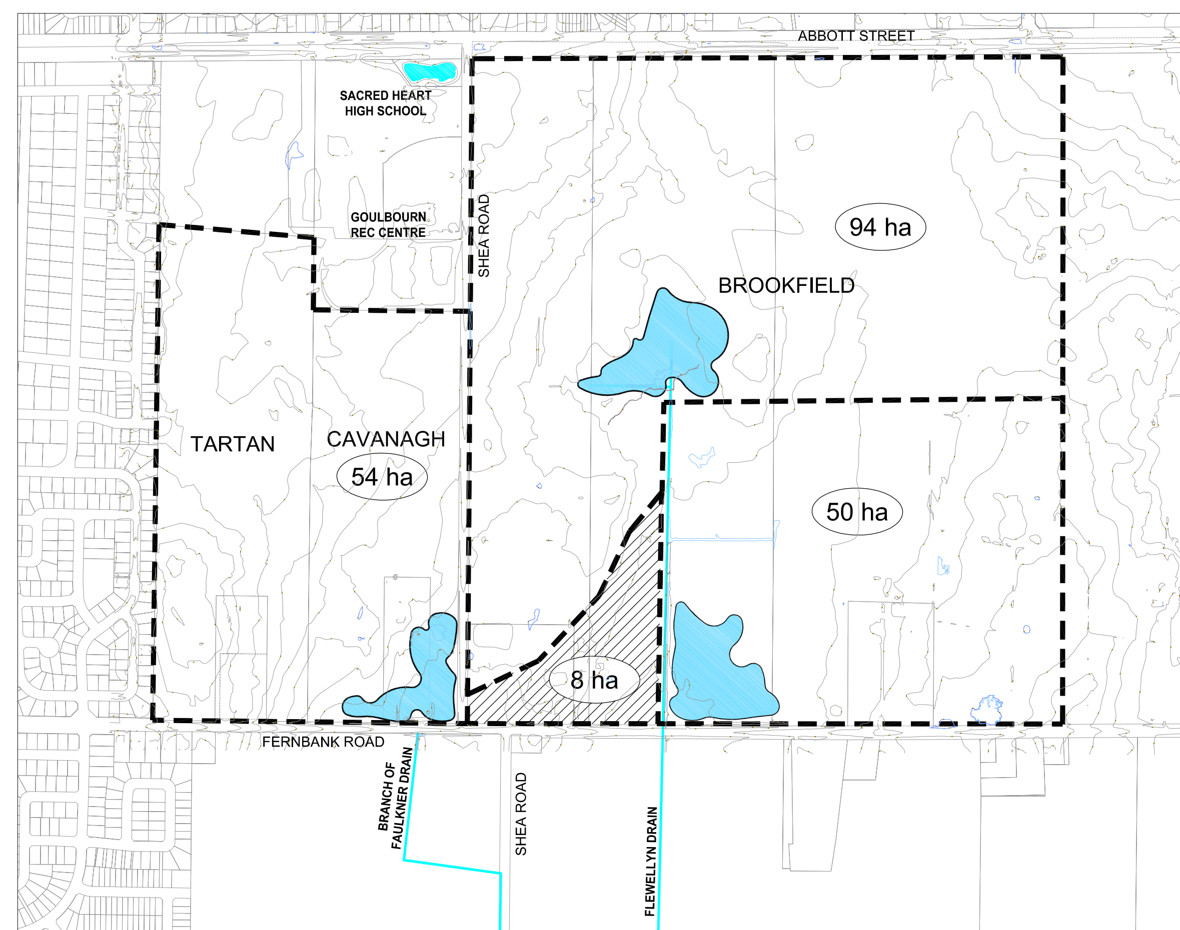
OPTION 1: ONE POND FOR COMBINED FLEWELLYN & FAULKNER DRAINS



OPTION 3: ONE POND FOR FAULKNER DRAIN; ONE POND AT HEADWATERS OF FLEWELLYN DRAIN, AND ONE INLINE POND ON FLEWELLYN DRAIN AT FERNBANK ROAD



OPTION 2: ONE POND FOR THE FAULKNER DRAIN
ONE POND FOR THE FLEWELLYN DRAIN (PREFERRED)



OPTION 4: ONE POND FOR FAULKNER DRAIN; ONE POND AT HEADWATERS OF FLEWELLYN DRAIN, AND ONE OFF-LINE POND ON FLEWELLYN DRAIN AT FERNBANK ROAD

SCALE : Not to Scale

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NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

The elimination of the Flewellyn Drain within the limits of the site would not constitute a HADD, as this reach of the drain is in poor condition, has no baseflow, and does not constitute fish habitat. The pond would provide an increase in baseflow downstream of Fernbank Road. This option would result in the permanent diversion of flows from the Faulkner Subwatershed to the Flewellyn Subwatershed, which will not be approved by RVCA.

<u>Option 2 (Preferred)</u>

- One pond located at Fernbank Road outletting to the Flewellyn Drain.
- A second pond located west of Shea Road outletting to the Faulkner Drain tributary.

Pros:

- Services entire drainage area.
- Preserves existing drainage patterns.
- Mitigates capital & operation/maintenance costs by providing 1 pond per drainage area.

Cons:

- Eliminates Flewellyn Drain upstream of Fernbank Road.
- Conveyance of major system drainage becomes an issue for large drainage areas (Flewellyn Drain).

While the tributary drainage area to the Flewellyn Pond will be quite large (±150 ha), the proposed pond configuration will utilize multiple forebays and will create a large linear pond extending northwards. This configuration will help to minimize the distance of overland flow routes and will provide the opportunity create several major system drainage paths to the pond. The elimination of the Flewellyn Drain within the limits of the site would not constitute a HADD, as this reach of the drain is in poor condition, has no baseflow, and does not constitute fish habitat.

The location of the Faulkner Drain SWM facility is flexible, and two potential locations for this option (A) & (B) are shown for Option 2 to accommodate current land ownership in this area. The placement of this facility can be re-visited as development plans are brought forward in this area.

<u>Option 3</u>

- One pond located at the Headwaters of the Flewellyn Drain.
- One inline pond on the Flewellyn Drain at Fernbank Road.
- One pond located west of Shea Road outletting to the Faulkner Drain tributary.

Pros:

- Services entire drainage area.
- Preserves existing drainage patterns.
- Preserves the Flewellyn Drain upstream of Fernbank Road.
- The use of multiple ponds will allow for easier management of major system flows.
- Retention of the Flewellyn Drain allows for surface conveyance of storm runoff, which can potentially reduce grade raise requirements in northern part of Flewellyn Watershed.

Cons:

- Highest capital cost & operation/maintenance costs due to multiple facilities.
- The use of inline ponds is not preferred.

The preservation of the Flewellyn Drain upstream of Fernbank Road is not a primary objective for this drainage area, and the benefits associated with providing two SWM facilities for the Flewellyn Drain (reduction in grade raise) are not sufficient to offset the additional capital costs, operation & maintenance costs, and reduction in developable land. The use of inline ponds is generally discouraged unless it can be demonstrated that they present the most viable option for SWM servicing.

<u>Option 4</u>

- One pond located at the Headwaters of the Flewellyn Drain.
- One off-line pond on the Flewellyn Drain at Fernbank Road.
- One pond located west of Shea Road outletting to the Faulkner Drain tributary.

Pros:

- Preserves existing drainage patterns.
- Preserves the Flewellyn Drain upstream of Fernbank Road.
- The use of multiple ponds will allow for easier management of major system flows.
- Retention of the Flewellyn Drain allows for surface conveyance of storm runoff, which can potentially reduce grade raise requirements in northern part of Flewellyn Watershed.

Cons:

- Highest capital cost & operation/maintenance costs due to multiple facilities.
- Cannot service entire drainage area. On-site SWM controls would be required for approximately 8 ha on the west side of the Flewellyn Drain.

The preservation of the Flewellyn Drain upstream of Fernbank Road is not a primary objective for this drainage area, and the benefits associated with providing two SWM facilities for the Flewellyn Drain (reduction in grade raise) are not sufficient to offset the additional capital costs, operation & maintenance costs, and reduction in developable land. The use of an off-line pond on the Flewellyn Drain at Fernbank Road does not provide a feasible SWM solution for the entire drainage area, as approximately 8 ha of land west of the Flewellyn Drain could not be serviced by the proposed ponds and would require separate SWM controls.

7.2.4 Flewellyn Drain Lowering

The existing Flewellyn Drain has an invert of approximately 103.50m at Fernbank Road. The drainage area upstream of Fernbank Road has a very flat topographic relief, and servicing of this area with storm sewers will require a considerable amount of earth moving to provide the required cover.

A potential cost-saving alternative would involve:

- lowering of the Flewellyn Drain by approximately 0.5 m at Fernbank Road, and tying back into existing grade approximately 375 m south.

Lowering of the Flewellyn Drain is not required for development, but it would reduce the amount of earth moving required for construction of the upstream storm drainage system, at an estimated cost savings of approximately $800,000. If the drain is not lowered, the SWM storage requirements for lands tributary to the Flewellyn Drain would remain unchanged.

Section 8.0 Post Development Storm Drainage Conditions

8.1 Hydrology

The post-development hydrologic analysis of the Fernbank community has been completed using the SWMHYMO hydrologic model, and includes both event-based modeling (2-100yr), and continuous modeling using long-term rainfall data for the City of Ottawa. The results of the pre-development analysis were used as a benchmark for the evaluation of post-development conditions.

8.1.1 Storm Drainage Areas

The post-development storm drainage areas used in the hydrologic model are based on the storm drainage area plans developed as part of the master servicing study. Minor system capture rates have been approximated at 100 L/s/ha. Major system storage has been approximated at 50 m^3/ha.

Post-development drainage areas have been established based on the proposed macro grading plan for the road network through the Fernbank Community. The grading plan can be found in the Master Servicing Study. The proposed grading plan results in changes to the drainage areas between the Flewellyn, Faulkner, and Monahan Drains. RVCA has confirmed that the proposed post-development drainage areas are acceptable. Correspondence is provided in **Appendix B**.

8.1.2 Modeling Parameters

The impervious values used in the post-development conditions analysis are based on the proposed land use plan from the Fernbank CDP and correspond to the runoff coefficients used in the storm sewer design sheets from the Master Servicing Study.

- The minor system capture rate was established at 100 L/s/ha.
- Major system storage in roadways was estimated at 50 m^3/ha.

Post-development drainage areas are shown on **Figure 8.1**. Modeling parameters are listed in **Table 8-1**.

Table 8-1: Post-Development Storm Drainage Areas to SWM Facilities

SWM Pond ID	Drainage Area[1] (ha)	Imperviousness		Soil CN	Major System Storage (m^3)	Minor System Capture Rate (m^3/s)
		Directly Connected	Total			
Carp River						
P1	77.13	0.45	0.56	80.5	3,857	7.71
P2	23.14	0.47	0.59	80.5	1,157	2.31
P3	91.68	0.34	0.43	80.5	4,584	9.17
Faulkner Drain						
P4	57.94	0.35	0.44	80.5	2,897	5.79
Flewellyn Drain						
P5	138.56	0.32	0.40	80.5	6,928	13.86
Monahan Drain						
P6	98.65	0.39	0.49	80.5	4,933	9.87
P7	43.09	0.29	0.36	80.5	2,155	4.31
P8	62.57	0.42	0.53	80.5	3,129	6.26

1. Drainage area does not include SWMF Block (refer to Figure 8.1)

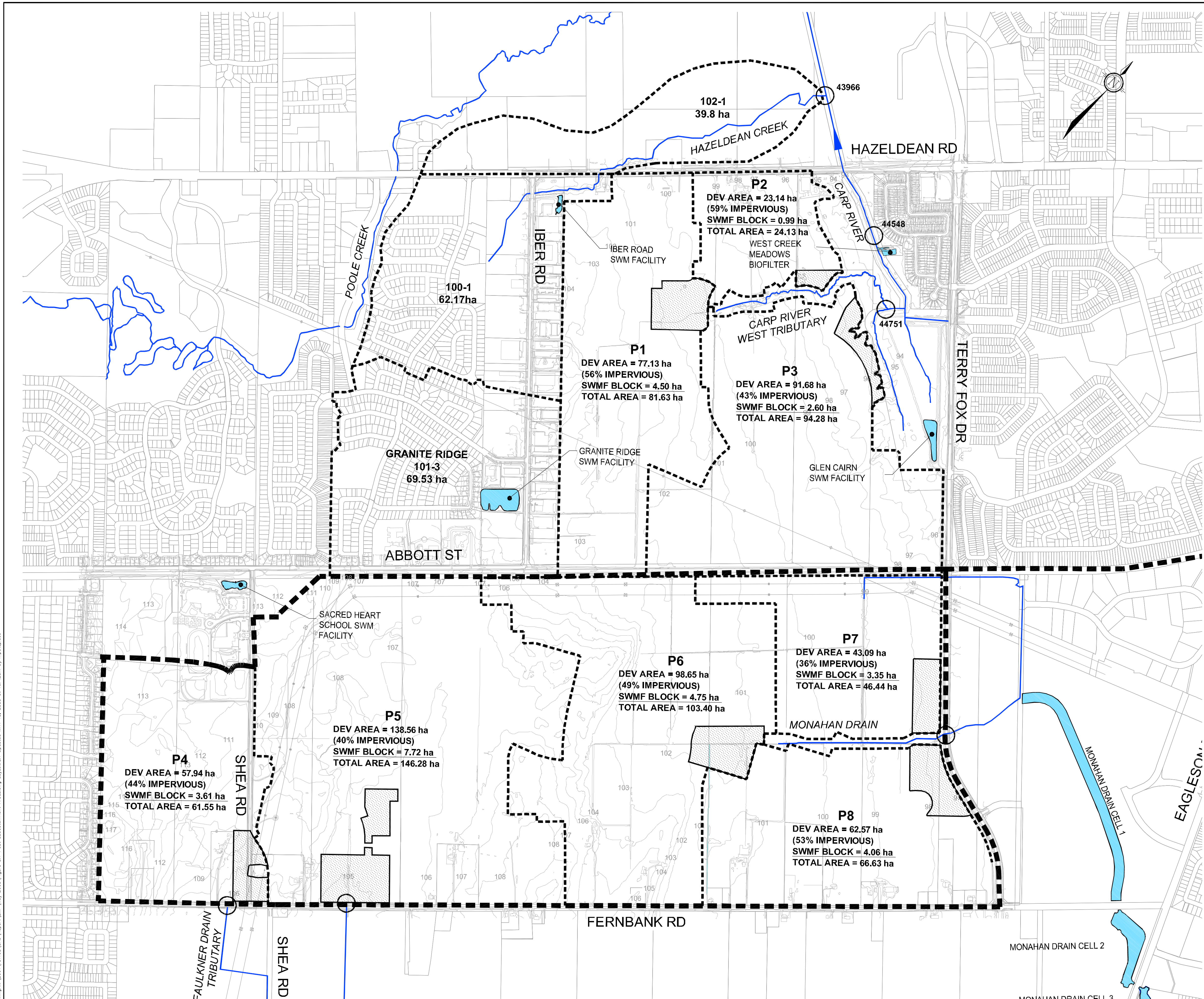

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FIGURE 8.1

Post-Development Conditions

Storm Drainage Subcatchments

○ HYDROGRAPH LOCATIONS

44751 HEC-RAS INFLOW NODE ID (CARP RIVER ONLY)

0 50 100 200 400 600 metres

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8.1.3 Infiltration Best Management Practices

Infiltration of surface runoff is best accomplished through lot level and conveyance controls. However care must be taken to ensure that infiltration measures are suitable for the proposed type of development and soil conditions:

- Infiltration of runoff containing high concentrations of sediment can result in clogging of the pores in the soil, thereby reducing its infiltration capacity.
- Infiltration should be avoided in areas where there is potential for surface spills, which would potentially result in contamination of groundwater.

The majority of the Fernbank Community will be low and medium density residential development. The most suitable practices for groundwater infiltration include:

- Infiltration of runoff captured by rearyard catchbasins.
- Direct roof leaders to rearyard areas.
- Infiltration trenches underlying drainage swales in park and open space areas.
- The use of fine sandy loam topsoil in parks and on residential lawns.

By implementing infiltration BMPs as part of the storm drainage design for the Fernbank Community, the impacts of development on the hydrologic cycle can be considerably reduced. Infiltration of clean runoff will have additional benefits for stormwater management. By reducing the volume of "clean" water conveyed to the SWM facilities, the performance of the SWM facilities will be increased.

<u>Modeling of Infiltration BMPs</u>

The methodology used to incorporate infiltration BMPs into the SWMHYMO model have been developed based on the MOE design guidelines outlined in the *SWM Planning and Design Manual* (MOE, 2003). Details of this methodology are provided in **Appendix G**.

8.2 Results of Post Development Hydrologic Analysis - Event Based

The 12-hour SCS distribution generated the highest peak flows for lands in the Carp River subwatershed in the existing conditions analysis, and consequently was used as the benchmark for analysis of the SWM facilities in the Carp River Subwatershed. The use of the 12-hour SCS distribution is consistent with the design event used in the HEC-RAS analysis of the Carp River.

The 24-hour SCS distribution generated the highest peak flows for lands in the Jock River subwatershed in the existing conditions analysis, and consequently was used as the benchmark for analysis of the SWM facilities in the Jock River Subwatershed.

The results of the hydrologic analysis are summarized in **Tables 8-2 and 8-3**. Pre vs. post-development hydrographs for the 100-year storm events are provided as **Figures 8.2 - 8.7**. SWMHYMO modeling files and pre vs. post-development hydrographs (2 - 100yr) are provided in **Appendix D**.

Table 8-2: Existing vs. Post-Development Peak Flows

Location		Peak Flow (m^3/s)					
		2yr	5yr	10yr	25yr	50yr	100yr
Jock River Subwatershed (24 hr SCS Distribution)							
Monahan Drain @ Terry Fox Drive	Existing	1.21	1.88	2.42	3.06	3.58	**4.29**
	Post (Uncontrolled)	6.99	10.3	12.5	15.5	17.8	**20.4**
	Post (Controlled)	1.16	1.86	2.49	3.07	3.56	**4.27**
	Post (With BMPs)	1.09	1.76	2.34	2.97	3.44	**4.13**
Flewellyn Drain @ Fernbank Road	Existing	1.13	1.76	2.29	2.90	3.39	**4.06**
	Post (Uncontrolled)	3.78	5.69	7.11	8.74	10.28	**12.15**
	Post (Controlled)	1.13	1.67	2.39	2.90	3.23	**3.70**
	Post (With BMPs)	1.09	1.61	2.36	2.88	3.21	**3.67**
Faulkner Tributary @ Fernbank Road	Existing	0.48	0.76	0.98	1.25	1.46	**1.75**
	Post (Uncontrolled)	1.67	2.46	3.05	3.82	4.41	**5.30**
	Post (Controlled)	0.28	0.45	0.66	1.04	1.34	**1.74**
	Post (With BMPs)	0.27	0.42	0.61	0.96	1.26	**1.67**
Carp River Subwatershed (12 hr SCS Distribution)							
Carp River West Tributary Pond 1	Existing	1.71	2.67	3.32	4.25	4.77	**5.43**
	Post (Uncontrolled)	4.71	7.16	8.79	10.49	10.82	**12.53**
	Post (Controlled)	1.50	2.34	4.60	4.89	5.09	**5.41**
	Post (With BMPs)	1.44	2.18	4.39	4.84	5.02	**5.31**
Fernbank north of West Tributary Areas 3536 pre-development Pond 2 out post-development	Existing	0.36	0.66	**0.87**	1.18	1.35	1.58
	Post (Uncontrolled)	1.17	1.76	**2.15**	2.41	2.41	2.86
	Post (Controlled)	0.34	0.60	**0.89**	2.41	2.41	2.77
	Post (With BMPs)	0.32	0.53	**0.68**	2.13	2.23	2.66
Hazeldean Creek @ Carp River Pond 3	Existing	1.09	1.85	**2.37**	3.12	3.54	4.08
	Post (Uncontrolled)	3.79	5.80	**7.13**	8.50	8.50	8.50
	Post (Controlled)	0.53	1.13	**1.57**	5.71	8.50	8.50
	Post (With BMPs)	0.50	1.09	**1.54**	6.38	6.77	8.50

Table 8-3: Existing vs. Post-Development Runoff Volumes

Location		Runoff Volume (ha.m)					
		2yr	5yr	10yr	25yr	50yr	100yr
Jock River Subwatershed (24 hr SCS Distribution)							
Monahan Drain Ponds 6,7,8	Existing	5.31	6.94	10.33	12.95	15.10	18.05
	Post (no BMPs)	7.05	9.74	11.56	13.86	15.72	18.28
	Post (With BMPs)	6.65	9.30	11.10	13.38	15.22	17.75
Flewellyn Drain Pond 5	Existing	3.52	4.60	6.85	8.59	10.01	11.97
	Post (no BMPs)	4.45	6.19	7.37	8.86	10.07	11.73
	Post (With BMPs)	4.13	5.84	7.00	8.48	9.67	11.31
Faulkner Drain Tributary Pond 4	Existing	1.09	1.42	2.11	2.65	3.09	3.69
	Post (no BMPs)	1.99	2.76	3.28	3.94	4.47	5.20
	Post (With BMPs)	1.86	2.61	3.13	3.78	4.31	5.03
Carp River Subwatershed (12 hr SCS Distribution)							
Carp Tributary Headwater Pond 1	Existing	3.72	5.66	6.97	8.86	9.91	11.27
	Post (Uncontrolled)	4.70	6.66	7.96	9.82	10.84	12.21
	Post (With BMPs)	4.56	6.50	7.80	9.65	10.67	12.02
Carp North Pond 2	Existing	0.44	0.76	1.00	1.34	1.53	1.79
	Post (Uncontrolled)	0.79	1.10	1.31	1.61	1.77	2.00
	Post (With BMPs)	0.75	1.06	1.27	1.56	1.73	1.95
Carp South Pond 3	Existing	1.46	2.40	3.03	3.95	4.47	5.13
	Post (Uncontrolled)	2.62	3.72	4.45	5.49	6.09	6.84
	Post (With BMPs)	2.54	3.65	4.40	5.48	6.06	6.85

<u>Pre vs. Post Development Runoff Volumes to Carp River (100 year event)</u>

Pre and post-development runoff volumes to the Carp River for the 100-year storm event have been calculated based on the results of the analysis (refer to **Table 8-4**). This analysis has been completed to demonstrate that the proposed development will meet the following criterion.

- Increases in runoff volume resulting from development are not to exceed an additional 40,000 m^3 above existing conditions for the 100-year event;

Table 8-4: 100yr Runoff Volumes to Carp River

Development Condition	100yr Runoff Volume (m3)				
	Pond 1	Pond 2	Pond 3	Total	Increase
Pre-Development	112,700	17,900	51,300	181,900	-
Post-Development (no BMPs)	122,100	20,000	68,400	210,500	**28,600**
Post-Development (with BMPs)	120,200	19,500	68,500	208,200	**26,300**

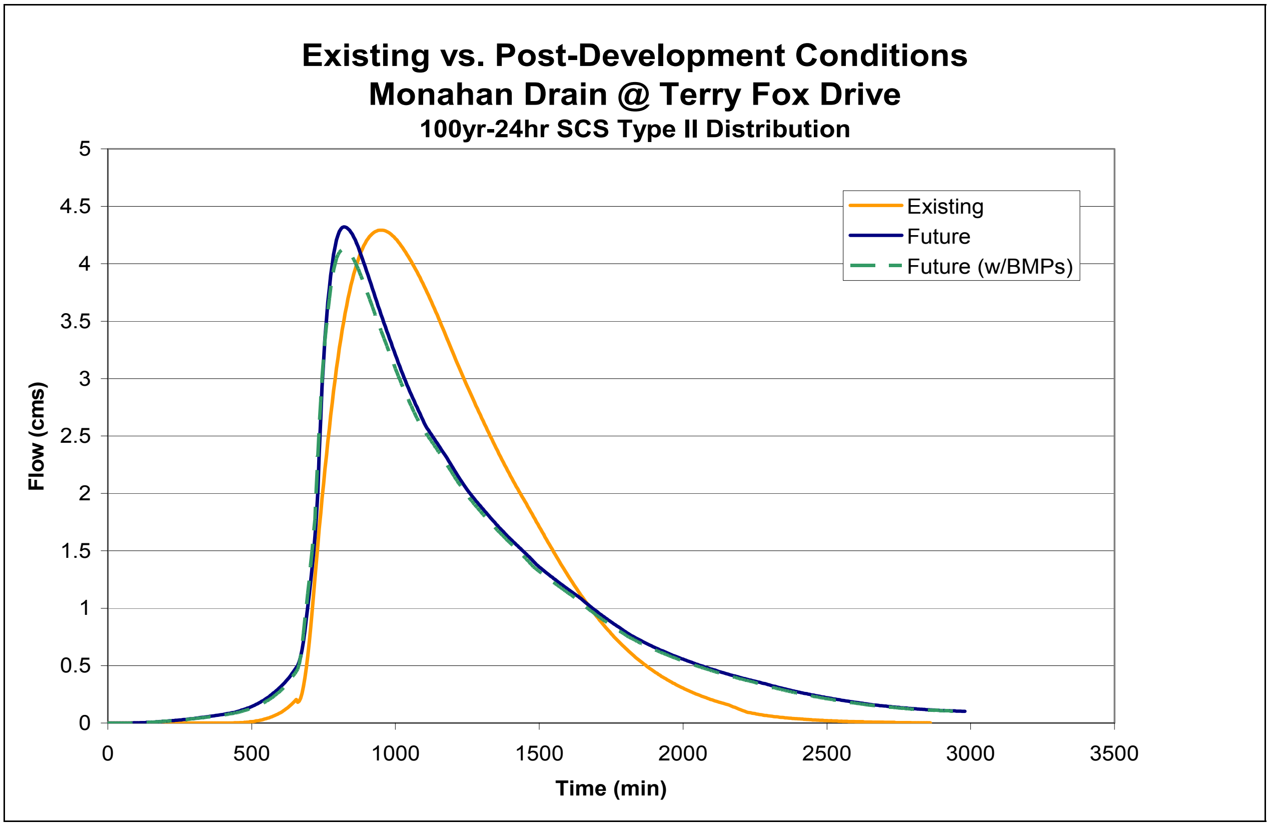

Figure 8.2 Pre vs. Post (100yr)Monahan Drain Hydrograph at Terry Fox Drive

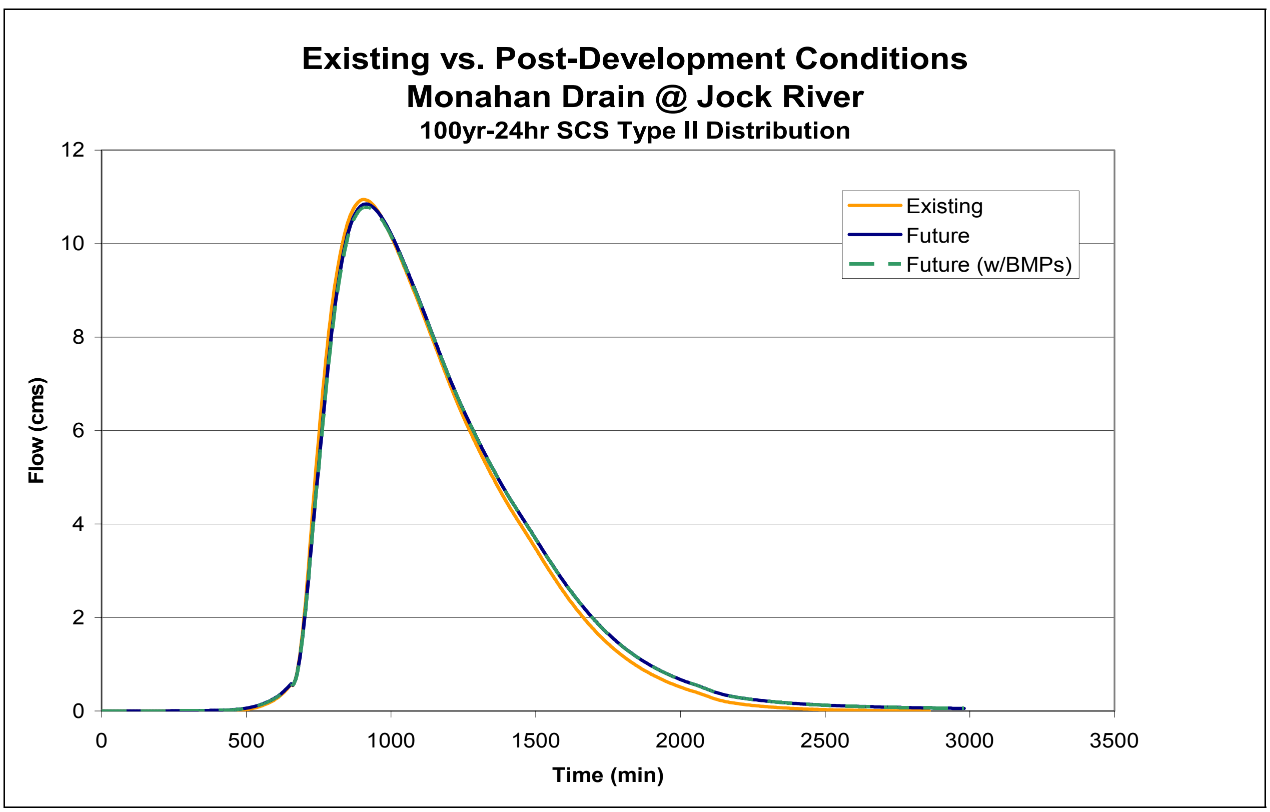

Figure 8.3 Pre vs. Post (100yr)Monahan Drain Hydrograph at Jock River

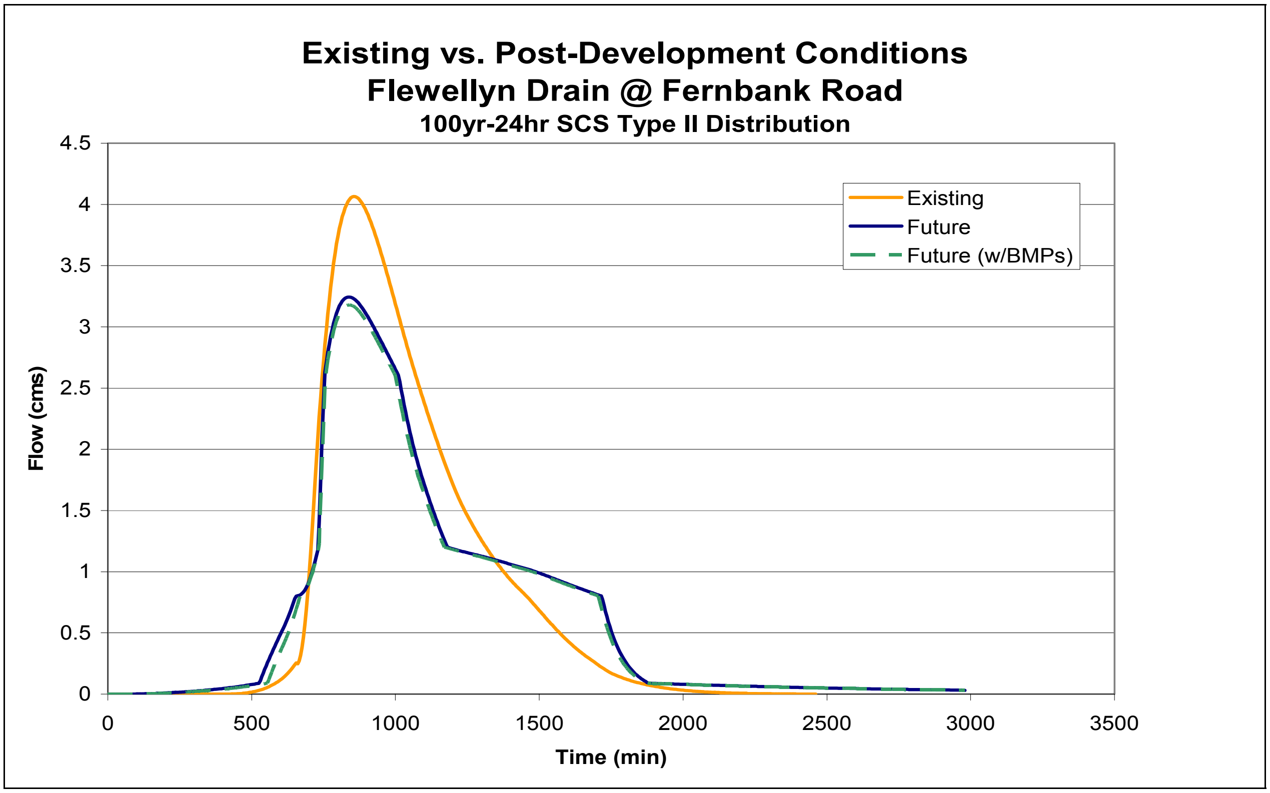

Figure 8.4 Pre vs. Post (100yr) Flewellyn Drain Hydrograph at Fernbank Road

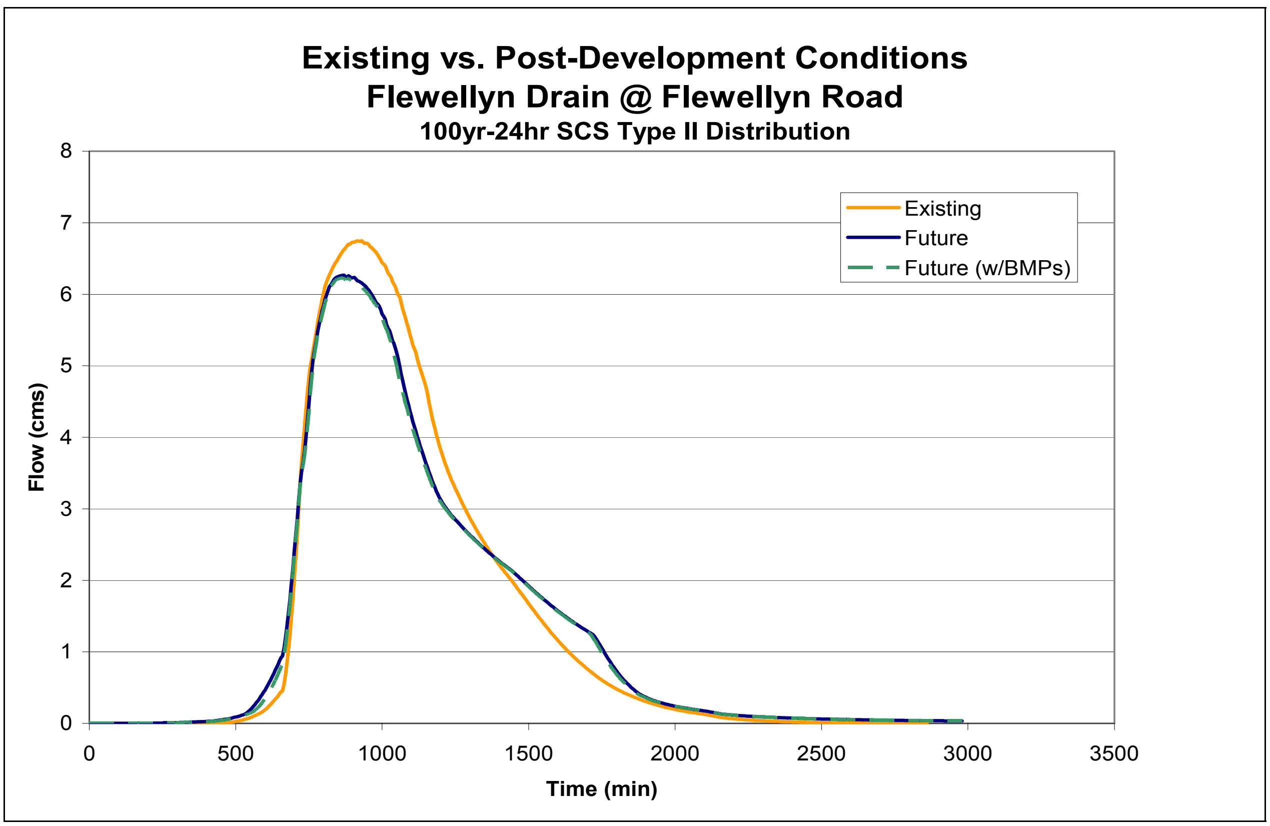

Figure 8.5 Pre vs. Post (100yr) Flewellyn Drain Hydrograph at Flewellyn Road

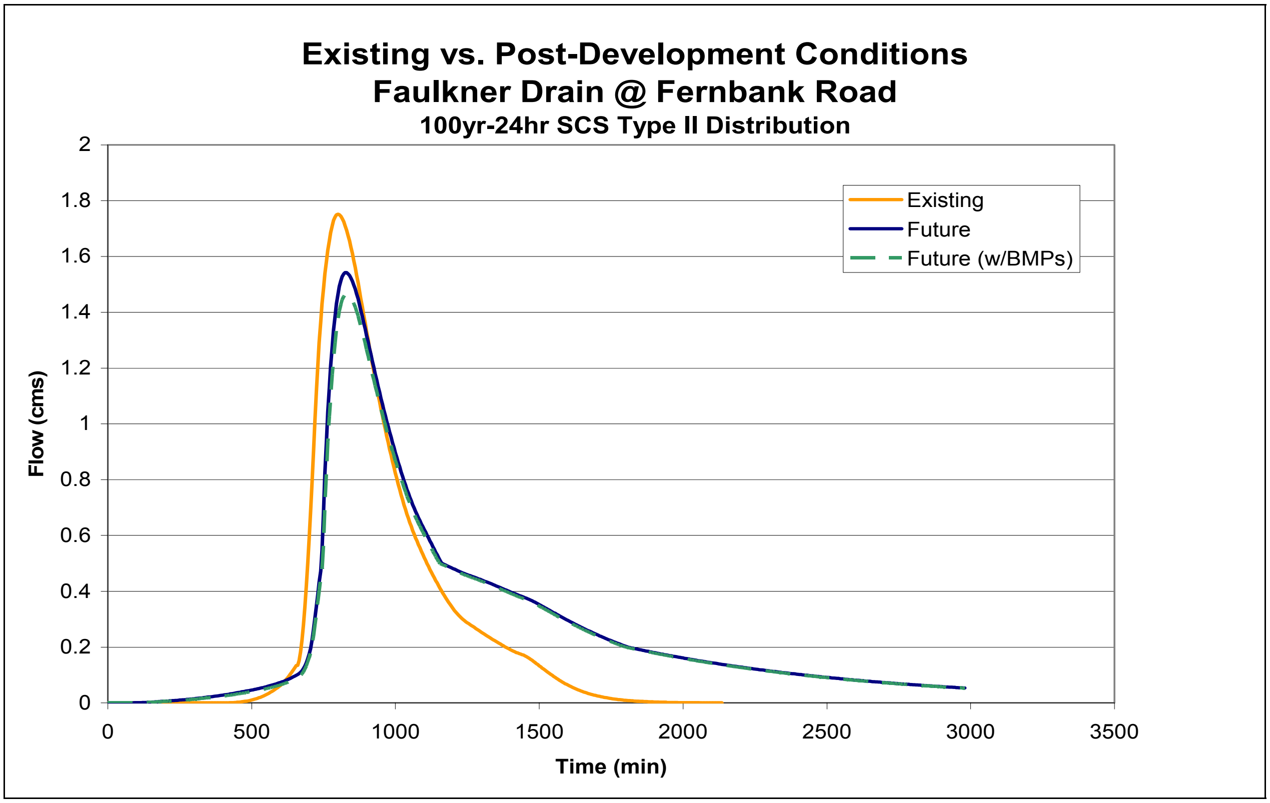

Figure 8.6 Pre vs. Post (100yr)Faulkner Drain Hydrograph at Fernbank Road

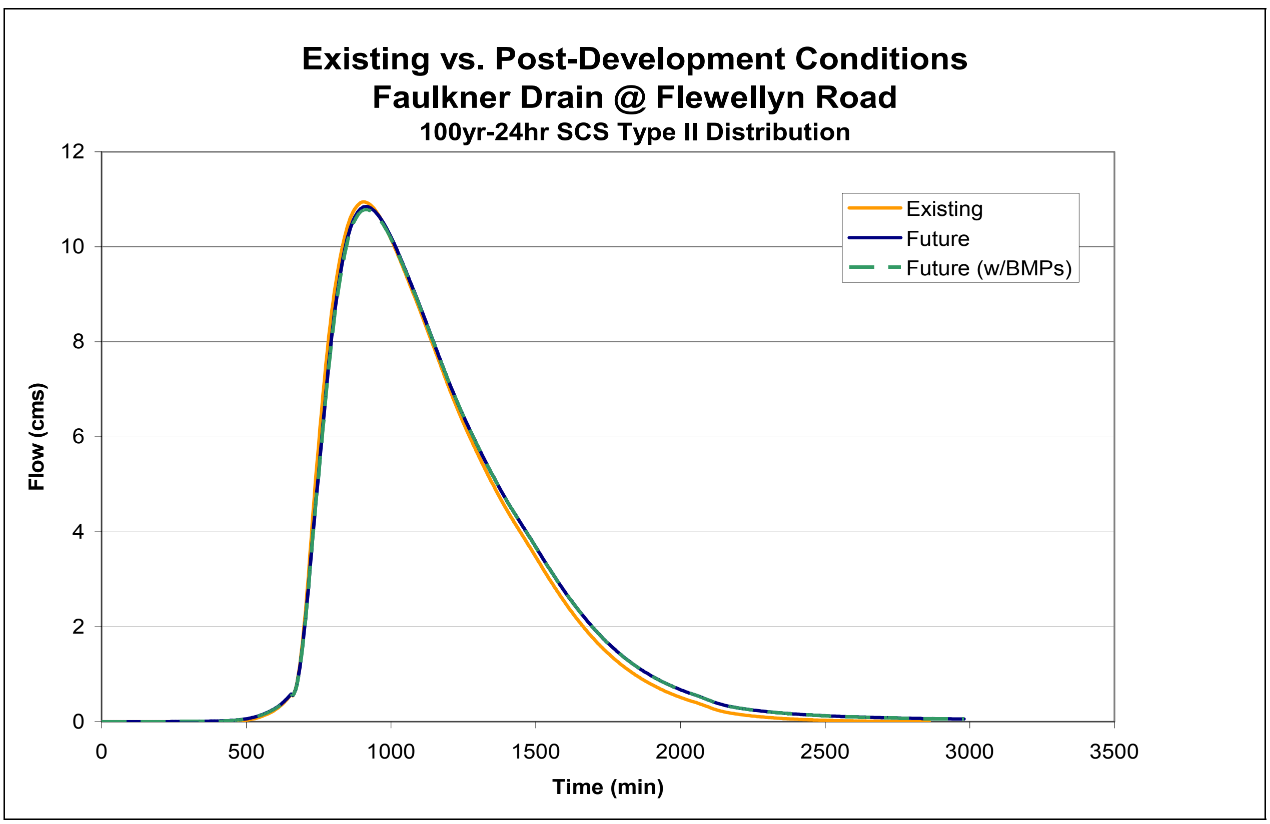

Figure 8.7 Pre vs. Post (100yr) Faulkner Drain Hydrograph at Flewellyn Road

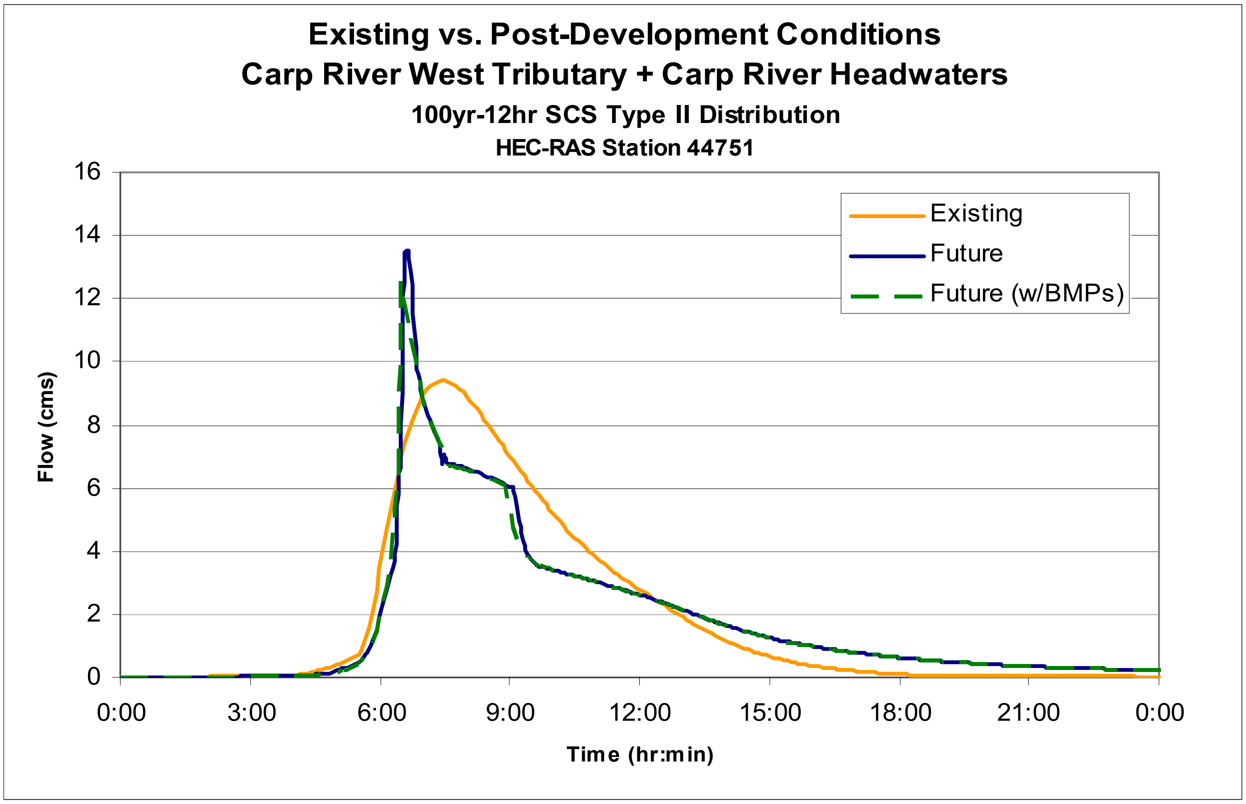

Figure 8.8 Pre vs. Post (100yr) Carp River Inflow Hydrograph at HEC-RAS Station 44751

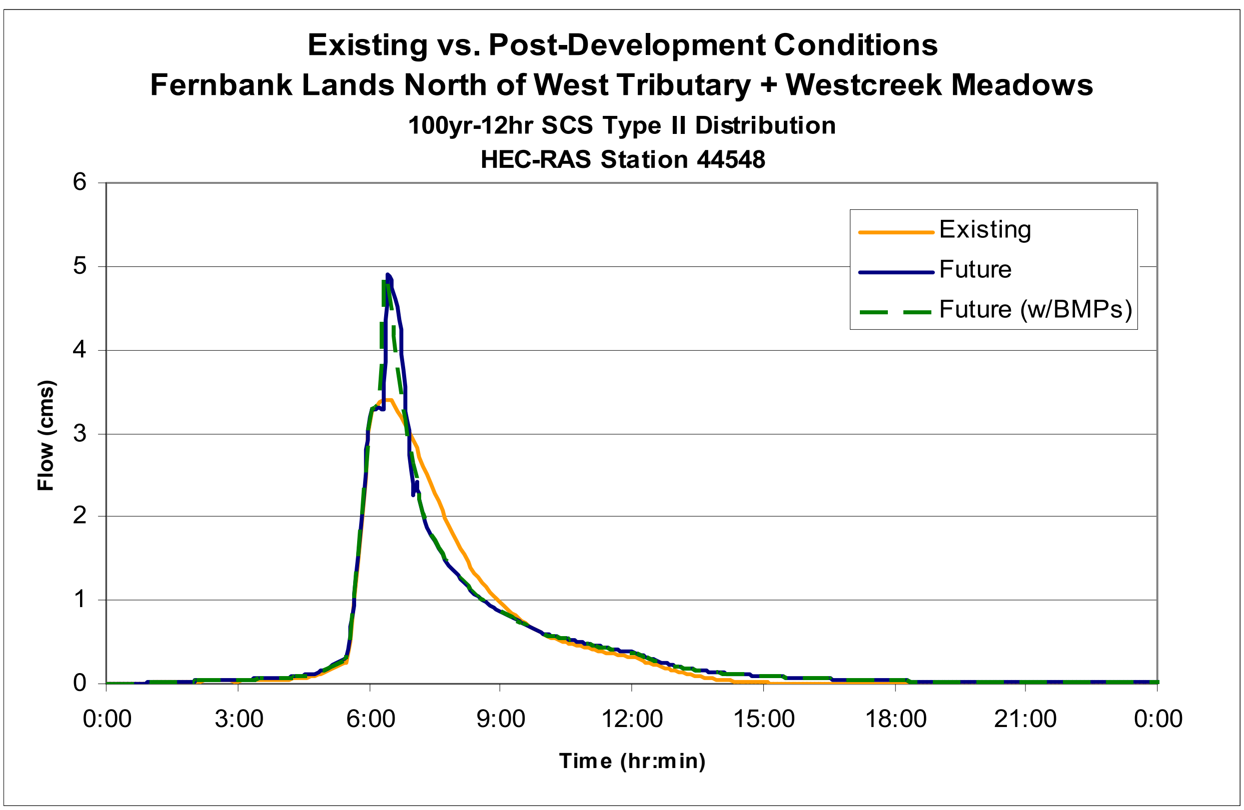

Figure 8.9 Pre vs. Post (100yr) Carp River Inflow Hydrograph at HEC-RAS Station 44548

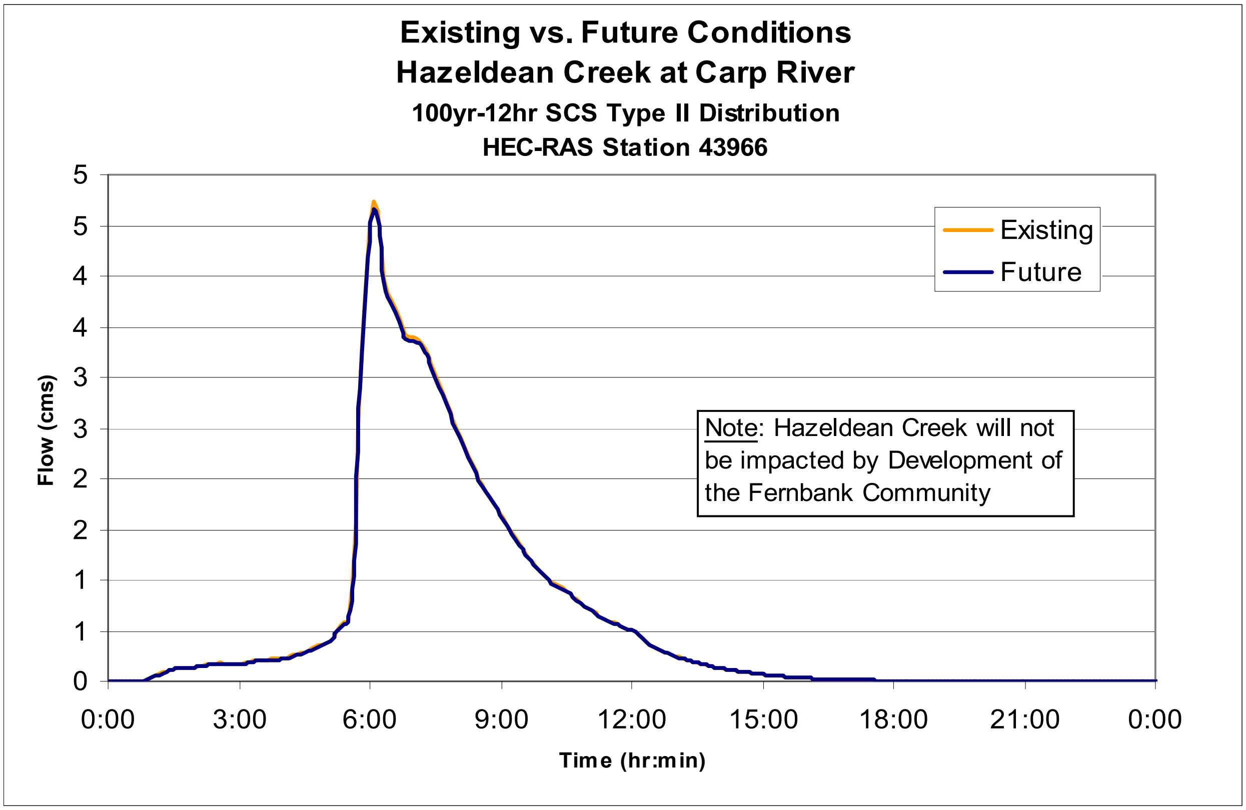

Figure 8.10 Pre vs. Post (100yr) Carp River Inflow Hydrograph at HEC-RAS Station 43966

8.3 Results of Post Development Hydrologic Analysis - Continuous

The protection of the fluvial geomorphic characteristics and functions of watercourses is an integral part of the Environmental Management Plan for the Fernbank study area. Continuous hydrologic modeling simulations have been performed to demonstrate that the proposed SWM strategy will not result in an increase in days of flow above the established erosion thresholds (critical flow) above pre-development conditions.

The results of the continuous analysis have been used to complete an erosion analysis of the receiving watercourses, as well as to quantify changes to the water balance resulting from the proposed development.

- Erosion Analysis - Refer to Section 8.4
- Water Balance Analysis - Refer to Section 8.5

8.3.1 Rainfall Data

Continuous rainfall data was obtained form Environmental Canada Atmospheric and Environmental Services (AES) in hourly format for the years 1967-2002. Rainfall record statistics for each of the years used in the analysis are provided in **Table 8-5**.

Table 8-5: Rainfall Statistics

Year	1974	1979	1981	1986	1995	1997
Annual Precipitation as Rain (mm)	346.9	858.5	928.2	827.4	497.3	396.1

The years selected for use in the analysis were based on the following criteria:

- 2 years with high annual rainfall
  - 1979: 859 mm
  - 1986: 827 mm
- 2 years with low annual rainfall
  - 1974: 347 mm
  - 1997: 396 mm
- 2 years with high return-period events
  - 1995: 99.2 mm over 33 hours
  - 1981: 115.9 mm over 15 hours

8.3.2 Model Results

The hydrologic analysis was run for the six selected years for a period of 245 days between March 1 and November 1. The results of the continuous simulations for the year 1981 are shown on **Figures 8.11 - 8.23**. Simulation results for the remaining years are provided in **Appendix E**.

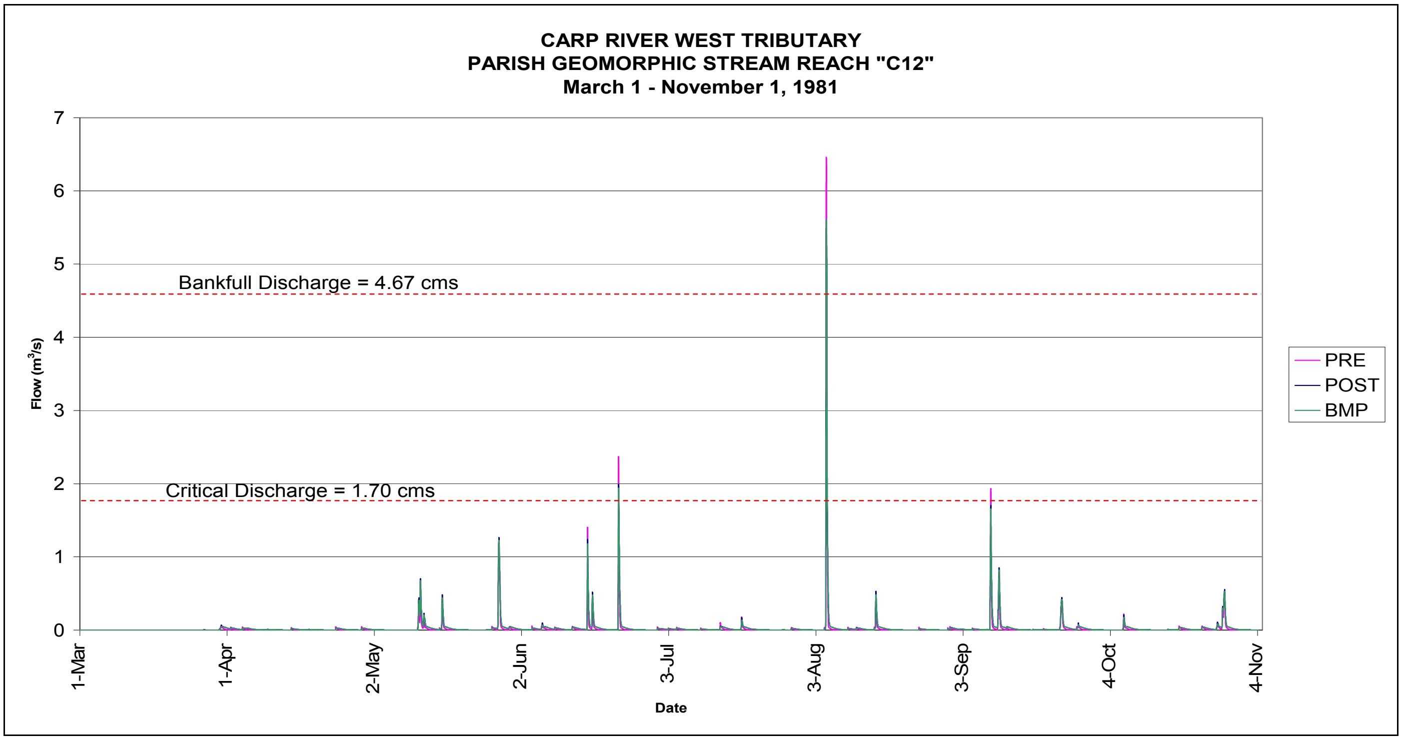

Figure 8.11 Carp River West Tributary (1981)

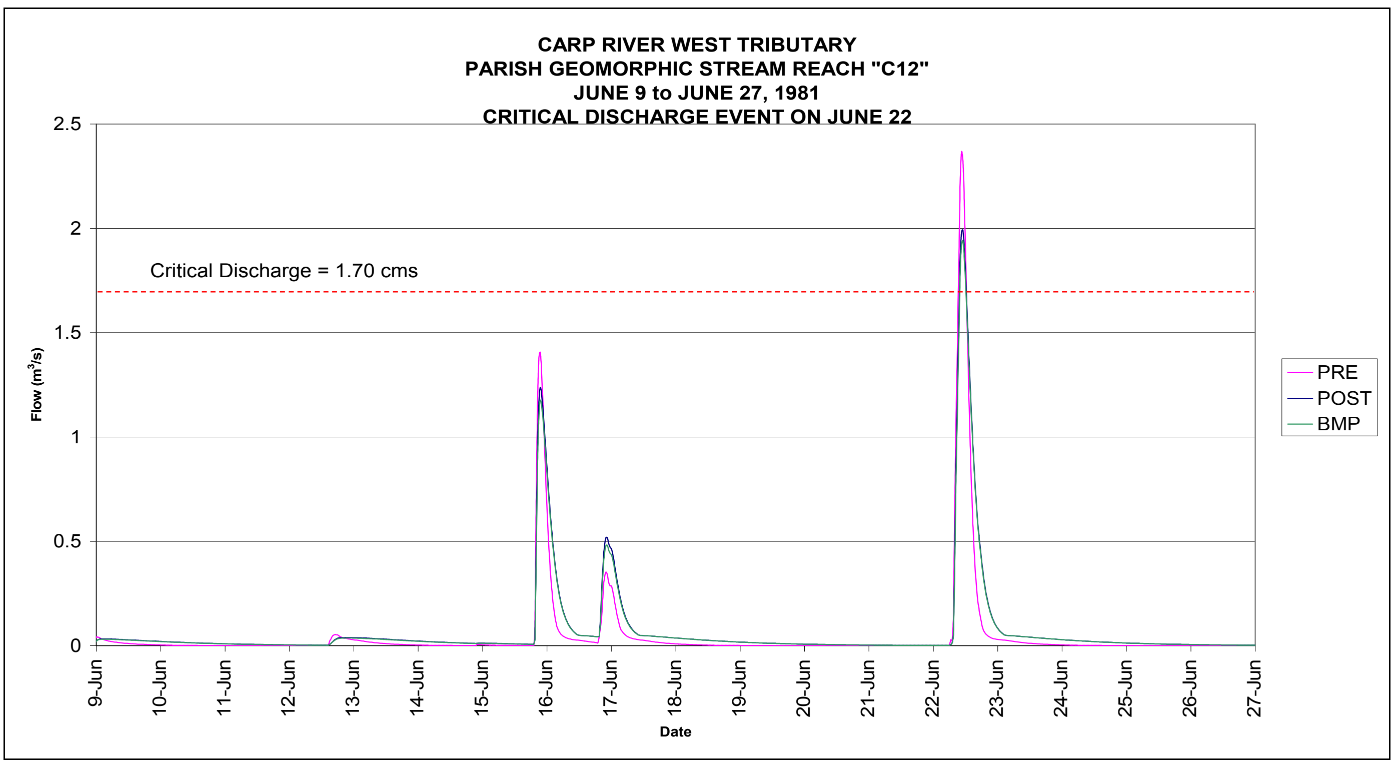

Figure 8.12 Carp River West Tributary - Critical Discharge Event (June 1981)

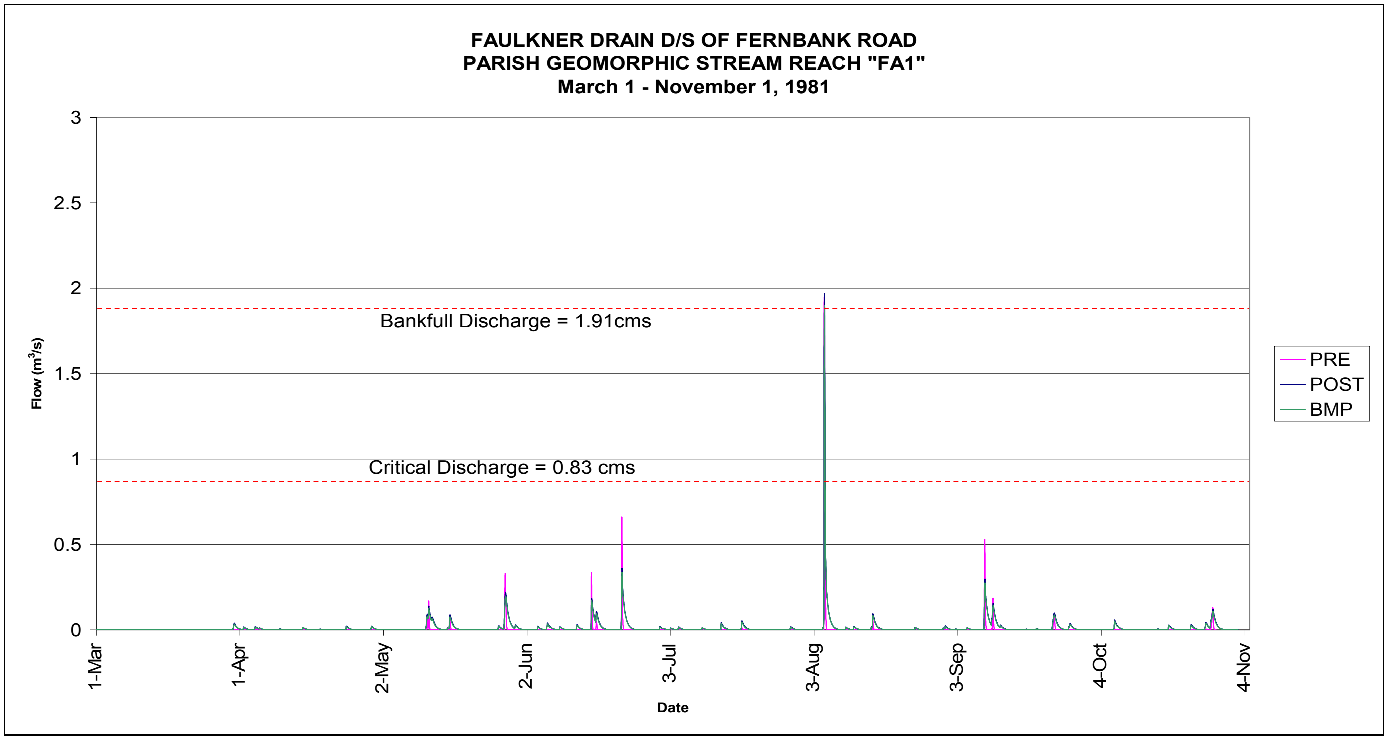

Figure 8.13 Faulkner Drain Tributary @ Fernbank Road (1981)

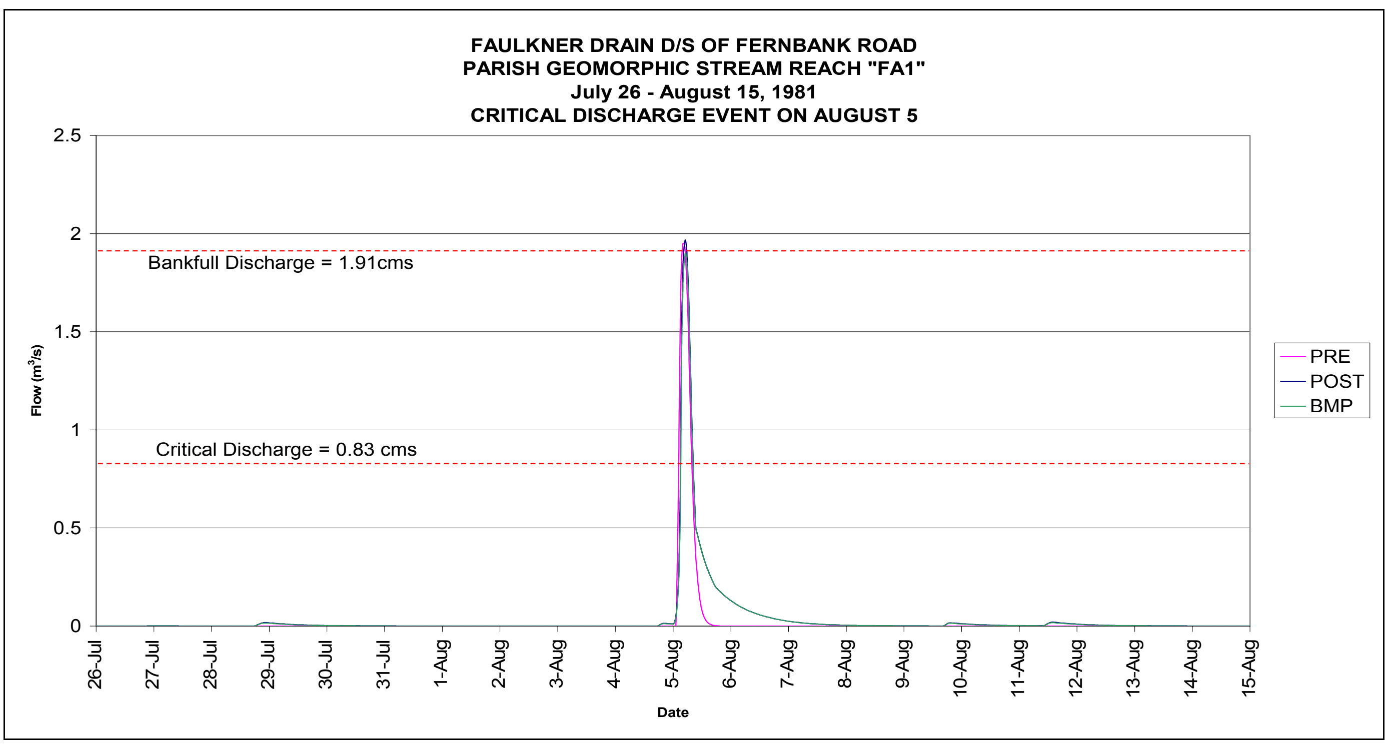

Figure 8.14 Faulkner Drain Tributary @ Fernbank Road - Critical Discharge Event (August 1981)

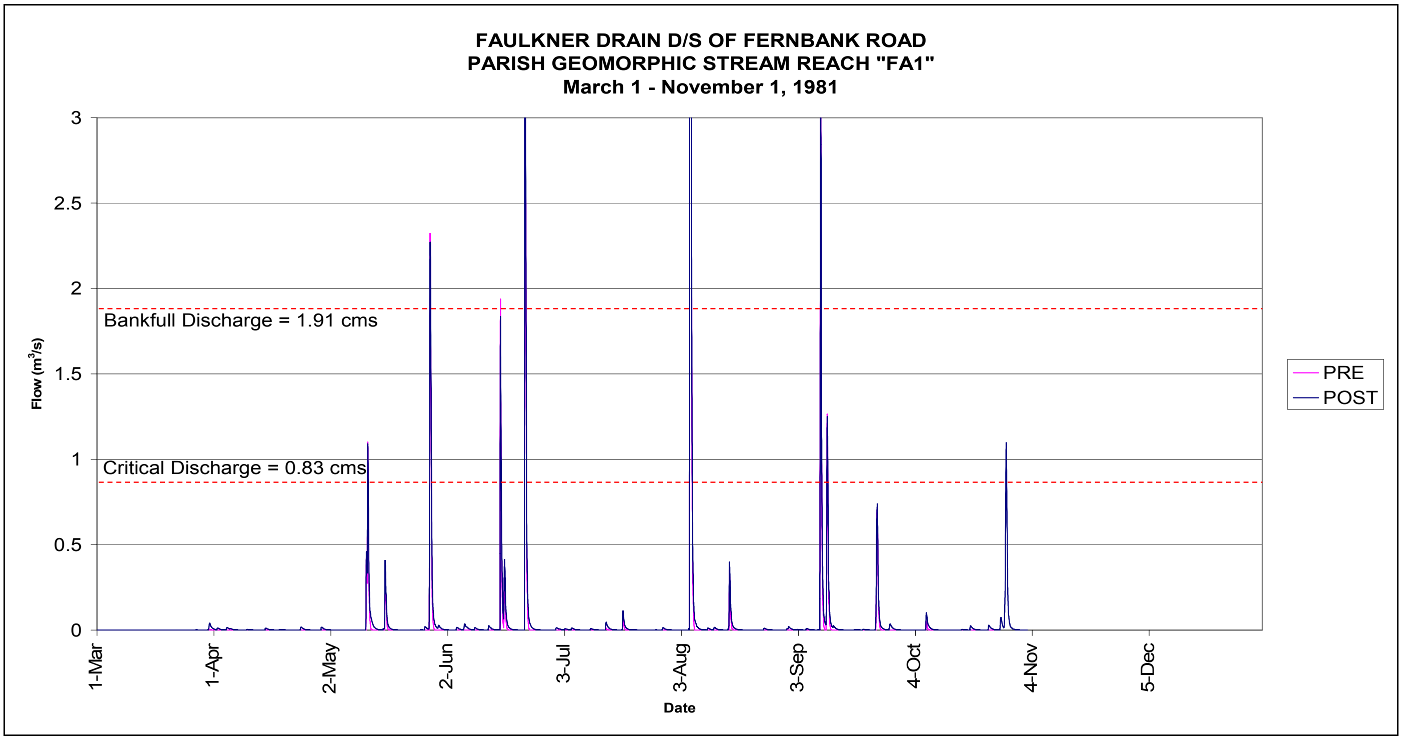

Figure 8.15 Faulkner Drain Tributary @ Flewellyn Road (1981)

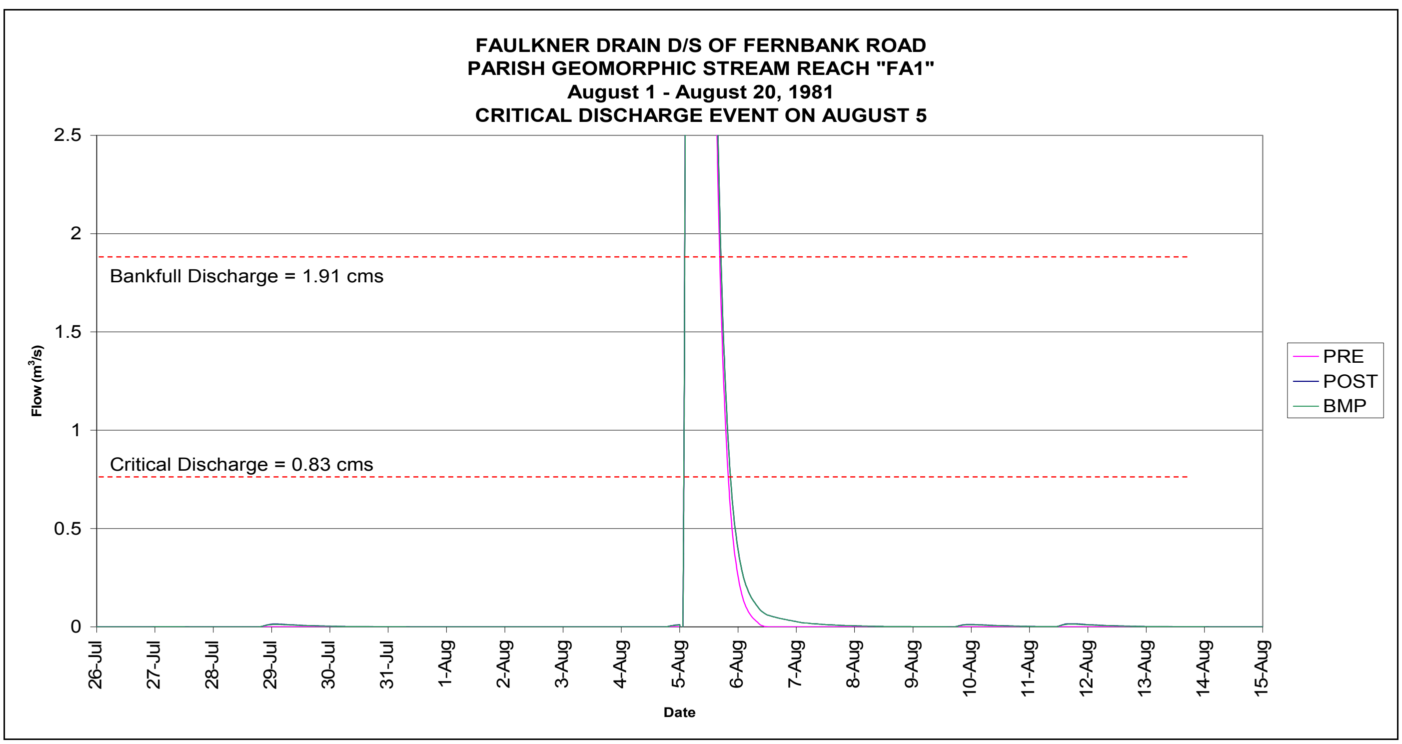

Figure 8.16 Faulkner Drain Tributary @ Flewellyn Road - Critical Discharge Event (August 1981)

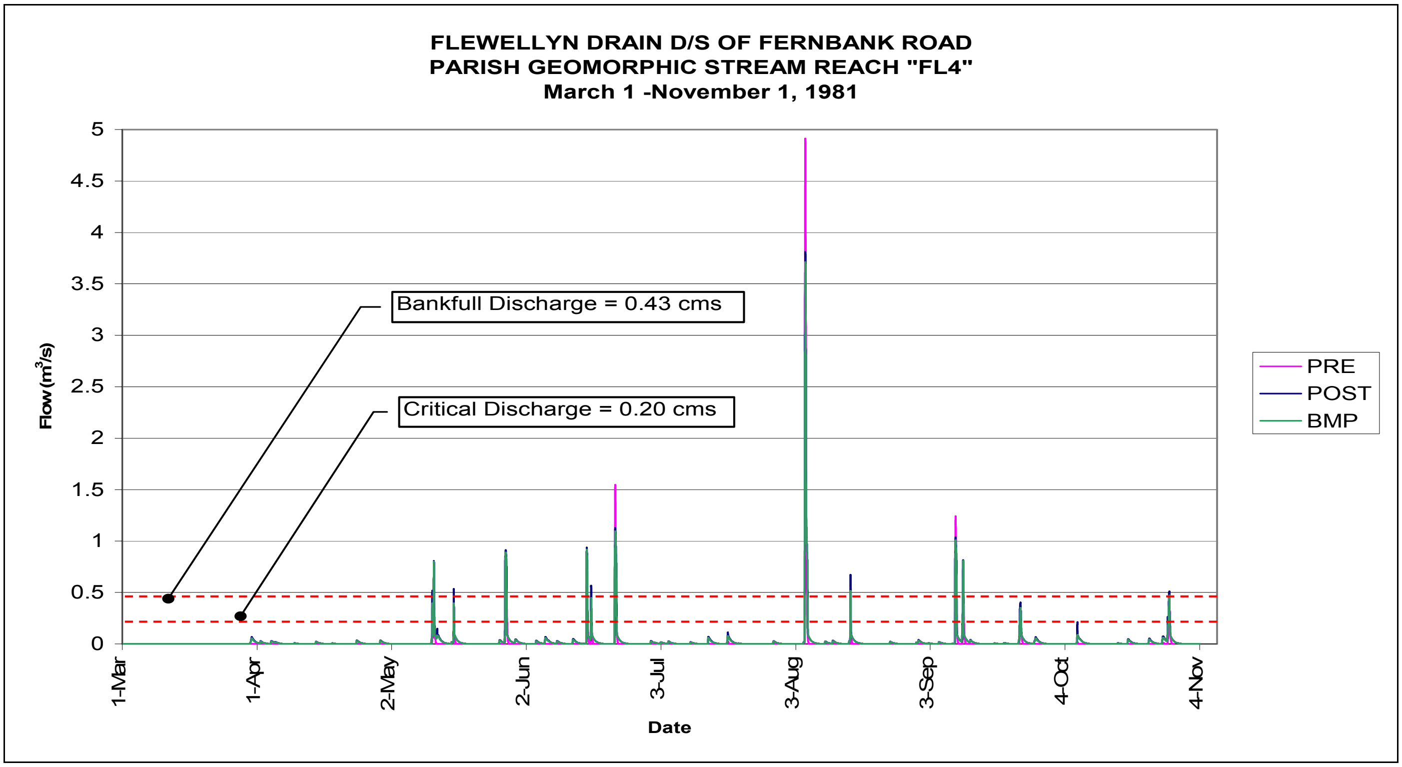

Figure 8.17 Flewellyn Drain @ Fernbank Road (1981)

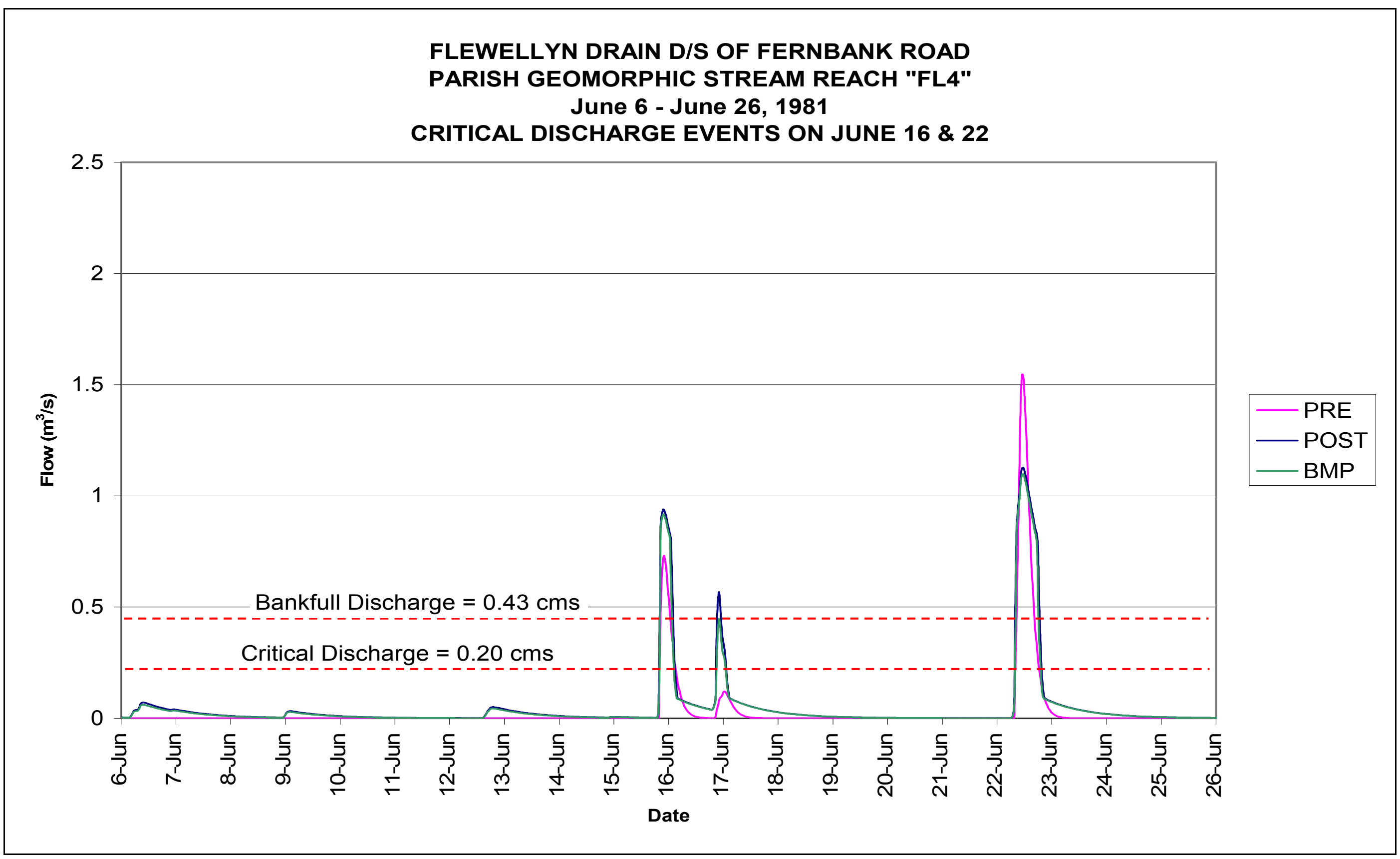

Figure 8.18 Flewellyn Drain @ Fernbank Road - Critical Discharge Events (June 1981)

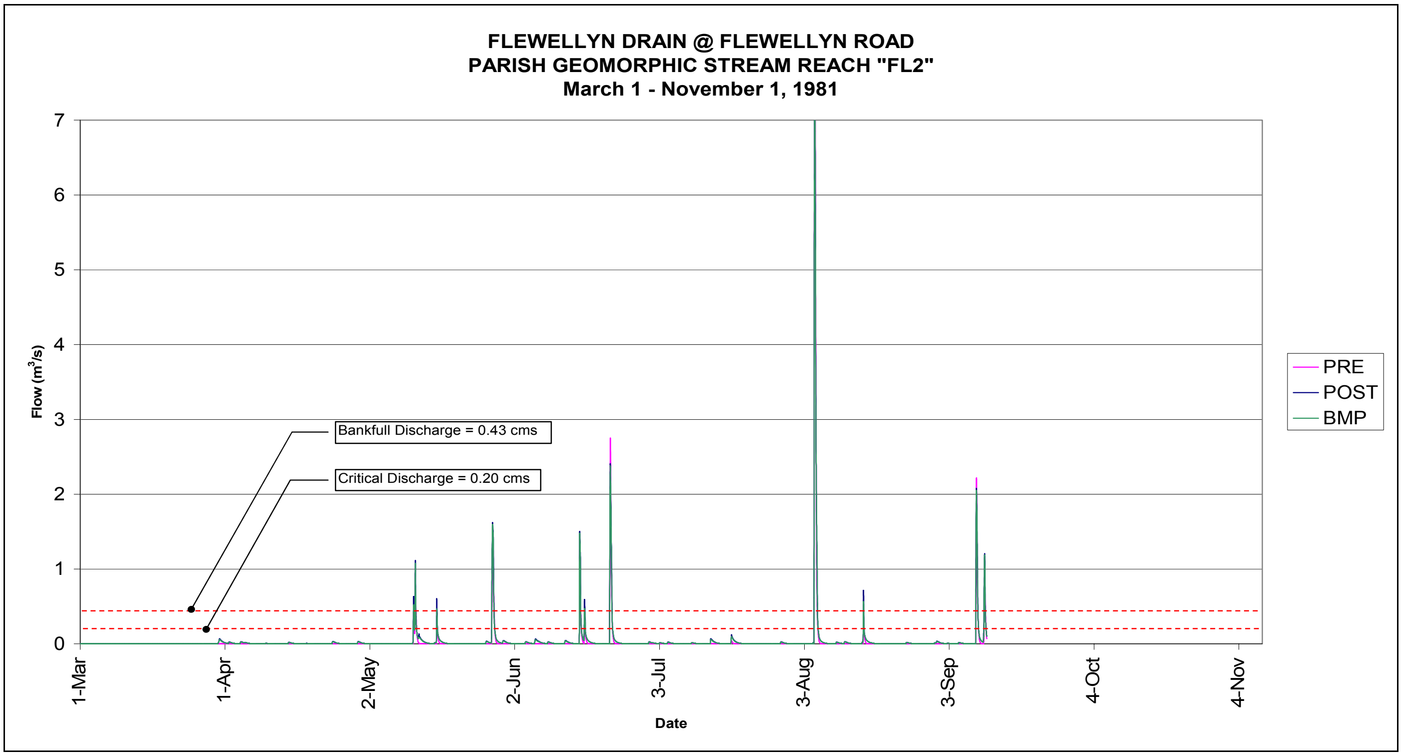

Figure 8.19 Flewellyn Drain @ Flewellyn Road (1981)

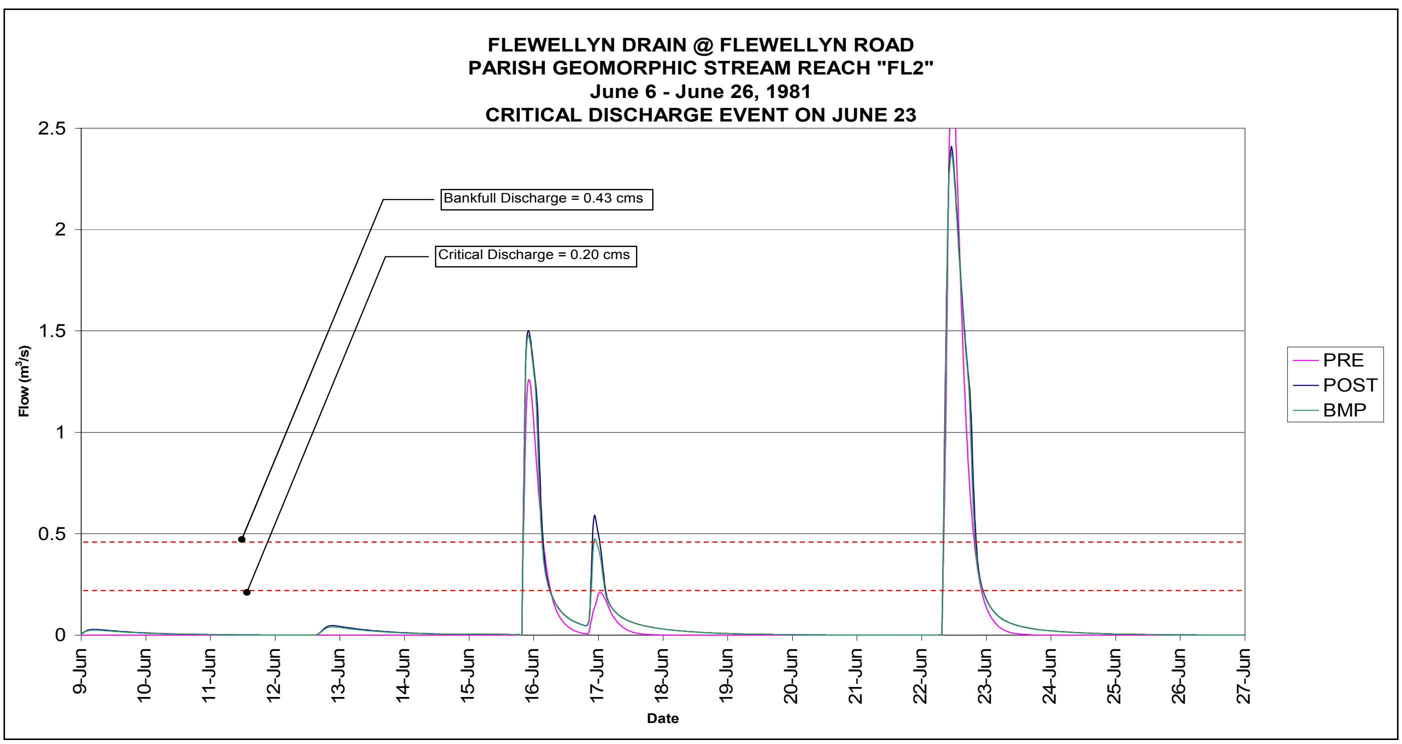

Figure 8.20 Flewellyn Drain @ Flewellyn Road - Critical Discharge Events (June 1981)

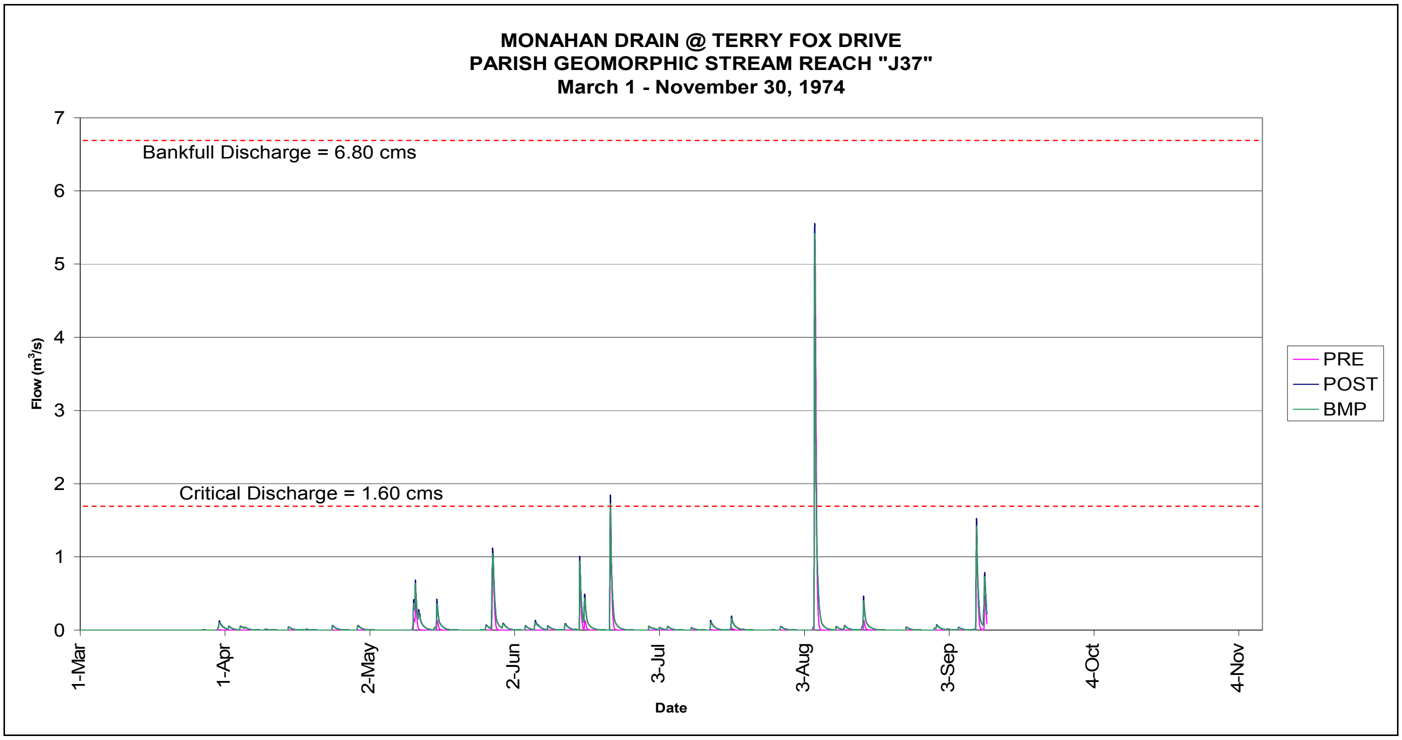

Figure 8.21 Monahan Drain @ Terry Fox Drive (1981)

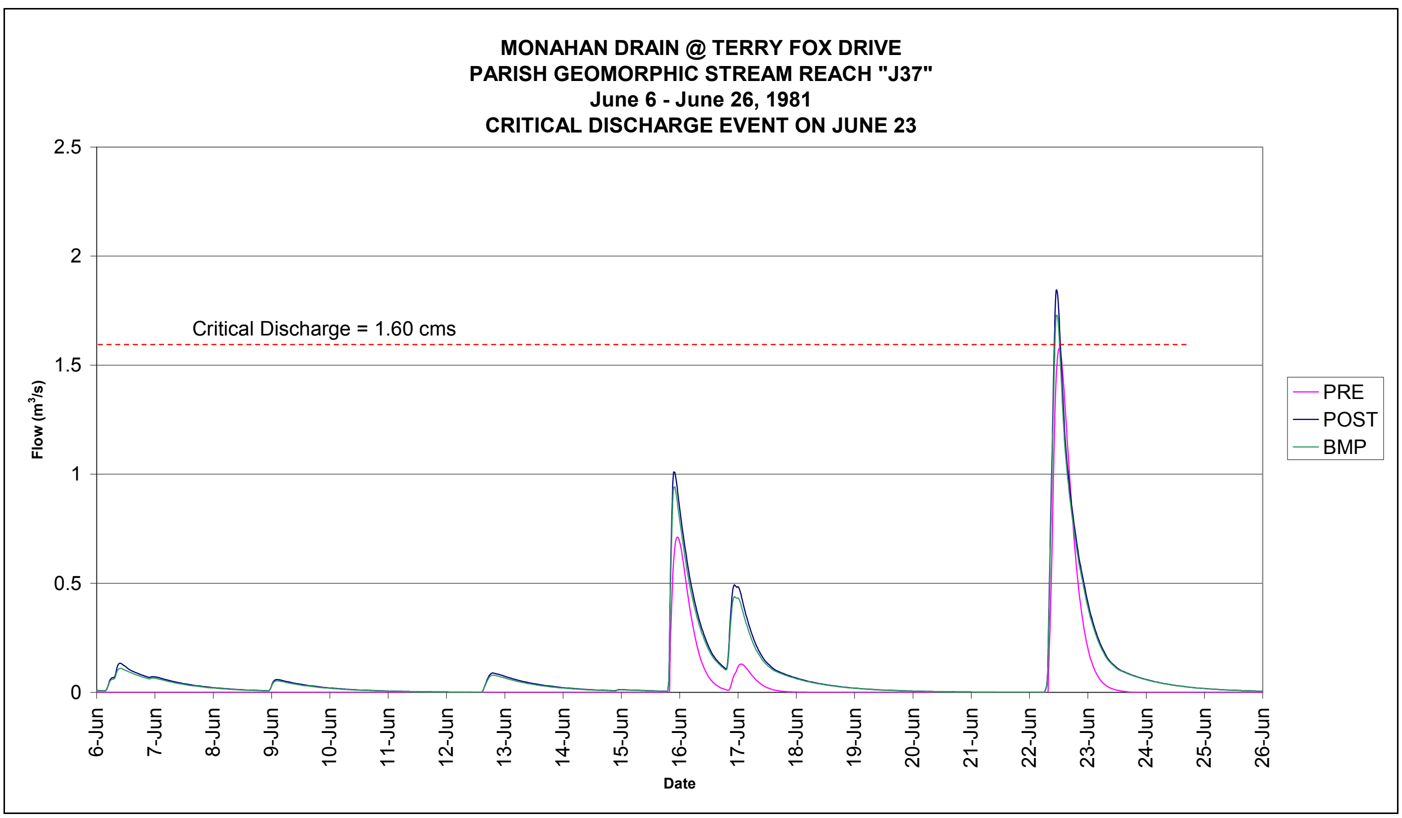

Figure 8.22 Monahan Drain @ Terry Fox Drive - Critical Discharge Event (June 1981)

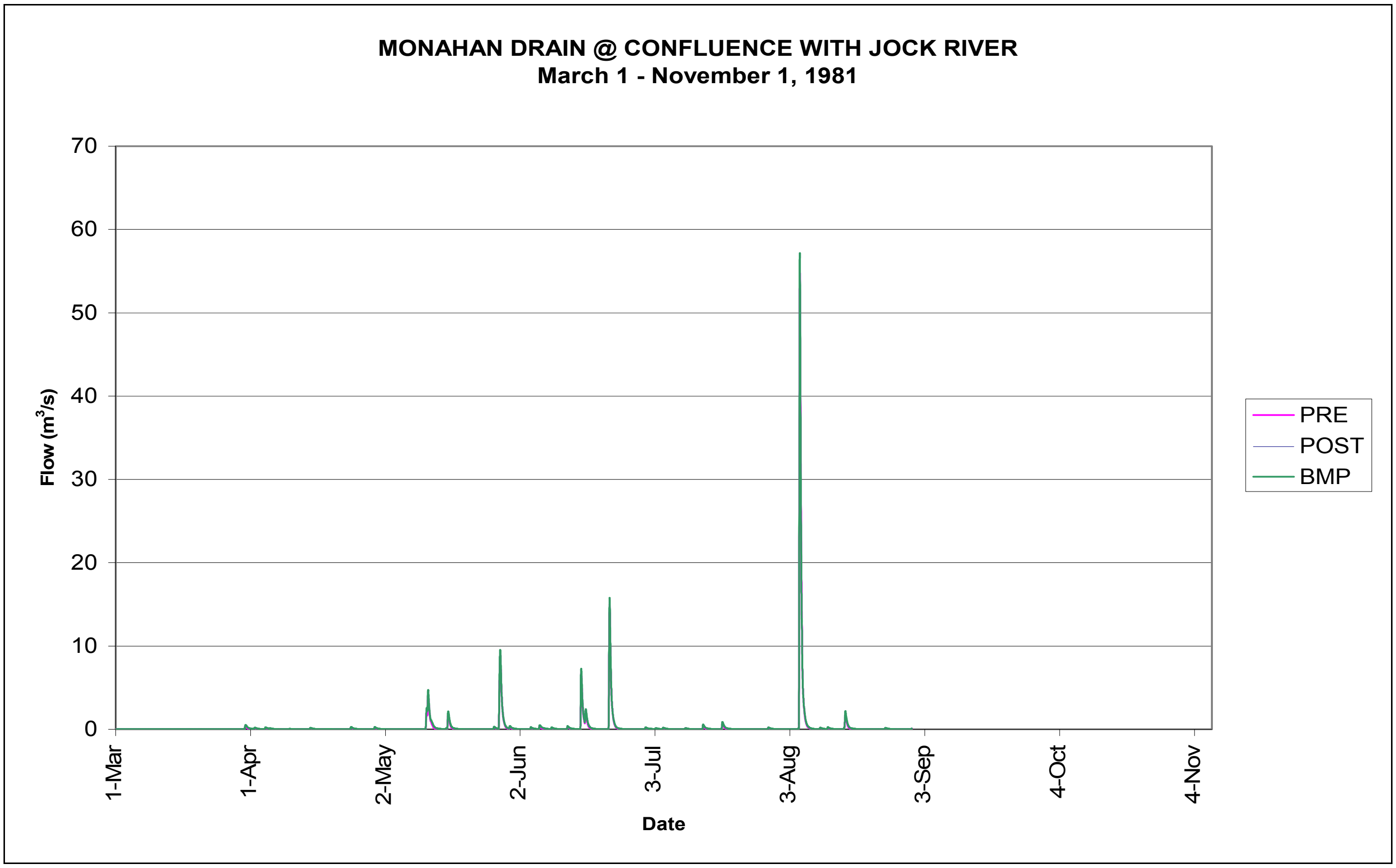

Figure 8.23 Monahan Drain @ Jock River (1981)

8.4 Erosion Analysis

In order to prevent the exacerbation of erosion issues due to land use changes within the study area, erosion threshold targets were established for the study sites. The critical discharge calculation indicates the minimum flows that are necessary to initiate sediment movement of the bed material. If these or larger flows are sustained for a prolonged period of time, then excessive erosion could occur. These targets will provide guidance for storm water management measures by outlining flow regime objectives.

The duration and volume of exceedences over critical flow values established through the fluvial geomorphology analysis have been summarized for each watercourse in the following sections.

8.4.1 Flewellyn Drain

The proposed lowering of the Flewellyn Drain may provide localized benefits with respect to bankfull capacity and flow velocity. The primary purpose of the proposed lowering is to reduce fill requirements in the upstream drainage area. The proposed lowering has not influenced the erosion analysis, as the benefits of this work will not extend downstream of the proposed modifications.

The continuous analysis of the Flewellyn Drain evaluated the annual duration of exceedences of the erosion threshold (critical flow) at two locations:

1) Fernbank Road
2) Flewellyn Road (approx 1.3 km downstream of Fernbank Road)

Table 8-6: Flewellyn Drain Erosion Analysis

# of Hours Exceeding Critical Flow Threshold for Erosion ***% of Total Annual Flow above Erosion Threshold***						
Location	**Year**					
	1974	**1979**	**1981**	**1986**	**1995**	**1997**
Critical Flow = 0.200 m^3/s (FL4)						
Flewellyn Drain @ Fernbank Rd.						
Pre-Development	18 hrs *0.5%*	70 hrs *1.2%*	78 hrs *1.3%*	82 hrs *1.4%*	59 hrs *1.0%*	3 hrs *0.0%*
Post-Development	29 hrs *0.6%*	96 hrs *1.6%*	110 hrs *1.8%*	116 hrs *1.9%*	67 hrs *1.1%*	22 hrs *0.4%*
Post-Development (with BMPs)	25 hrs *0.5%*	81 hrs *1.4%*	99 hrs *1.6%*	100 hrs *1.6%*	62 hrs *1.1%*	11 hrs *0.2%*
Flewellyn Drain @ Flewellyn Rd.						
Pre-Development	40 hrs *1.1%*	107 hrs *1.9%*	126 hrs *2.2%*	132 hrs *2.2%*	76 hrs *1.3%*	11 hrs *0.2%*
Post-Development	42 hrs *0.9%*	133 hrs *2.3%*	149 hrs *2.5%*	158 hrs *2.6%*	84 hrs *1.4%*	37 hrs *0.6%*
Post-Development (with BMPs)	41 hrs *0.9%*	123 hrs *2.1%*	143 hrs *2.4%*	150 hrs *2.5%*	80 hrs *1.4%*	25 hrs *0.4%*

8.4.2 Faulkner Drain

The Lands west of Shea road outlet to a tributary of the Faulkner Drain. The continuous analysis of the Faulkner Drain evaluated the annual duration of erosion threshold (critical flow) exceedences at two locations:

1) Fernbank Road
2) Flewellyn Road (approx 1.3 km downstream of Fernbank Road)

Table 8-7: Faulkner Drain Tributary Erosion Analysis

# of Hours Exceeding Critical Flow Threshold for Erosion ***% of Total Annual Flow above Erosion Threshold***						
Location	**Year**					
	1974	**1979**	**1981**	**1986**	**1995**	**1997**
Critical Flow = 0.830 m^3/s (FA1)						
Faulkner Drain Tributary @ Fernbank Rd.						
Pre-Development	0 hrs *0%*	0 hrs *0%*	6 hrs *0.1%*	0 hrs *0%*	4 hrs *0%*	0 hrs *0%*
Post-Development	0 hrs *0%*	0 hrs *0%*	5 hrs *0.1%*	0 hrs *0%*	0 hrs *0%*	0 hrs *0%*
Post-Development (with BMPs)	0 hrs *0%*	0 hrs *0%*	5 hrs *0.1%*	0 hrs *0%*	0 hrs *0%*	0 hrs *0%*
Faulkner Drain Tributary @ Flewellyn Rd.						
Pre-Development	19 hrs *0.5%*	67 hrs *1.2%*	77 hrs *1.3%*	77 hrs *1.3%*	65 hrs *1.1%*	0 hrs *0%*
Post-Development	20 hrs *0.4%*	73 hrs *1.2%*	83 hrs *1.4%*	83 hrs *1.4%*	69 hrs *1.2%*	0 hrs *0%*
Post-Development (with BMPs)	20 hrs *0.4%*	71 hrs *1.2%*	82 hrs *1.4%*	81 hrs *1.4%*	69 hrs *1.2%*	0 hrs *0%*

8.4.3 Monahan Drain

The Monahan Drain outlets to Cell 1 of the Monahan Drain Constructed Wetlands approximatley 400 m downstream of Terry Fox Drive. The detailed monitoring site (MO2 - refer to **Figure 3.8**) used to establish the critical erosion threshold for the Monahan Drain is now located within Cell 1 of the Constructed Wetlands. This site was determined to be the most sensitive reach of the Monahan Drain with respect to erosion downstream of Terry Fox Drive, and so the use of the critical flow values from this site represent a conservative approach to the erosion analysis.

The continuous analysis of the Monahan Drain evaluated the annual duration of flows above the erosion threshold (critical flow) at the following location:

3) Downstream of Terry Fox Drive

Additional analysis downstream of the Monahan Drain Constructed Wetlands SWM Facility was deemed unnecessary, as the Fernbank Lands have been sufficiently accounted for in the design of the Constructed Wetlands, as outlined in the *Monahan Drain Constructed Wetlands Phase 2 Final Design Report* (Novatech, October 2006).

Table 8-8: Monahan Drain Erosion Analysis

# of Hours Exceeding Critical Flow Threshold for Erosion *% of Total Annual Flow above Erosion Threshold*						
Location	**Year**					
	1974	**1979**	**1981**	**1986**	**1995**	**1997**
Critical Flow = 1.60 m³/s (J37)						
Monahan Drain @ Terry Fox Drive						
Pre-Development	0 hrs *0%*	6 hrs *0.1%*	12 hrs *0.2%*	5 hrs *0.1%*	19 hrs *0.3%*	0 hrs *0%*
Post-Development	0 hrs *0%*	9 hrs *0.1%*	14 hrs *0.2%*	7 hrs *0.1%*	20 hrs *0.3%*	0 hrs *0%*
Post-Development (with BMPs)	0 hrs *0%*	7 hrs *0.1%*	13 hrs *0.2%*	6 hrs *0.1%*	16 hrs *0.3%*	0 hrs *0%*

8.4.4 Carp River West Tributary

The Carp River West Tributary outlets to the Carp River approximately 600 m downstream of proposed SWM Facility P1. The continuous analysis of the Carp River Tributary evaluated the annual duration of flows above the erosion threshold (critical flow) at the following location:

4) Monitoring Location C12 - refer to **Figure 3.8**

Table 8-9: Carp River West Tributary Erosion Analysis

# of Hours Exceeding Critical Flow Threshold for Erosion *% of Total Annual Flow above Erosion Threshold*						
Location	**Year**					
	1974	**1979**	**1981**	**1986**	**1995**	**1997**
Critical Flow = 1.70 m³/s (C12)						
Carp River West Tributary @ Monitoring Location C12 (Downstream of SMWF P1)						
Pre-Development	0 hrs *0%*	7 hrs *0.1%*	12 hrs *0.2%*	6 hrs *0.1%*	16 hrs *0.3%*	0 hrs *0%*
Post-Development	0 hrs *0%*	6 hrs *0.1%*	10 hrs *0.2%*	4 hrs *0.1%*	15 hrs *0.3%*	0 hrs *0%*
Post-Development (with BMPs)	0 hrs *0%*	5 hrs *0.1%*	10 hrs *0.2%*	4 hrs *0.1%*	14 hrs *0.2%*	0 hrs *0%*

8.4.5 Erosion Analysis Results

The largest increase in duration of flows exceeding the erosion threshold occurs in the Flewellyn Drain at Flewellyn Road for the year 1986 (refer to **Table 8-6**). Erosive flows occurred for an additional 26 hours which represents a 0.4% increase of the total annual flow volume above the erosion threshold (from model results), and a 0.4% increase in duration of annual flow above the erosion threshold (refer to calculations below).

<u>Ex. Flewellyn Drain @ Flewellyn Road (1986)</u>	
Duration of Flows above erosion threshold (existing conditions)	132 hrs
Duration of Flows above erosion threshold (post-development)	158 hrs
Increase in duration above erosion threshold (pre vs. post)	158 - 132 = 26 hrs 26 hrs = 1.1 days
Number of Days in Simulation	245 days
% Increase in Duration of Flows above Erosion Threshold	1.1 / 245 = 0.4%

The results of the erosion analysis for all outlet watercourses indicate that the proposed SWM Facilities will ensure that there is no increase in erosion potential resulting from the proposed development.

8.5 Groundwater Infiltration & Water Balance

The hydrogeologic conditions of the Fernbank Community are described in terms of infiltration potentials, groundwater recharge and discharge, and the groundwater flow systems. Infiltration rates are controlled by the nature of the surface and near-surface materials.

The hydrogeologic conditions of the Fernbank Community will be altered by the increase in hard surfaces and the increased efficiency of stormwater conveyance resulting from the proposed development. The net result will be a reduction in groundwater infiltration, which can potentially result in a reduction in the groundwater table, reduction of baseflow in watercourses, reduced well capacities and consolidation of the overburden, among other impacts.

8.5.1 Water Balance

A water balance has been completed for the Fernbank CDP lands to provide an estimate of infiltration under both existing conditions and post-development conditions. Infiltration, evapotranspiration, and runoff values used in the water balance calculations for the Fernbank Community have been established based on the results of the hydrogeologic and geotechnical investigations completed as part of the existing conditions analysis, in conjunction with values used in previous studies in the area (Robinson, 2001; MMM & WESA, 2005). Hydrologic cycle component values used for the Fernbank Community are provided in **Table 8-10**.

Table 8-10: Water Balance - Hydrologic Cycle Component Values

Land Use	Soil Type	Annual Precipitation: 944 mm		
		ET (mm)	INFIL (mm)	RUNOFF (mm)
Pasture / Meadow / Open Space	Beach Formations (Sand / Sand & Gravel)	510	300	134
	Fine to Medium Sand	520	250	174
	Thick Organic Deposits (Peat)	530	175	239
	Sensitive Marine Silty Clay	530	100	314
	Thin Discontinuous Organic Deposits	530	135	279
	Paleozolic Bedrock	530	120	294
	Glacial Till	530	73	341
Agricultural	Beach Formations (Sand / Sand & Gravel)	400	290	254
	Fine to Medium Sand	410	230	304
	Thick Organic Deposits (Peat)	420	160	364
	Sensitive Marine Silty Clay	420	110	414
	Thin Discontinuous Organic Deposits	420	130	394
	Paleozolic Bedrock	420	125	399
	Glacial Till	420	80	444
Woodland	Beach Formations (Sand / Sand & Gravel)	530	310	104
	Fine to Medium Sand	540	275	129
	Thick Organic Deposits (Peat)	550	220	174
	Sensitive Marine Silty Clay	550	150	244
	Thin Discontinuous Organic Deposits	550	145	249
	Paleozolic Bedrock	550	140	254
	Glacial Till	550	125	269
Urban Grassed Area (no BMPs)	Beach Formations (Sand / Sand & Gravel)	495	290	159
	Fine to Medium Sand	510	230	204
	Thick Organic Deposits (Peat)	525	160	259
	Sensitive Marine Silty Clay	525	145	274
	Thin Discontinuous Organic Deposits	525	130	289
	Paleozolic Bedrock	525	125	294
	Glacial Till	525	90	329
Urban Grassed Area (with Infiltration BMPs)	Beach Formations (Sand / Sand & Gravel)	300	580	64
	Fine to Medium Sand	400	460	84
	Thick Organic Deposits (Peat)	490	320	134
	Sensitive Marine Silty Clay	480	290	174
	Thin Discontinuous Organic Deposits	460	260	224
	Paleozolic Bedrock	500	250	194
	Glacial Till	480	180	284
Water / Wetland / SWMF	Clay / Silty Clay	660	50	234
Impervious Areas	N/A	194	0	750

The surficial soils underlying the majority of the Fernbank Lands are comprised of relatively impervious Paleozoic bedrock, sensitive marine clay, and glacial till and infiltration rates are quite low throughout the study area.

The impervious values used in the water balance calculations have been established based on the proposed land use areas shown on the demonstration land use plan. Standard imperviousness values from the City of Ottawa design guidelines were assigned for each land use and used to calculate an average imperviousness for each drainage basin.

The use of stormwater management Best Management Practices (BMPs) is encouraged to help minimize the impact of development on the hydrologic cycle. The native soils on-site are relatively impermeable, which results in a relatively low annual infiltration. Infiltration BMPs will not increase the infiltration rate of the native soil, but will promote the retention of storm runoff, thereby increasing the amount of runoff available for infiltration.

Recommended stormwater management BMPs are listed in **Section 8.1.3**. Infiltration BMPs were accounted for in the water balance calculations using the following methodology:

- Assume infiltration BMPs will double the amount of annual infiltration.
    - i.e. Urban grassed areas with clay soil will have an average annual infiltration of approximately 145 mm/yr (refer to **Table 8-10**). With infiltration BMPs, average annual infiltration was assumed at 290 mm/yr.

The post-development water balance calculations have been completed for two scenarios:

1) Urban development with no infiltration BMPs.
2) Urban development with infiltration BMPs implemented over approximately 70% of the urban grassed areas.

8.5.2 Water Balance Results

Water balance calculations have been completed for the Carp, Faulkner, Flewellyn, and Monahan drainage areas. The results of the water balance analysis are summarized in **Tables 8-11 to 8-14**. Calculations are provided in **Appendix G**.

Table 8-11: Water Balance - Carp River Drainage Area

Component	Pre-Development	Post-Development, 43% Impervious			
		No Infiltration BMPs		With Infiltration BMPs	
	(mm/yr)	(mm/yr)	(% Change)	(mm/yr)	(% Change)
Precipitation	944	944	-	944	-
Evapotranspiration	437	393	10% Decrease	384	12% Decrease
Infiltration	112	70	38% Decrease	112	0%
Runoff	395	481	22% Increase	448	13% Increase

Table 8-12: Water Balance - Faulkner Drainage Area

Component	Pre-Development	Post-Development, 44% Impervious			
		No Infiltration BMPs		With Infiltration BMPs	
	(mm/yr)	(mm/yr)	(% Change)	(mm/yr)	(% Change)
Precipitation	944	944	0%	944	0%
Evapotranspiration	554	386	30% Decrease	375	32% Decrease
Infiltration	109	69	37% Decrease	100	8% Decrease
Runoff	281	489	74% Increase	469	67% Increase

Table 8-13: Water Balance - Flewellyn Drainage Area

Component	Pre-Development	Post-Development, 38% Impervious			
		No Infiltration BMPs		With Infiltration BMPs	
	(mm/yr)	(mm/yr)	(% Change)	(mm/yr)	(% Change)
Precipitation	944	944	0%	944	0%
Evapotranspiration	486	406	17% Decrease	391	20% Decrease
Infiltration	107	68	37% Decrease	107	0%
Runoff	351	470	34% Increase	446	27% Increase

Table 8-14: Water Balance - Monahan Drainage Area

Component	Pre-Development	Post-Development, 47% Impervious			
		No Infiltration BMPs		With Infiltration BMPs	
	(mm/yr)	(mm/yr)	(% Change)	(mm/yr)	(% Change)
Precipitation	944	944	0%	944	0%
Evapotranspiration	429	381	11% Decrease	368	14% Decrease
Infiltration	110	75	31% Decrease	114	4% Increase
Runoff	405	488	20% Increase	462	14% Increase

8.5.3 Water Balance Targets

The results of the water balance calculations indicate that there will be a change in the hydrologic cycle resulting from the proposed development. Changes in runoff and infiltration can potentially have adverse impacts on ground and surface water resources. Changes in evapotranspiration can have an impact on climate over a very large area in conjunction with other factors, but will have negligible impact on local hydrologic conditions.

Runoff

The increase in storm runoff will be accounted for by the proposed stormwater management facilities. The SWM facilities will control post-development flows to ensure that the outlet watercourses are not adversely impacted by the increase in runoff (water quality, peak flows, thermal impacts, flood risk, erosion potential). The increase in storm runoff will provide an opportunity for baseflow enhancement in the outlet watercourses.

Infiltration

The recommended infiltration target is to match pre-development infiltration rates. The water balance analysis indicates that maintaining annual pre-development infiltration should be achievable through the use of infiltration best management practices.

The types, locations, and suitability of infiltration BMPs will be dependant on site specific details and land use. Water balance targets will need to be evaluated and confirmed on a case-by-case basis as development plans are brought forward.

Section 9.0 Conceptual SWM Facility Designs

Conceptual designs for SWM Facilities servicing the Fernbank CDP lands have been completed based on the preferred servicing options, using the SWM criteria outlined in Section 6.0. The recommended areas for SWM blocks have been oversized to allow for flexibility in the configuration of the SWM facilities, as well as to allow provide flexibility for expansion of the SWM facilities to account for any intensification of development from the current land use plan. The SWMHYMO hydrologic model has been used to confirm the required sizes for the proposed facilities.

The conceptual designs are intended to demonstrate the size of the SWM blocks required for the facilities. The detailed designs of the facilities should avoid rectangular and/or linear shapes, and be landscaped with natural features to maximize their amenity values.

Conceptual design drawings from the 8 proposed SWM facilities are provided on **Figures 9.1-9.9**.

9.1 Carp River SWM Facilities

The recommended SWM strategy for the Fernbank Community lands tributary to the Carp River includes the construction of three SWM facilities to provide water quality, erosion, and peak flow control for the proposed development. The preservation and enhancement of the lower reach of the Carp River Tributary was the primary factor in determining the number of SWM facilities required for servicing of this area.

Conceptual design details for the proposed Carp River Tributary Headwater SWM Facility (P1) are provided in **Table 9-1**. A conceptual design drawing for this facility is provided as **Figure 9.1**.

Table 9-1: Carp River Tributary Headwater SWM Facility (P1)

Area of SWM Block	4.50 ha	
Drainage Area to SWMF	77.13 ha	(56% Impervious)
Quality Control	Normal 5,500 m^3 3,100 m^3	(70% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume
Quantity Control	Up to 100yr 5.43 m^3/s	(post-to-pre) Target 100yr Release Rate

Stage	Elevation (m)	Volume (m3)	Release Rate (m^3/s)
Bottom	96.25	0	0.00
Normal Water Level	97.75	26,200*	0.00
Extended Detention Storage	98.00	4,990	0.05
1:2yr	98.65	20,300	1.50
1:5yr	98.95	28,100	2.50
1:10yr	99.00	29,200	4.50
1:25yr	99.15	35,000	4.80
1:50yr	99.35	39,300	5.00
1:100yr	99.50	45,000	5.30

* Permanent Pool Volume

Conceptual design details for the proposed Carp River North SWM Facility (P2) are provided in **Table 9-2**. A conceptual design drawing for this facility is provided as **Figure 9.2**.

Table 9-2: Carp River North SWM Facility (P2)

Area of SWM Block	0.99 ha		
Drainage Area to SWMF	23.14 ha	(59% Impervious)	
Quality Control	Normal 1,750 m^3 950 m^3	(70% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	Up to 10yr 0.700 m^3/s	(post-to-pre) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	91.90	0	0.00
Normal Water Level	93.40	4,250*	0.00
Extended Detention Storage	93.65	1,280	0.03
1:2yr	94.15	2,770	0.15
1:5yr	94.65	4,410	0.35
1:10yr	95.20	6,750	0.70

* Permanent Pool Volume

Conceptual design details for the proposed Carp River South SWM Facility (P3) are provided in **Table 9-3**. A conceptual design drawing for this facility provided as **Figure 9.3**.

Table 9-3: Carp River south SWM Facility (P3)

Area of SWM Block	2.60 ha		
Drainage Area to SWMF	91.68 ha	(43% Impervious)	
Quality Control	Normal 5,350 m^3 3,700 m^3	(70% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	Up to 10yr 1.75 m^3/s	(post-to-pre) Target 10yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	92.35	0	0.00
Normal Water Level	93.85	14,800*	0.00
Extended Detention Storage	94.20	4,270	0.05
1:2yr	94.90	15,700	0.30
1:5yr	95.20	21,200	0.80
1:10yr	95.60	29,000	1.75

* Permanent Pool Volume

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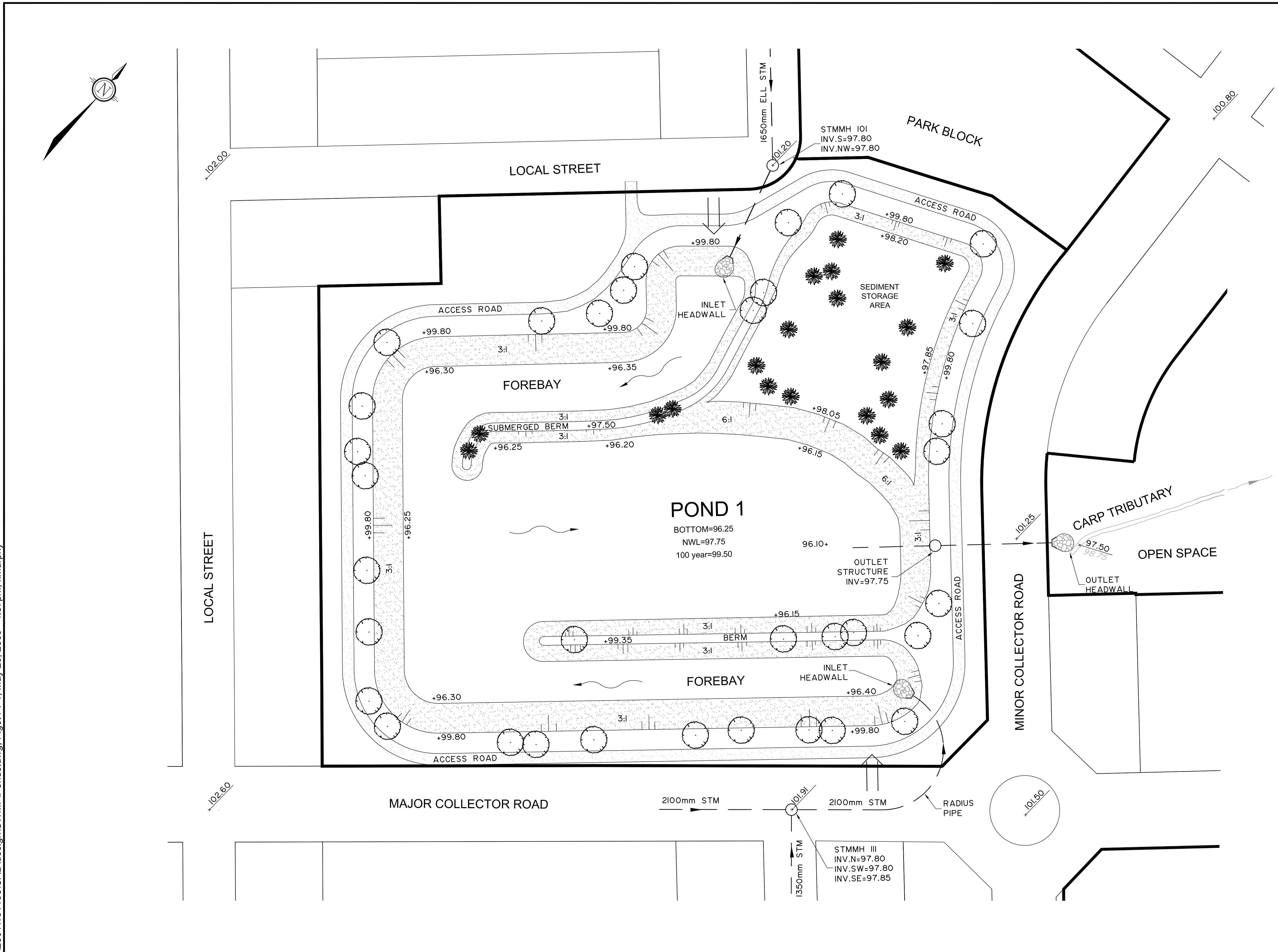
FIGURE 9.1

SWMF POND 1



LEGEND

	ACCESS ROAD
	DIRECTION OF POND FLOW
	STORM SEWER AND DIRECTION OF FLOW
101.25 / 100.25	PROPOSED GRADE / EXISTING GRADE
+96.65	PROPOSED GRADE
	HEADWALL C/W RIPRAP
	MAJOR OVERLAND FLOW DIRECTION
NWL	NORMAL WATER LEVEL
	STORM MANHOLE
3:1	TERRACING (MAX SLOPE)
	TREE
	WATER TOLERANT TREE
	EXISTING BRUSH LINE
	EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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NOVATECH
ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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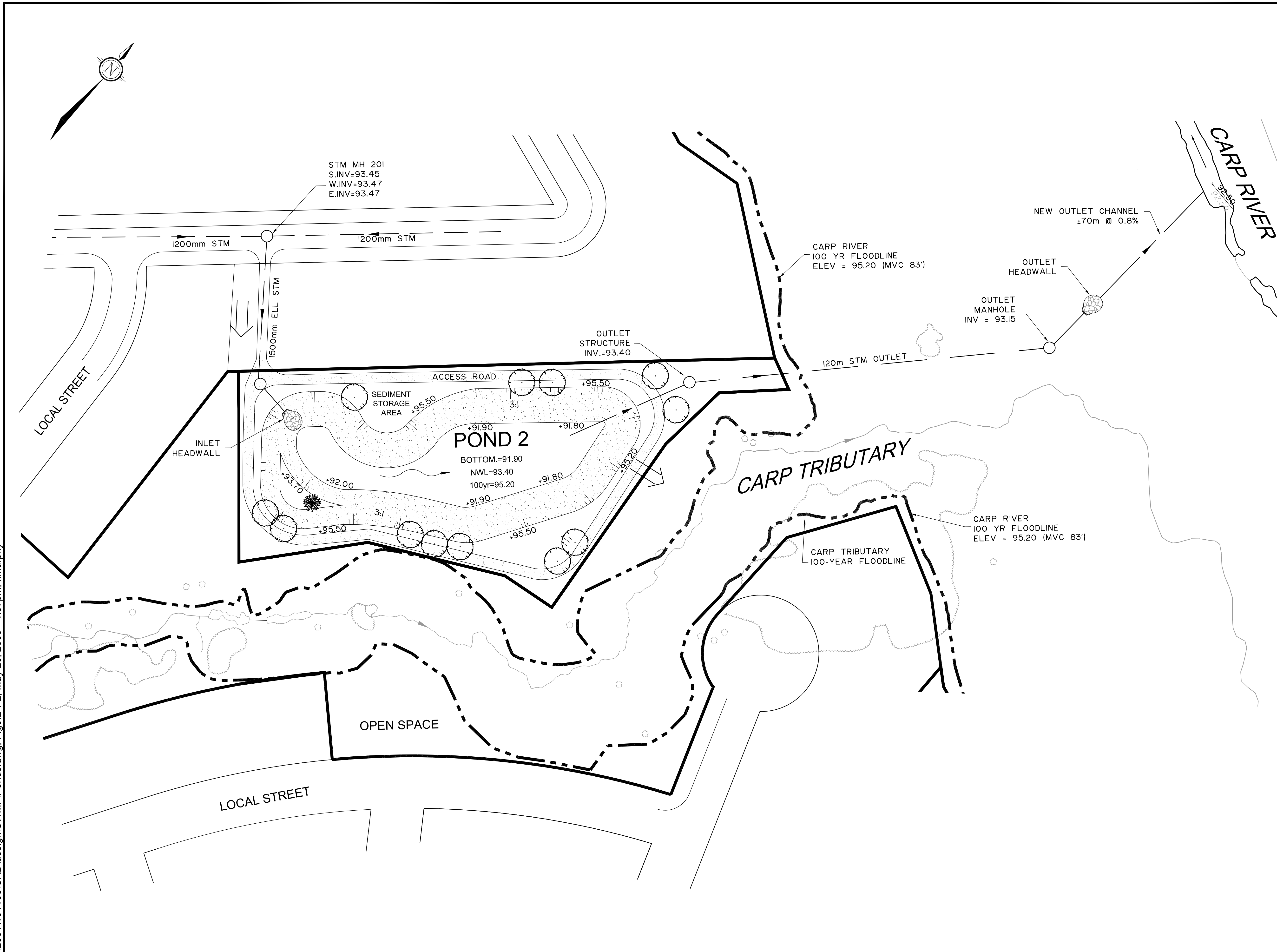

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FIGURE 9.2

SWMF POND 2

LEGEND

- ACCESS ROAD
- DIRECTION OF POND FLOW
- STORM SEWER AND DIRECTION OF FLOW
- 101.25 / 100.25 — PROPOSED GRADE / EXISTING GRADE
- +96.65 — PROPOSED GRADE
- HEADWALL C/W RIPRAP
- MAJOR OVRERLAND FLOW DIRECTION
- NWL — NORMAL WATER LEVEL
- STORM MANHOLE
- 3:1 — TERRACING (MAX SLOPE)
- TREE
- WATER TOLERANT TREE
- EXISTING BRUSH LINE
- EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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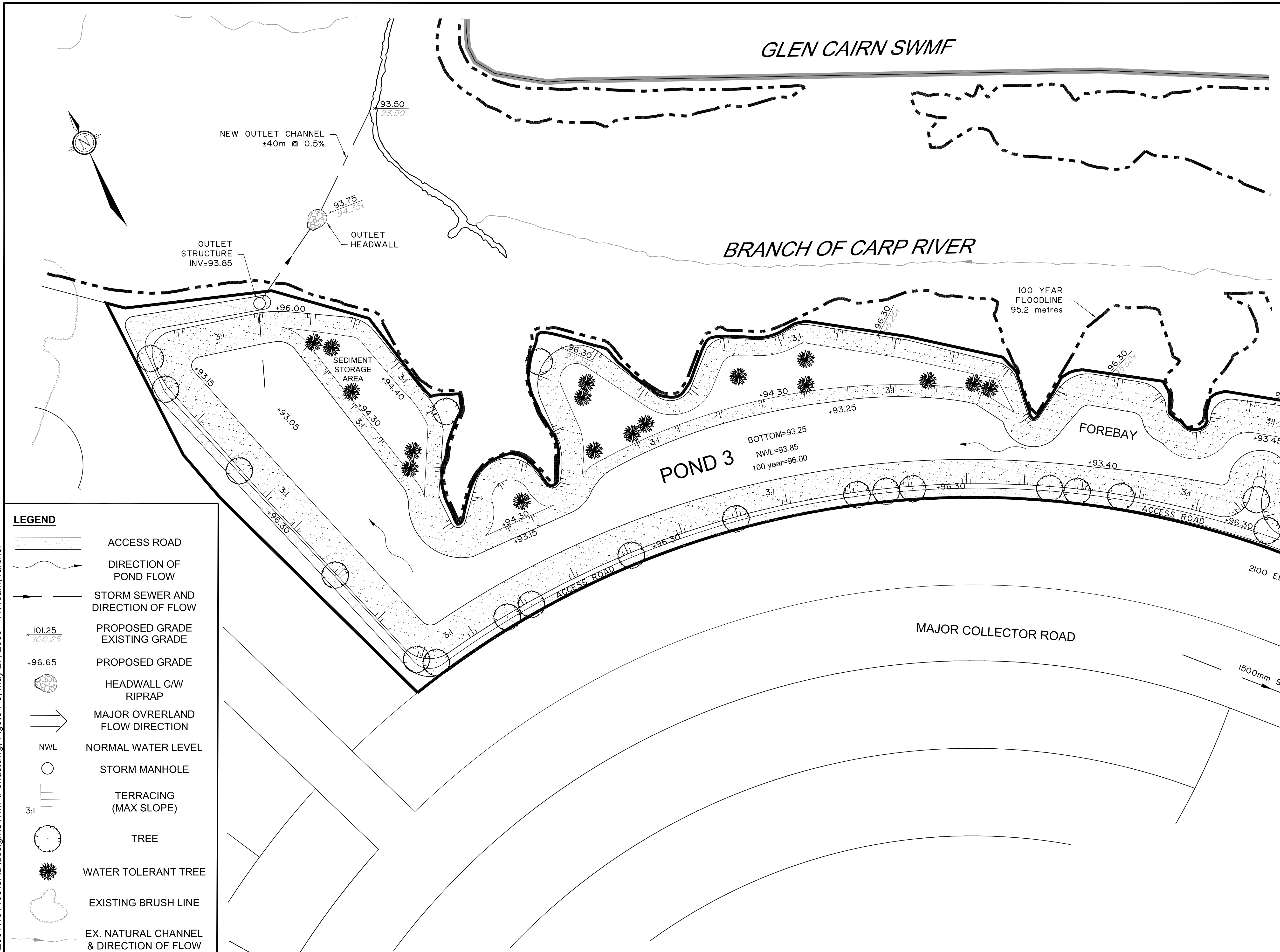

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FIGURE 9.3

SWMF POND 3

SCALE : 1:1250

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Suite 200, 240 Michael Cowpland Drive Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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9.2 Faulkner Drain SWM Facility

The recommended SWM strategy for the Fernbank Community lands west of Shea Road includes the construction of a SWM facility at the northwest corner of Shea Road and Fernbank Road to provide water quality, erosion, and peak flow control. This facility will outlet to a tributary of the Faulkner Drain that flows southwards from Fernbank Road.

The location of the Faulkner Drain SWM facility is flexible, and two optional locations for this facility were shown in **Figure 7.3** to accommodate current land ownership in this area. This concept shows the facility located partially in the hydro corridor. The placement of the Faulkner Drain can be re-visited as development plans are brought forward in this area.

Conceptual design details for the proposed Faulkner Drain SWM facility (P4) are provided in **Table 9-4**. A conceptual design drawing for this facility is provided as **Figure 9.4**.

Table 9-4: Faulkner Drain SWM Facility (P4)

Area of SWM Block	3.61 ha		
Drainage Area to SWMF	57.94 ha	(44% Impervious)	
Quality Control	Enhanced 7,200 m^3 2,400 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	100yr 1.75 m^3/s	(post-to-pre) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	104.25	0	0.00
Normal Water Level	105.75	8,700*	0.00
Extended Detention Storage	106.00	2,400	0.04
1:2yr	106.65	13,400	0.29
1:5yr	109.85	18,300	0.45
1:10yr	107.05	21,300	0.67
1:25yr	107.10	24,200	1.05
1:50yr	107.25	26,450	1.35
1:100yr	107.45	29,600	1.75

* Permanent Pool Volume

9.3 Flewellyn Drain SWM Facility

The recommended SWM strategy for the Fernbank Community lands tributary to the Flewellyn Drain includes the construction of a SWM facility to provide water quality, erosion, and peak flow control for the proposed development prior to outletting to the Flewellyn Drain.

Portions of the Flewellyn Drain downstream of the site do not have the capacity to convey the 1:100 year pre-development peak flow, and the increase in runoff associated with development has the potential to increase the extent of flooding in those areas. The facility has been designed to provide reduce post-development peak flows to less than pre-development conditions for larger storm events (>1:10yr event) to reduce the potential for downstream flooding. Storage requirements have been based on providing sufficient storage to control post-development flooding volumes (volume of flow above channel capacity) to pre-development levels.

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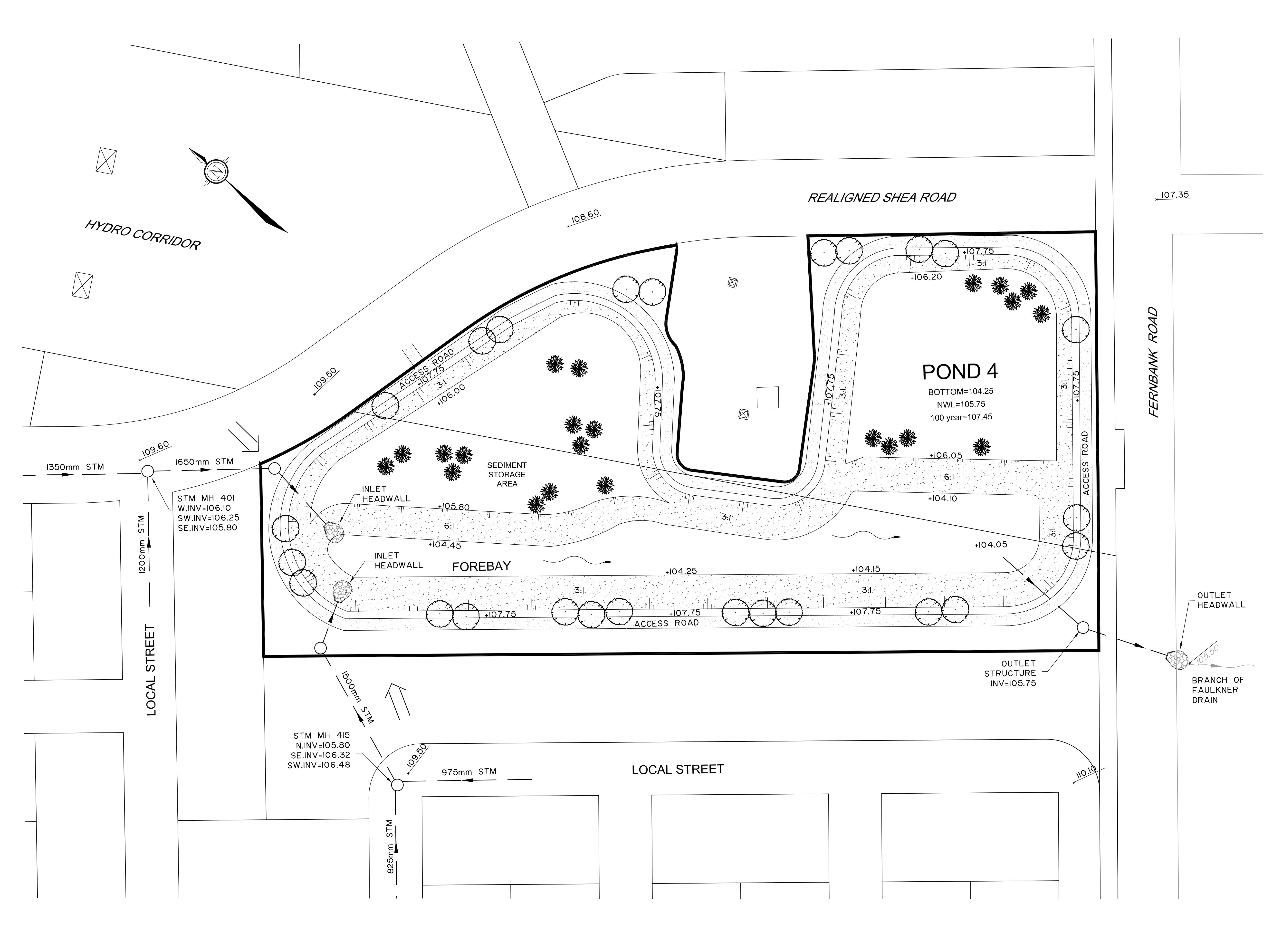
FIGURE 9.4

SWMF POND 4



LEGEND

	ACCESS ROAD
	DIRECTION OF POND FLOW
	STORM SEWER AND DIRECTION OF FLOW
101.25 / 100.25	PROPOSED GRADE / EXISTING GRADE
+96.65	PROPOSED GRADE
	HEADWALL C/W RIPRAP
	MAJOR OVERLAND FLOW DIRECTION
NWL	NORMAL WATER LEVEL
	STORM MANHOLE
3:1	TERRACING (MAX SLOPE)
	TREE
	WATER TOLERANT TREE
	EXISTING BRUSH LINE
	EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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9.3.1 Impact of Flewellyn Drain Lowering on Conceptual SMWF Design

The existing Flewellyn Drain has an invert of approximately 103.50m at Fernbank Road. The drainage area upstream of Fernbank Road has a very flat topographic relief, and servicing of this area with storm sewers will require a considerable amount of earth moving to provide the required cover.

A potential cost-saving alternative would involve lowering of the Flewellyn Drain by approximately 0.5 m at Fernbank Road, and tying back into existing grade approximately 375 m south. The required size of the pond is not affected by the proposed lowering, as the lowering is intended to reduce the amount of fill required to service the upstream drainage area. The size of the pond is dictated by the conveyance capacity of the Flewellyn drain, which will be unchanged downstream of the proposed lowering. The conceptual design of the Flewellyn Drain SWM facility is based on the proposed lowering of the Flewellyn Drain. If the lowering does not occur, the only change to the conceptual design will be to raise all design elevations by 0.5 metres.

Conceptual design details for the proposed Flewellyn Drain SWM facility (P5) are provided in **Table 9-5**. Conceptual design drawings for this facility are provided as **Figures 9.5 and 9.6**.

Table 9-5: Flewellyn Drain SWM Facility (P5)

Area of SWM Block	7.72 ha		
Drainage Area to SWMF	138.56 ha	(40% Impervious)	
Quality Control	Enhanced 15,700 m^3 5,600 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	100yr 4.06 m^3/s 3.60m^3/s	(over-control to mitigate downstream flooding) 100yr Pre-Development Peak Flow Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	101.50	0	0.00
Normal Water Level	103.00	35,300*	0.00
Extended Detention Storage	103.20	5,750	0.09
1:2yr	103.60	24,550	1.06
1:5yr	103.85	35,900	1.63
1:10yr	104.00	41,100	2.35
1:25yr	104.20	48,200	2.85
1:50yr	104.35	54,700	3.16
1:100yr	104.50	63,800	3.60

* Permanent Pool Volume

9.3.2 Sensitivity Analysis

The Flewellyn Pond services the largest drainage area within the Fernbank Community, and the Flewellyn Drain represents the most restrictive outlet. Consequently, the proposed active storage volume for the Flewellyn SWM pond is relatively large.

A sensitivity analysis of storage volume in the Flewellyn SWM pond vs. downstream flooding volume was performed using the SWMHYMO model to determine the impact a 25% reduction in storage volume would have on potential flooding downstream. The results of the analysis indicate that the conceptual facility size shown in **Table 9-5** should mitigate downstream flooding volumes to existing conditions, but

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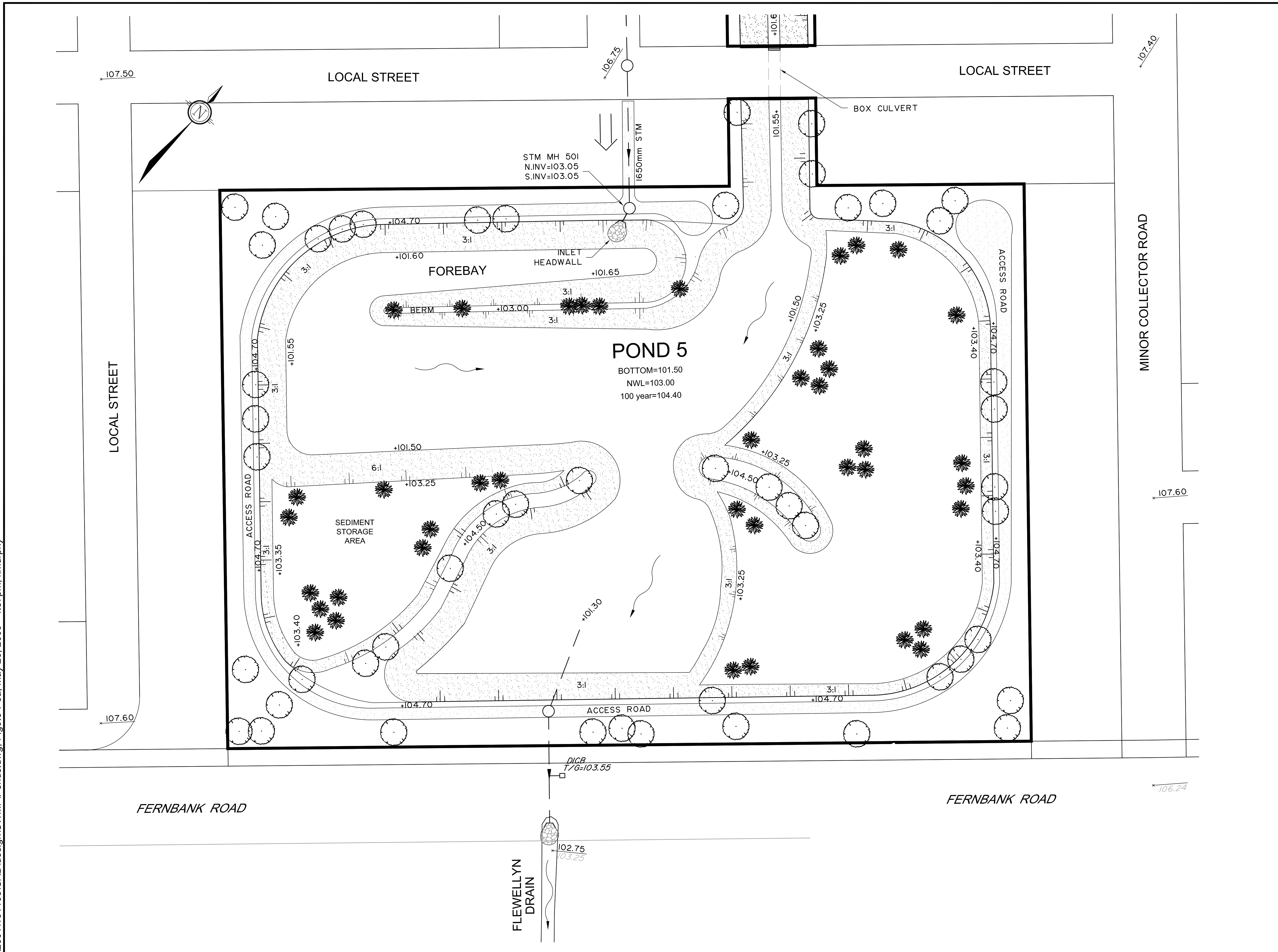
FIGURE 9.5

SWMF POND 5a (SOUTH BLOCK)



LEGEND

ACCESS ROAD

DIRECTION OF POND FLOW

STORM SEWER AND DIRECTION OF FLOW

101.25 / 100.25 PROPOSED GRADE / EXISTING GRADE

+96.65 PROPOSED GRADE

HEADWALL C/W RIPRAP

MAJOR OVRERLAND FLOW DIRECTION

NWL NORMAL WATER LEVEL

STORM MANHOLE

3:1 TERRACING (MAX SLOPE)

TREE

WATER TOLERANT TREE

EXISTING BRUSH LINE

EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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ENGINEERS & PLANNERS

Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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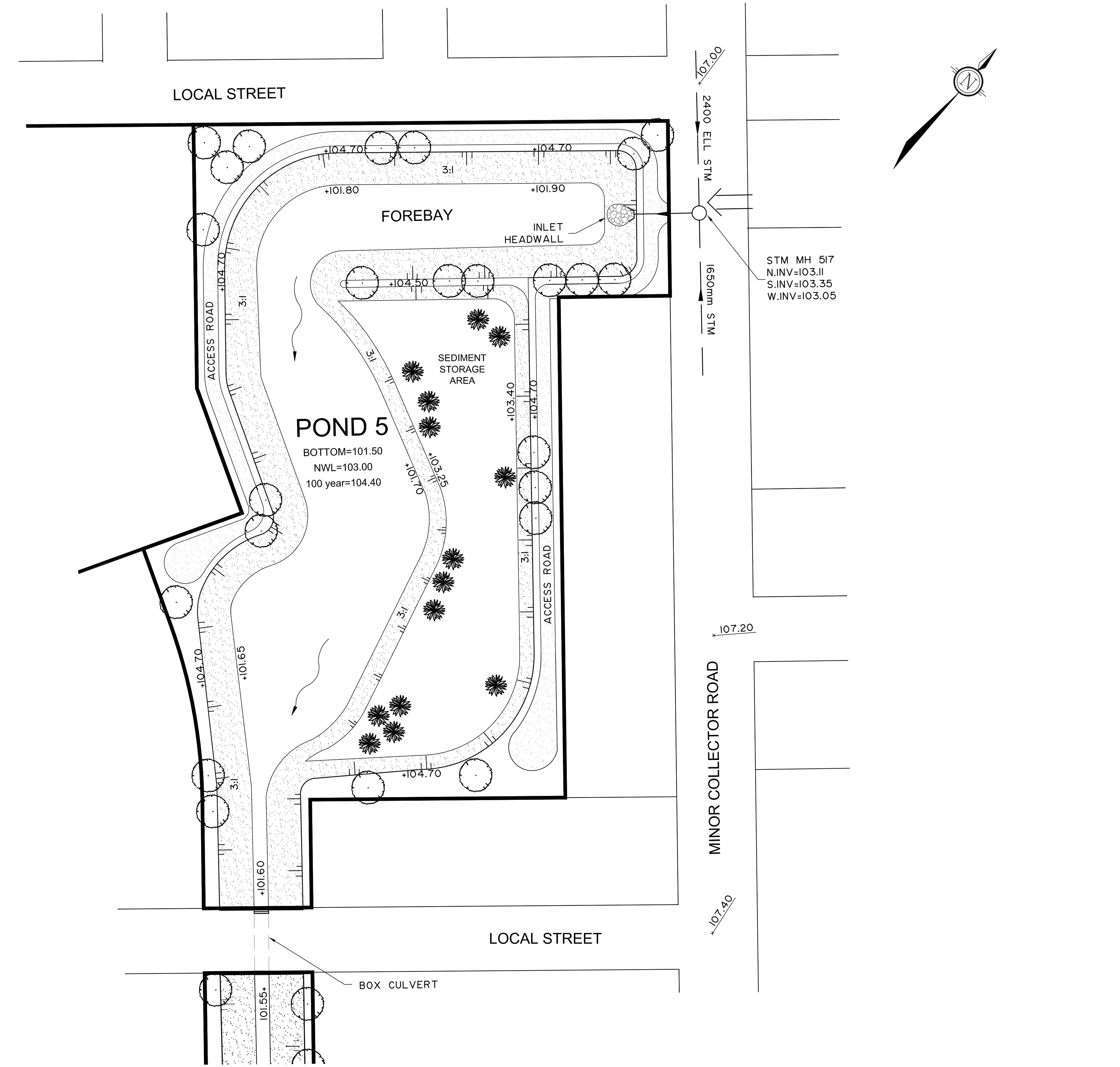

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FIGURE 9.6

SWMF POND 5b (NORTH BLOCK)

LEGEND

- ACCESS ROAD
- DIRECTION OF POND FLOW
- STORM SEWER AND DIRECTION OF FLOW
- 101.25 / 100.25 — PROPOSED GRADE / EXISTING GRADE
- +96.65 — PROPOSED GRADE
- HEADWALL C/W RIPRAP
- MAJOR OVERLAND FLOW DIRECTION
- NWL — NORMAL WATER LEVEL
- STORM MANHOLE
- 3:1 — TERRACING (MAX SLOPE)
- TREE
- WATER TOLERANT TREE
- EXISTING BRUSH LINE
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SCALE : 1:1250

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ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

M:\2001\101108\CAD\design\SWMF\Ponds.dwg, Fig9.6-P5b, May 26, 2009 - 4:57pm, kmurphy any reduction in the active storage volume will result in a corresponding increase in downstream flooding. The Flewellyn Drain sensitivity analysis is provided in **Appendix K**.

9.4 Monahan Drain SWM Facilities

The recommended SWM strategy for the Fernbank Community lands tributary to the Monahan Drain includes the construction of three SWM facilities to provide water quality, erosion, and peak flow control for the proposed development. The preservation and enhancement of the main branch of the Monahan Drain was the primary factor in determining the number of SWM facilities required for servicing of this area.

Conceptual design details for the proposed Monahan Drain Headwater SWM Facility (P6) are provided in **Table 9-6**. A conceptual design drawing for this facility is provided as **Figure 9.7**.

Table 9-6: Monahan Drain Headwater SWM Facility (P6)

Area of SWM Block	4.75 ha		
Drainage Area to SWMF	98.65 ha	(49% Impervious)	
Quality Control	Enhanced 13,650 m^3 4,000 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	Up to 100yr 2.30 m^3/s	(post-to-pre @ Terry Fox Drive) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	95.70	0	0.00
Normal Water Level	97.20	17,300*	0.00
Extended Detention Storage	97.45	4,000	0.05
1:2yr	97.75	21,900	0.62
1:5yr	97.95	29,400	1.08
1:10yr	98.15	33,800	1.44
1:25yr	98.35	39,400	1.74
1:50yr	98.50	44,400	2.03
1:100yr	98.70	51,600	2.40

* Permanent Pool Volume

Conceptual design details for the proposed Monahan Drain North SWM Facility (P7) are provided in **Table 9-7**. A conceptual design drawing for this facility is provided as **Figure 9.8**.

Table 9-7: Monahan Drain North SWM Facility (P7)

Area of SWM Block	3.35 ha		
Drainage Area to SWMF	43.09 ha	(36% Impervious)	
Quality Control	Enhanced 4,400 m^3 1,750 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	Up to 100yr 0.62 m^3/s	(post-to-pre @ Terry Fox Drive) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	93.50	0	0.00
Normal Water Level	95.00	16,000*	0.00
Extended Detention Storage	95.25	2,000	0.03
1:2yr	95.75	10,000	0.18
1:5yr	95.90	13,000	0.29
1:10yr	96.05	16,000	0.36
1:25yr	96.20	19,500	0.48
1:50yr	96.35	22,500	0.54
1:100yr	96.50	26,500	0.62

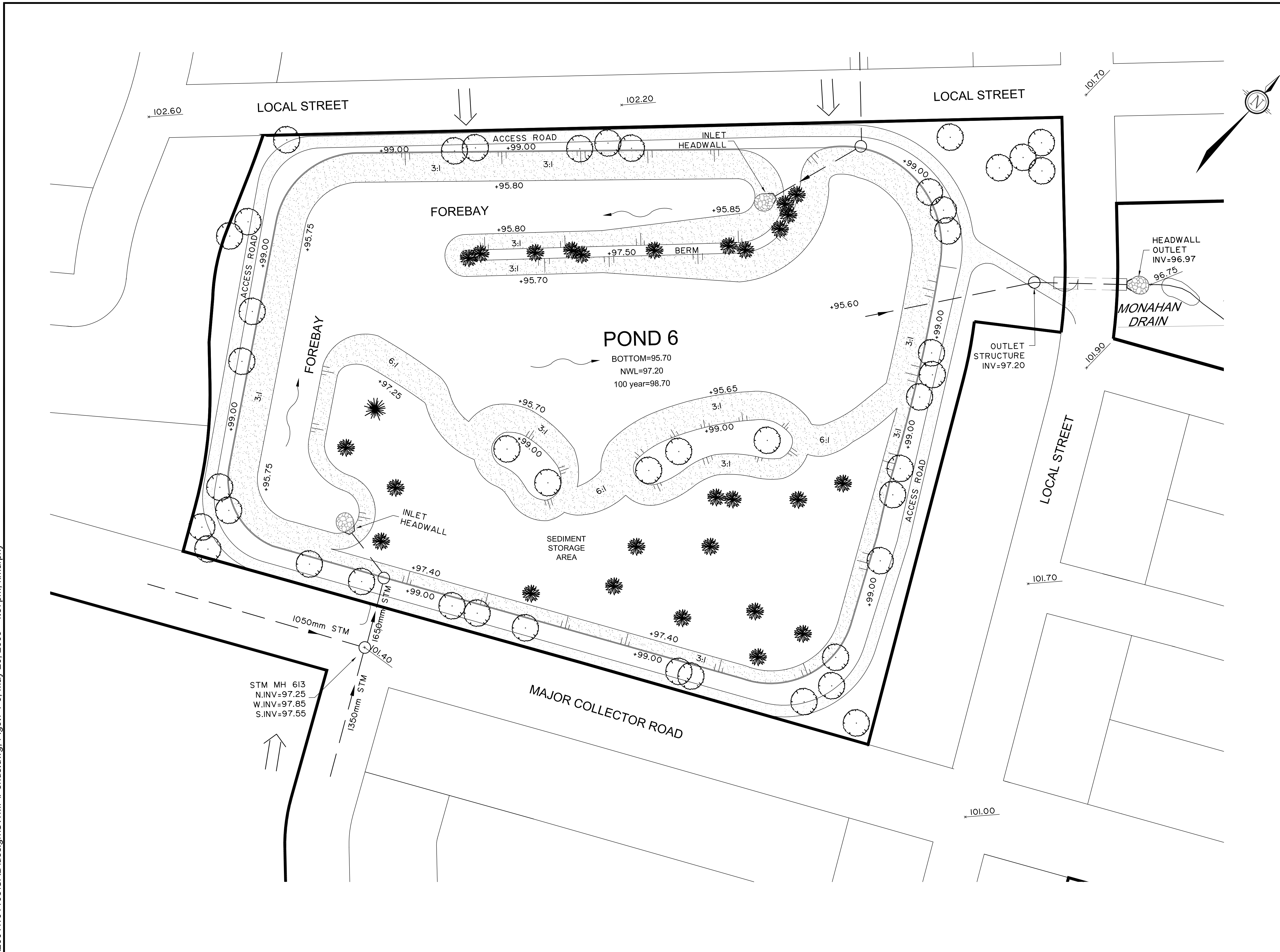
* Permanent Pool Volume

Conceptual design details for the proposed Monahan Drain South SWM Facility (P8) are provided in **Table 9-8**. A conceptual design drawing for this facility is provided as **Figure 9.9**.

Table 9-8: Monahan Drain South SWM Facility (P8)

Area of SWM Block	4.06 ha		
Drainage Area to SWMF	62.57 ha	(53% Impervious)	
Quality Control	Enhanced 9,100 m^3 2,550 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	Up to 100yr 1.25 m^3/s	(post-to-pre @ Terry Fox Drive) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	93.50	0	0.00
Normal Water Level	95.00	12,270*	0.00
Extended Detention Storage	95.25	2,675	0.04
1:2yr	95.75	16,000	0.37
1:5yr	95.90	21,500	0.49
1:10yr	96.05	24,800	0.68
1:25yr	96.20	30,200	0.83
1:50yr	96.35	33,000	0.95
1:100yr	96.50	38,390	1.25

* Permanent Pool Volume



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FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 9.7

SWMF POND 6

LEGEND

- ACCESS ROAD
- DIRECTION OF POND FLOW
- STORM SEWER AND DIRECTION OF FLOW
- 101.25 / 100.25 — PROPOSED GRADE / EXISTING GRADE
- +96.65 — PROPOSED GRADE
- HEADWALL C/W RIPRAP
- MAJOR OVRERLAND FLOW DIRECTION
- NWL — NORMAL WATER LEVEL
- STORM MANHOLE
- 3:1 — TERRACING (MAX SLOPE)
- TREE
- WATER TOLERANT TREE
- EXISTING BRUSH LINE
- EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

JUNE 2009

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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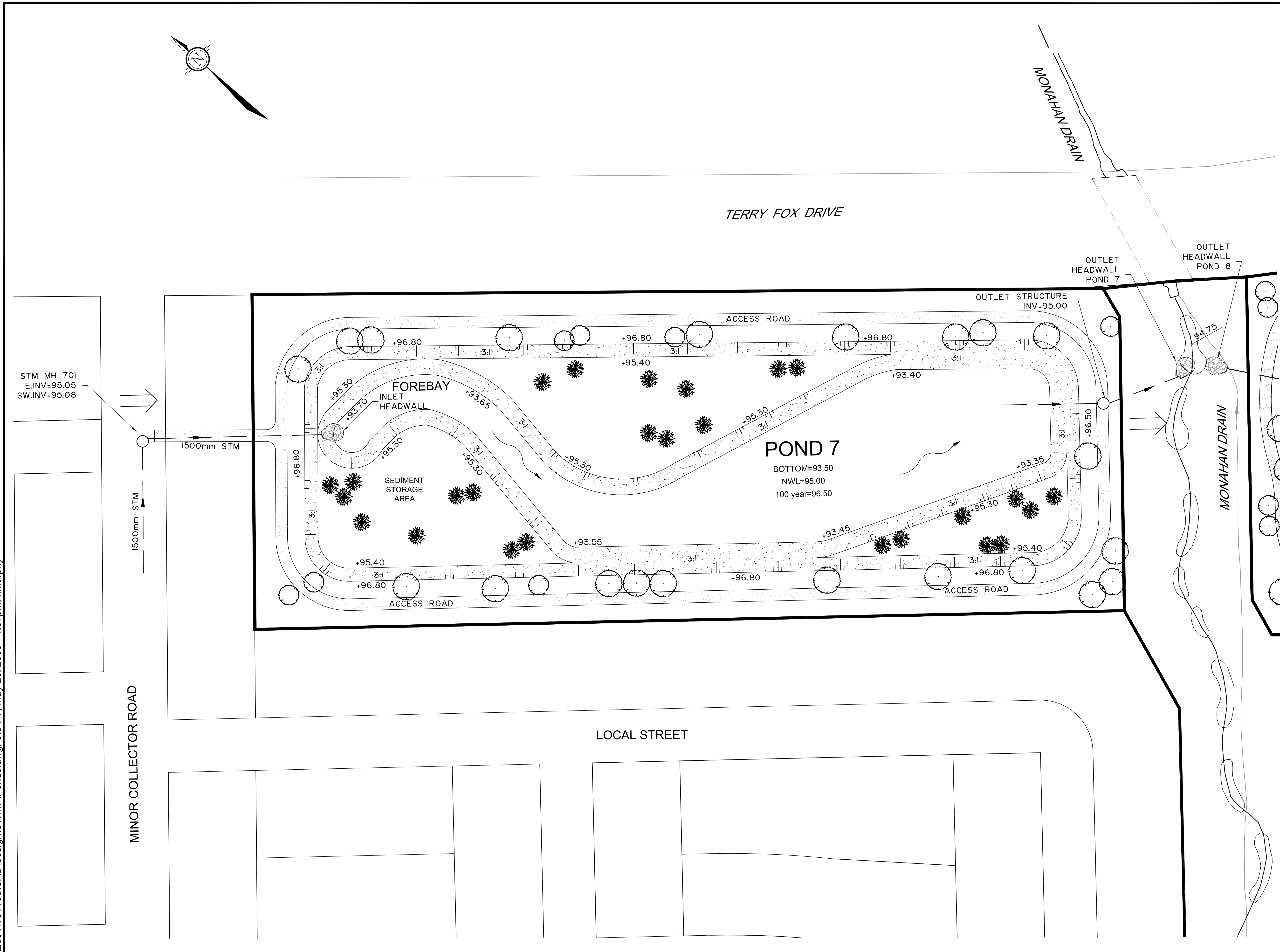
FIGURE 9.8

SWMF POND 7



LEGEND

(symbol)	ACCESS ROAD
(symbol)	DIRECTION OF POND FLOW
(symbol)	STORM SEWER AND DIRECTION OF FLOW
101.25 / 100.25	PROPOSED GRADE / EXISTING GRADE
+96.65	PROPOSED GRADE
(symbol)	HEADWALL C/W RIPRAP
(symbol)	MAJOR OVERLAND FLOW DIRECTION
NWL	NORMAL WATER LEVEL
(symbol)	STORM MANHOLE
3:1	TERRACING (MAX SLOPE)
(symbol)	TREE
(symbol)	WATER TOLERANT TREE
(symbol)	EXISTING BRUSH LINE
(symbol)	EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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NOVATECH
ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M IP6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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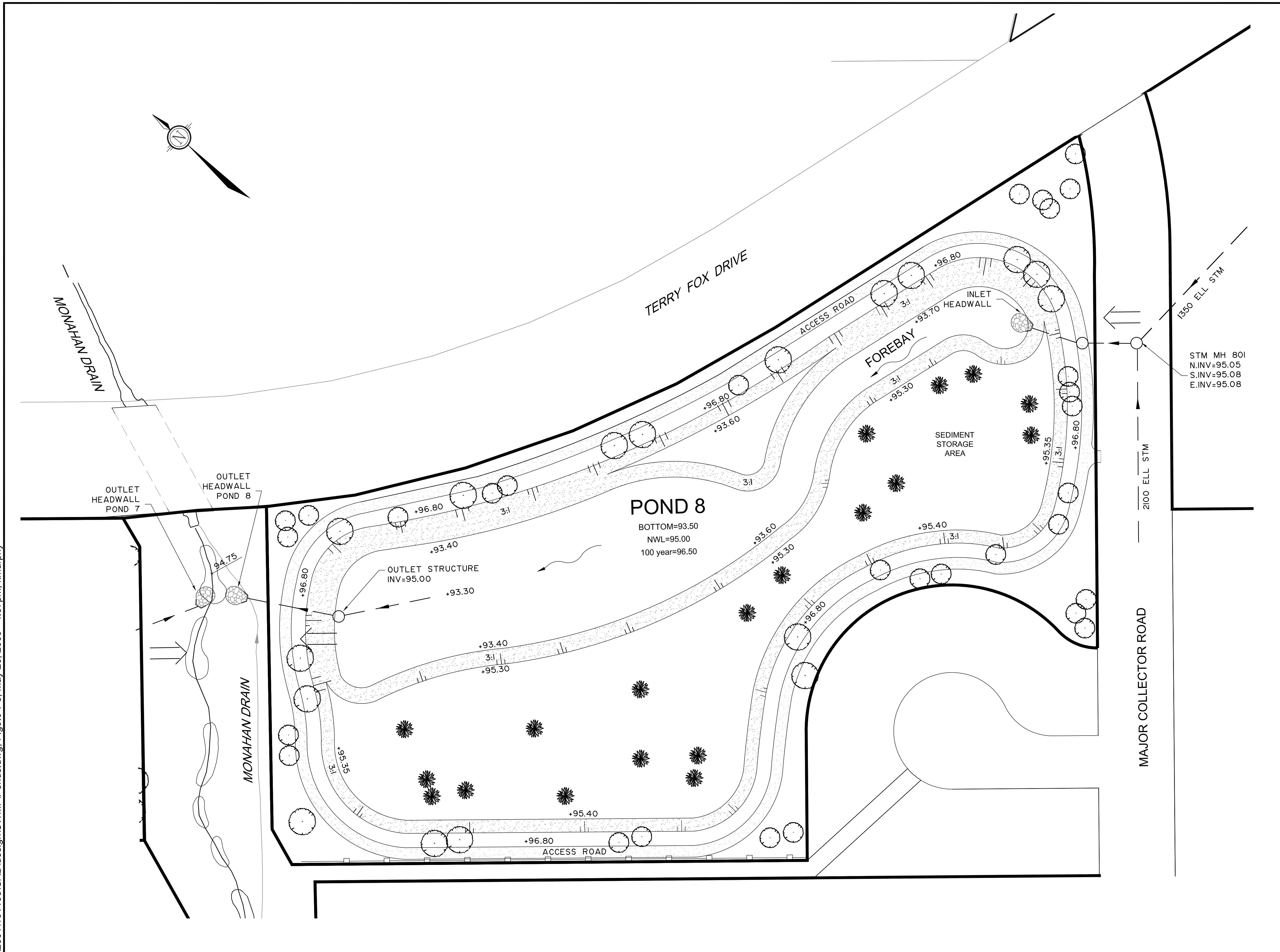

FERNBANK COMMUNITY DESIGN PLAN

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ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 9.9

SWMF POND 8

LEGEND

- ACCESS ROAD
- DIRECTION OF POND FLOW
- STORM SEWER AND DIRECTION OF FLOW
- 101.25 / 100.25 — PROPOSED GRADE / EXISTING GRADE
- +96.65 — PROPOSED GRADE
- HEADWALL C/W RIPRAP
- MAJOR OVERLAND FLOW DIRECTION
- NWL — NORMAL WATER LEVEL
- STORM MANHOLE
- 3:1 — TERRACING (MAX SLOPE)
- TREE
- WATER TOLERANT TREE
- EXISTING BRUSH LINE
- EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

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NOVATECH
ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

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9.5 Conceptual SWMF Outlet Structure

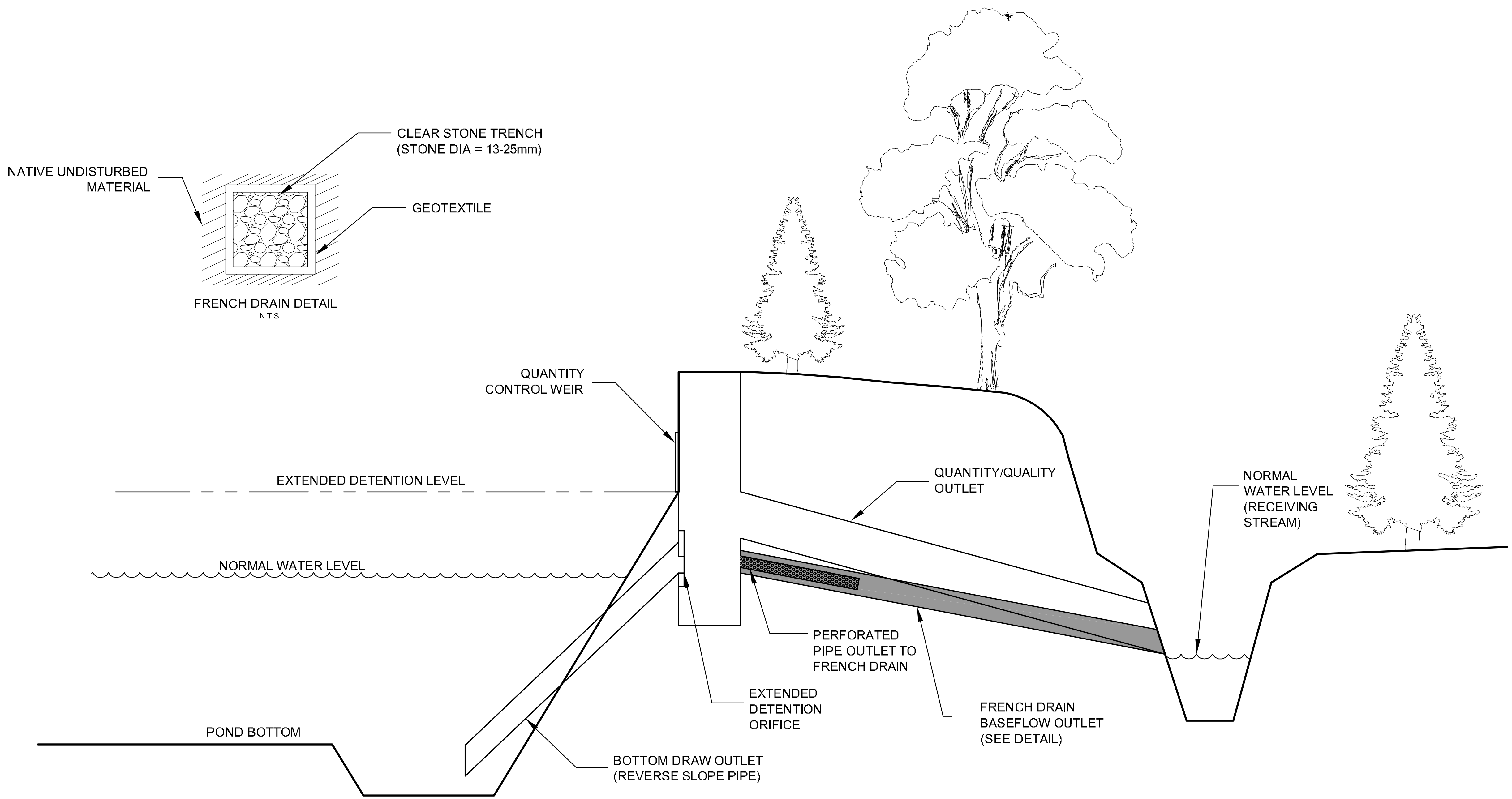
A conceptual design for a typical SWM facility outlet is provide in **Figure 9.10**. The conceptual outlet design incorporates the following design elements:

Extended Detention Outlet

- A reverse slope pipe is used to convey extended detention outflows from the SWM facility to the outlet control structure. The reverse slope pipe prevents floating debris from clogging the outlet, and also provides some temperature benefits by drawing water from the bottom of the pond.
    - An orifice installed on the outlet of the reverse-slope pipe will attenuate extended detention outflows to the design release rate (typically 24-48 hour drawdown).
    - A french drain outlet will provide baseflow augmentation and temperature benefits for low flows from the pond. Routing of water through a subsurface trench filled with clear stone will reduce water temperatures through heat transfer.

Quantity Control Outlet

- A High flow weir is built into the sides of the outlet structure that will be sized to attenuate peak flows from larger storm events to the design release rate.



FERNBANK COMMUNITY DESIGN PLAN

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FIGURE 9.10

Existing Conditions

Conceptual SWMF Outlet Structure

0 50 100 200 400 600 metres

SCALE : Not to Scale -B1 Sheet
SCALE : Not to Scale -Report

MAY 2009

NOVATECH
ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

Section 10.0 Floodplain Evaluation

10.1 Carp River

The current regulatory flood mapping (1991) for the Carp River indicates a 100-year flood elevation of 95.20 upstream of Hazeldean Road. The regulatory floodplain for the Carp River upstream of Hazeldean Road is shown on the Constraints and Opportunities Plan (**Figure 5.1**).

Pending approval of the updated floodplain mapping (presently undergoing review as part of the Carp River Restoration Study), the current regulatory flood elevation has been used for planning purposes (i.e. siting of stormwater management facilities, hydraulic grade line calculations, etc). This represents a conservative approach, as the current regulatory flood elevation upstream of Hazeldean Road is higher than the flood levels predicted in any of the subsequent analyses, including the latest existing conditions and post-development (2009) analyses which have subject to an independent 3rd party review.

The targets for assessing impacts in the Carp River resulting from development of the Fernbank Community are as follows:

- Ensure that the proposed SWM strategy for the Carp River does not present an increase in flood risk downstream. Any increase in 1:100 year water levels in the Carp River **above the existing condition elevations** will be reviewed to determine if the increase represents any increase in flood risk.
- Ensure that the post-development runoff volume from the Fernbank Lands tributary to the Carp River does not exceed an additional 40,000 m^3 above existing conditions for the 100-year event.
    - The post-development hydrologic analysis indicates that the increase in the 100-year runoff volume to the Carp River resulting from development of from the Fernbank lands will be approximately 28,600 m^3 (refer to **Table 8-4**).
    - Model results indicate that the use of infiltration BMPs could reduce the increase in runoff volume for the 100-year event to approximately 26,300 m^3 (refer to **Table 8-4**).

10.1.1 HEC-RAS Analysis

Pre and post-development hydrographs for lands tributary to the Carp River (**Figures 8.8 - 8.10**) have been input into the HEC-RAS model of the Carp River. This analysis has been performed for both the existing Carp River geometry and the proposed geometry as per the recommendations of the Carp River Restoration EA.

The results of this analysis are summarized below. HEC-RAS model output is provided in **Appendix H**.

Carp River Existing Conditions Model

- This model represents the Carp River without any of the modifications proposed in the Carp River Restoration Plan, prior to development of the Kanata West Lands.
- The proposed Fernbank SWM facilities (P1, P2, P3) will ensure that post-development peak flows and flood elevations in the Carp River are controlled to pre-development conditions or less.
- The use of Best Management Practices will slightly reduce runoff volumes, but have no significant impact on peak flows or flood elevations in the Carp River.

Flows and water elevations from the HEC-RAS analysis are summarized in **Table 10-1**.

Table 10-1: Carp River Existing Conditions HEC-RAS Model 100yr Flood Elevations (12hr SCS Distribution)

Location	**Ex. Conditions (CH2MHill)**		**Ex. Conditions (Novatech)**		**Fernbank Future Conditions**		**Fernbank Future Conditions (w/BMPs)**	
	WSEL	***Flow***	**WSEL**	***Flow***	**WSEL**	***Flow***	**WSEL**	***Flow***
Glen Cairn SWMF *Station 44953*	94.92	*9.89*	94.97	*9.46*	94.88	*9.67*	94.88	*9.89*
U/S Hazeldean Road *Station 44325*	94.87	*15.95*	94.92	*17.06*	94.84	*15.58*	94.83	*15.51*
U/S Maple Grove Road *Station 43375*	94.44	*17.42*	94.44	*18.06*	94.42	*16.50*	94.42	*16.41*
U/S Palladium Drive *Station 42890*	94.36	*34.25*	94.36	*34.51*	94.34	*33.28*	94.34	*33.22*
U/S Highway 417 South *Station 42182*	94.18	*34.66*	94.18	*34.84*	94.16	*33.66*	94.16	*33.60*
U/S Highway 417 North *Station 42124*	94.08	*34.62*	94.08	*34.80*	94.07	*33.58*	94.07	*33.56*
U/S Richardson Side Road *Station 40092*	93.48	*26.57*	93.49	*26.82*	93.47	*25.35*	93.47	*25.30*

* *Flows listed in Table 10-1 represent the total flow in the Carp River at the time of the maximum water surface elevation.*

Carp River Future Conditions Model (Carp River Restoration / Kanata West Development)

- This model represents the Carp River based on the proposed modifications from the Carp River Restoration Plan, including development of the Kanata West Lands.
- The proposed Fernbank SWM facilities (P1, P2, P3) will ensure that post-development peak flows and flood elevations in the Carp River are controlled to pre-development conditions or less.
- The use of Best Management Practices will slightly reduce runoff volumes, but have no significant impact on peak flows or flood elevations in the Carp River.

Flows and water elevations from the HEC-RAS analysis are summarized in **Table 10-2**.

Table 10-2: Carp River Future Conditions HEC-RAS Model 100yr Flood Elevations (12hr SCS Distribution)

Location	Ex. Conditions (CH2MHill)		Ex. Conditions (Novatech)		Fernbank Future Conditions		Fernbank Future Conditions (w/BMPs)	
	WSEL	*Flow*	WSEL	*Flow*	WSEL	*Flow*	WSEL	*Flow*
Glen Cairn SWMF *Station 44953*	94.95	*11.16*	94.97	*10.93*	94.90	*10.89*	94.90	*10.89*
U/S Hazeldean Road *Station 44325*	94.92	*19.20*	94.93	*20.07*	94.87	*17.80*	94.87	*17.74*
U/S Maple Grove Road *Station 43375*	94.69	*21.35*	94.68	*23.10*	94.65	*20.44*	94.65	*20.33*
U/S Palladium Drive *Station 42889*	94.62	*45.92*	94.60	*45.42*	94.58	*44.37*	94.58	*44.30*
U/S Highway 417 South *Station 42182*	94.12	*46.80*	94.11	*46.09*	94.09	*45.14*	94.09	*45.07*
U/S Highway 417 North *Station 42124*	93.91	*45.52*	93.90	*45.84*	93.88	*44.53*	93.88	*44.31*
Future Transitway *Station 41743*	93.77	*46.57*	93.76	*43.65*	93.75	*42.66*	93.75	*42.63*
Future Campeau Drive *Station 41608*	93.73	*48.00*	93.72	*47.52*	93.71	*46.54*	93.70	*46.50*
U/S Richardson Side Road *Station 40092*	93.59	*46.71*	93.59	*45.90*	93.58	*45.22*	93.57	*45.17*

* *Flows listed in Table 10-2 represent the total flow in the Carp River at the time of the maximum water surface elevation.*

10.1.2 Carp River SWM Facilities

Two of the proposed SWM Facilities (P2 & P3) are proposed on either side of the Carp River West Tributary, adjacent to the Carp River Floodplain. These facilities have been sited outside of the floodplain limits and will have no impact on floodplain storage in the Carp River.

SWM Facilities P2 & P3 have been designed for storms up to a 10-year event. Runoff from larger storms will not be attenuated prior to outletting to the Carp River. This design allows peak flows from the Fernbank Lands to enter the Carp River in advance of peak flows from the upstream area (Glen Cairn), and significantly mitigates the impact of development. Model results indicate a slight reduction in the 100-year flood elevations under post-development conditions (refer to **Tables 10-1 and 10-2**).

10.1.3 Castlefrank Road Extension

A collector road is proposed connecting to Terry Fox Drive opposite the existing Castlefrank Road intersection. The proposed roadway cuts through MVC owned lands upstream of the southerly limit of the Glen Cairn SWM Facility. The proposed roadway will not encroach or impact the operation of the SWM pond, but it will eliminate some backwater ponding upstream of the facility.

MVC has confirmed that the proposed Castlefrank Road extension is acceptable in principle, as the ponding upstream of the Glen Cairn Pond is the result of backwater and is not considered part of the active storage volume in the facility. Conveyance of flows from the upstream drainage area under the proposed roadway will need to be accounted for in the roadway design.

Correspondence from MVC regarding the proposed road extension is provided in **Appendix B**.

10.2 Carp River West Tributary

A HEC-RAS model of the Carp River West Tributary has been developed to identify the 100-year floodplain on the lower reach of the tributary:

- Geometric data used in the model (cross-sections, reach lengths and in-stream structures) was generated based on detailed topographic mapping and field reconnaissance;
- The downstream boundary condition was set at an elevation of 95.20, which represents the regulatory flood elevation in the Carp River;
- A steady-state analysis of the tributary was run using peak flows from the existing conditions SWMHYMO model.

There are two existing crossings on the lower reach of the Carp River Tributary that provide access for agricultural vehicles. The model was run for two scenarios:

- Existing crossings & culverts included in analysis; and
- Existing crossings & culverts removed (future conditions)

10.2.1 Model Results

The proposed SWM facility located upstream of the lower reach of the Carp River West Tributary (P1) has been designed to control post-development peak flows to less than pre-development conditions for all storm events up to the 100-year event. Consequently, there will be no increase in the 100-year flood elevations in this channel from pre-development conditions.

The results of the analysis are as follows:

- Floodplain elevations range from 95.20 at the confluence with the Carp River to 99.40 at the upstream end of the reach identified for retention and preservation.
- The existing culvert crossings create localized backwater conditions, with high flows spilling across the agricultural crossings.
    - Removal of the culverts and access roads will result in a localized reduction to the HGL, but will not have any impact on flood elevations upstream or downstream of the crossings.
- The demonstration land use plan for the Fernbank Community has been developed so that the 100-year floodplain of the Carp River Tributary will be contained within the proposed riparian corridor.

Details of the hydraulic analysis are provided in Appendix I. The 100-year floodplain is shown on the Plan and Profile Drawing provided in **Appendix N**.

10.3 Monahan Drain

10.3.1 Existing conditions

The existing conditions SWMHYMO analysis indicates that 100-year peak flow in the Monahan Drain at Terry Fox Drive is approximately 4.3 m^3/s. Robinson Consultants prepared an Engineer's Report for proposed modifications and improvements to the Monahan Drain in July 2003 to accommodate the proposed extension of Terry Fox Drive and the new culvert for the Monahan Drain. The 100-year peak flow used in the Engineer's Report was approximately 5.2 m^3/s.

Both the drain and the culvert were sized to accommodate the 100-year peak flow from the upstream drainage area, and the 100-year floodplain is confined within the banks of the existing channel.

Backwater effects do not influence the existing floodplain elevations in the Monahan Drain upstream of Terry Fox Drive: The invert of the existing channel upstream of Terry Fox drive is considerably higher than the downstream invert - a gabion basket weir is currently used to tie the two channel sections together. Furthermore, the 100-year flood elevation in Cell 1 of the Monahan Drain Constructed wetlands is below the invert of the existing channel upstream of Terry Fox Drive.

10.3.2 Post-Development Conditions

Under post-development conditions, the Monahan Drain will be designed with a more naturalized planform. The main channel will convey flows up to the 1:2 year event, with larger flows spilling out into a floodplain. The 100-year floodplain will be contained within the limits of the riparian corridor, as established by the meander belt width and aquatic habitat buffer.

Floodplain elevations in the Monahan Drain will range from 95.59 at Terry Fox Drive to 96.97 at the outlet from Pond 6. The demonstration land use plan for the Fernbank Community has been developed so that the 100-year floodplain of the Monahan Drain will be contained within the proposed riparian corridor.

Details of the hydraulic analysis are provided in **Appendix J**. The 100-year floodplain is shown on the Plan and Profile Drawing provided in **Appendix N**.

Section 11.0 Environmental Management Guidelines & Recommendations

The recommended SWM strategy for each watershed has been selected based on the evaluation of SWM alternatives, as well as agency and public comments received. The size and location of the recommended SWM facilities, riparian corridors and other areas recommended for retention have been integrated into the demonstration land use plan (**Figure 11.1**) for the Fernbank Community along with the recommended solutions for land use planning and transportation.

11.1 Natural Environment Area

The fresh-moist cedar forest in the northwest corner of the study area south of Abbott Street is identified as a Natural Environment Area on Schedule A of the City of Ottawa 2003 Official Plan and is the most significant natural environment feature in the study area. The NEA lands will remain undisturbed in their existing condition.

The impact of the proposed development on the NEA will be assessed as part of an EIS to be submitted with a development application. There is to be no development within 120 m (as per OP policy) of the Natural Environment Feature until the EIS is completed.

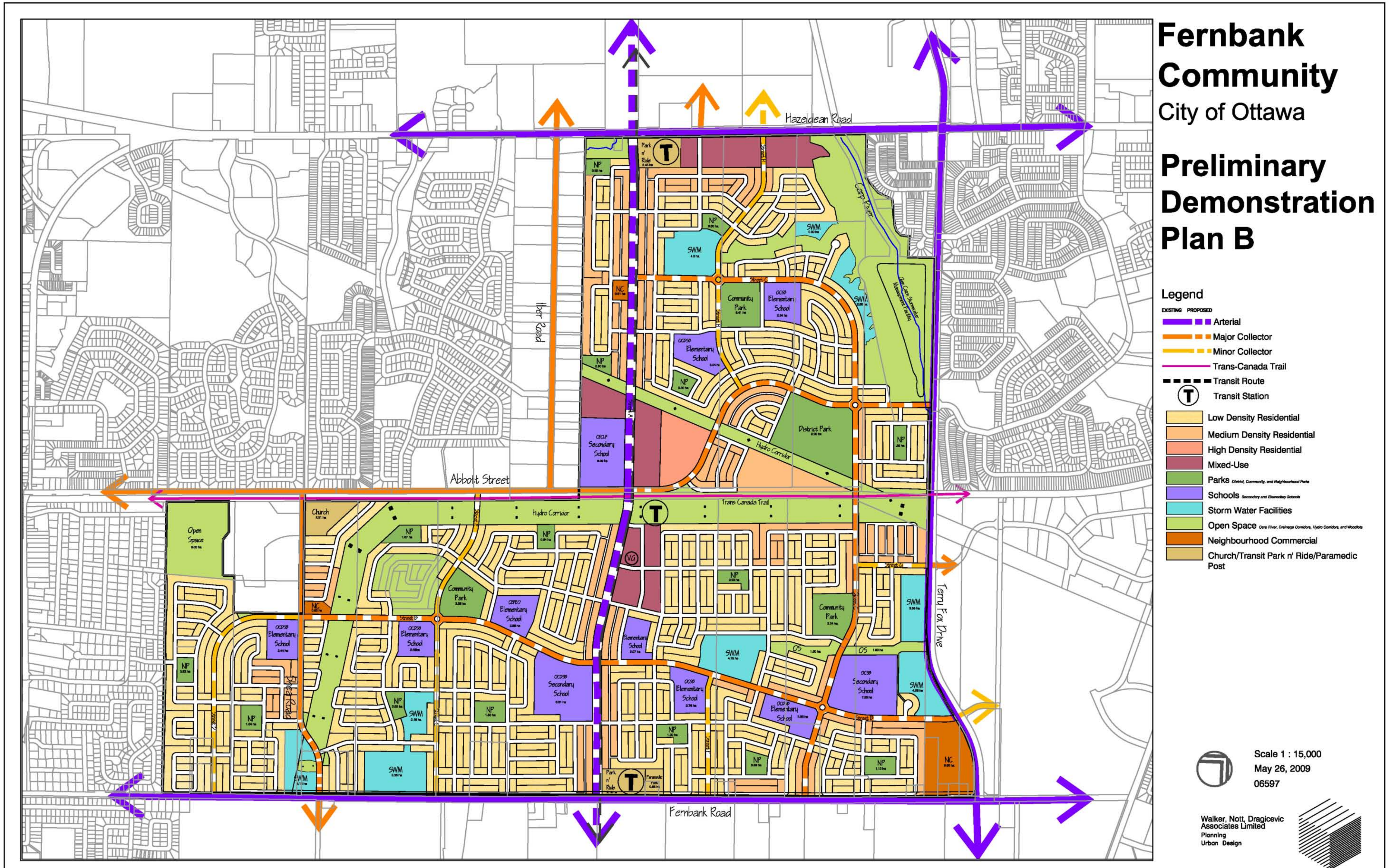
The most effective way for a future development to minimize the indirect impact on adjacent vegetation will be to leave an undisturbed buffer in terms of tree retention and no grading along the boundaries of the NEA. This buffer limit will be established as part of the EIS and could be north or south of the existing property line. Given the lower elevations to the south of the NEA, surface hydrology contributions from lands south of the NEA to the NEA lands appear minimal and are not expected to change significantly as a result of development.

The Natural Environment Area will be designated as Open Space and will be fully surrounded by development. There is the potential to provide a recreational pathway through the NEA without significantly disrupting the natural function of this area, which should be investigated as part of the EIS.

The EIS prepared for the Natural Environment area should include the following:

- Discussion of how the private lands to the south support the natural heritage features and functions of the NEA lands to the north;
- An assessment and recommendations for a recreational pathway linkage through and/or adjacent to the NEA lands;
- Detail assessment of the recommended line for the south boundary of the NEA lands
- An appropriate setback from the NEA boundary and associated mitigation measures to protect the NEA flora, fauna and their functions;
- An assessment of the potential impacts of a new forest edge;
- Identification of any trees or other on-site environmental features recommended for protection, considering grading and other servicing constraints for the site;
- Methodology for the relocation of the narrow-leaved vervain;
- Other mitigation measures to minimize the impacts of the development on the natural heritage features.

Figure 11.1: Preliminary Demonstration Plan



11.2 Urban Natural Features

The City have expressed potential interest in purchasing one of the Urban Natural Areas identified using the UNAEES criteria. At the Draft Plan stage, the City will have option to purchase this UNA at market value. If the City exercises their option to purchase these lands, there is to be no development within 30 m (as per OP policy) until an EIS is completed for this area. No EIS is required if the City does not purchase these lands.

The Urban Natural Feature recommended for retention has been carried over into the demonstration land use plan provided as **Figure 11.1**.

The proposed development will not have any significant impact on the long-term viability of this woodlot, as it is situated in an existing disturbed environment (agricultural). The impact of proposed grading changes will need to be evaluated during detailed design, but is not expected to have an adverse impact on the viability of this area. This woodlot currently accommodates some recreational use and contains a number of dog walking trails, and it could be expected to continue to serve this recreational use under post-development conditions.

<u>Tree Preservation outside the UNA</u>

Grade raise conditions for a balanced subdivision preclude the large-scale preservation of trees outside the natural areas. Individual trees and clusters of woody vegetation can be saved on a case-by-case basis as permitted along the edge conditions, in neighborhood parks and school sites where possible. The identification of individual trees and/or vegetation clusters suitable for retention is outside the scope of the EMP, and will need to be evaluated at the Plan of Subdivision stage based on proposed road layouts and grading/servicing requirements.

The demonstration plan provided in the EMP is a high-level plan that is subject to adjustment as subdivision development applications are brought forward. Retention of the remnant higher quality trees would be considered at that time.

11.3 Species of Special Concern

A regionally rare plant, narrow-leaved vervain, was observed in the cultural meadows adjacent to the south cedar forest. This species transplants very well, provided the transplant site has similar physical and biological properties (full sun, dry fields, limited soils).

Transplant and seed planting locations could include residential or municipal gardens, parks, or open space corridors. The most suitable open space transplant locations are within the Hydro Corridor west of Shea Road, between Fernbank Road and the proposed North/South Arterial Road.

11.4 Tree Planting Strategy in Areas of Sensitive Marine Clay

The City of Ottawa applies restrictions for tree planting in areas where sensitive marine clay is known to exist. Tree planting strategies in these areas should be developed in accordance with the *Tree and Foundations Strategy in Areas of Sensitive Marine Clay in the City of Ottawa*.

- Only low water demand trees with a lateral separation distance of 1 full mature tree height are to be planted in proximity to buildings or structures;
- In areas where adjoining properties result in one combined greenspace, only 1 tree per front yard area will be planted;
- All landscaping plans are to be reviewed to ensure compliance with the City's Trees and Foundations process;

- When planting replacement trees in locations where insufficient space allows an appropriate separation distance to place the tree on city property, when requested the city will action a tree planting on the adjacent private property on the condition that the resident signs a waiver assuming ownership of the tree and absolving the city of all future liability.

Alternatives that can be considered to meet tree planting requirements include:

- Planting shrubs instead of trees;
- Additional tree planting in parks, open spaces and SWM facilities.

11.5 Riparian Corridors

Low water levels and the lack of baseflow are of concern for both of the Carp River and Jock River subwatersheds' tributaries. Maintaining and/or enhancing natural streambed conditions along the Carp River West Tributary and the main branch of the Monahan Drain will assist in the preservation of discharge potential within in the site. These channels will represent an integral part of the proposed land use plans groundwater discharge features.

Meander development is a long-term geomorphic process and movement of the channel will be expected. Creeks and rivers are dynamic features on the landscape. Through time, their configuration and position on the floodplain changes as part of meander evolution, development, and migration processes. When meanders change their shape and shift in their position, the associated erosion and deposition that enable these changes to occur, can cause loss or damage to land. For this reason, when development or other activities are contemplated near a watercourse, it is desirable to designate a corridor that is intended to contain all of the natural meander and migration tendencies of the channel. The corridor widths for this project were based on the meander belt width and have the safety setback incorporated into it. This allocates the ability to compensate for such factors as bank erosion and any other process that may approach the original belt width delineation.

A corridor width of 40 m is recommended for all watercourses within the limits of the study area. The recommended riparian corridors for watercourses to be preserved have been integrated into the demonstration land use plan provided as **Figure 11.1**.

11.6 Adaptive Management Techniques for Watercourses (Monitoring)

In order to ensure the outlet watercourses will not be affected due to future changes in channel morphology, long-term monitoring devices should be installed in various locations of the outlet watercourse. Long-term performance monitoring of the outlet watercourses will allow the assessment of future changes in channel morphology resulting from the proposed development of the Fernbank Lands.

The long-term monitoring program and assessment of impacts should follow the recommendations outlined in the Stormwater Management Criteria in Section 6.1.

11.7 Carp River Restoration Plan - Third Party Review Recommendations

The proposed demonstration plan has been evaluated with respect to the recommendations of the *Third Party Review - Carp River Restoration Plan* (Greenland, March 2009) and the recommendations from the City of Ottawa Planning and Environment Committee. Recommendations for development of the Fernbank Lands from the Third Party Review are as follows:

Deficit Volume

- All Development within the portion of the Fernbank Lands tributary to the Carp River should accommodate a per hectare share of the 85,600 m^3 deficit volume until data is available to confirm the HEC-RAS model of the Carp River. This volume represents a worst-case scenario and will be revisited and refined as monitoring data becomes available and the modeling is refined.

Kanata West Development Area:		725 ha
Fernbank Area tributary to Carp River:		198 ha
Total Development Area:		923 ha
Per hectare share:	85,600 m^3 ÷ 923 ha =	93 m^3/ha
Fernbank Share:	93 m^3/ha x 198 ha =	18,400 m^3

This deficit volume could be provided in the following areas:

- open space areas such as the hydro corridors
- through additional on-site storage in commercial and high-density residential areas.
- Through additional storage within the Carp River Corridor outside the limits of the main channel.

The recommended stormwater best management practices for the Fernbank Community will also promote infiltration and reduce the volume of runoff to the Carp River. Hydrologic modeling of infiltration BMPs have indicated that they could reduce the 100-year post-development runoff volume by approximately 2,300 m^3, thereby reducing the deficit volume by a corresponding amount.

Post-Development Targets

- Post-development peak flows and flood elevations in the Carp River are not to exceed existing conditions, and increases in runoff volume are not to exceed an additional 40,000 m3 above existing conditions for the 100-year event.

The proposed stormwater management strategy for the Fernbank lands tributary to the Carp River meets the recommended post-development targets from the Third Party Review.

Interim Development

The third party review provides recommendations for development thresholds until such time as the modeling has been refined and the Carp River Restoration Plan is implemented:

- Prior to the completion of the Carp River Restoration, interim development phasing (with provision for the deficit volume) should be limited to 65% of the overall development plan.

The hydrologic and hydraulic analysis of the Fernbank Lands has demonstrated that this area can be developed in accordance with the recommendations of the Third Party Review. Based on the analysis completed, the EMP has the flexibility to adapt to any future changes to the Third Party Review criteria or requirements which may occur.

11.8 Carp River West Tributary

The lower reach of the Carp River Tributary has been identified as warm water fish habitat and is recommended for retention.

11.8.1 Geomorphic Channel Assessment

In order to prevent the exacerbation of erosion issues due to land use changes within the study area, erosion threshold targets were established for the Carp Tributary. The critical discharge calculation indicates the minimum flows that are necessary to initiate sediment movement of the bed material. If these or larger flows are sustained for a prolonged period of time, then excessive erosion could occur. The erosion assessment of the Carp River West Tributary (refer to Section 8.4.4) indicates that there will be no substantial increase in duration of flows above the threshold targets, and excessive erosion should not be an issue.

In order to address aggradational issues in the Carp River Tributary, flushing flow thresholds were established for the study site. The flushing flow thresholds provide flow requirements for sediment entrainment and mobilization based on existing conditions and historic daily flow records. Flushing flows are typically defined as those frequent flows, well below a two-year return period, which flush fines from the coarse matrix that comprises a riffle. As these flows likely limit the degree of seasonal or periodic embeddedness (filling of interstitial spaces with fine sediments), they are important for maintaining aquatic habitat, particularly during lower flow periods. During these periods, flows would not be sufficient to mobilize the coarser materials of the matrix but would remove fines smaller than sand from the bed. Consequently, the threshold was set to entrain the coarsest component of the fine sediments, arbitrarily assumed to be medium sand. It should be noted that, under these conditions, flows are below a bankfull event and are not sufficient to scour fines from pools but will affect the fines in riffles. The flushing flow threshold help reduce aggradation within a channel system.

11.8.2 Proposed Works

The recommended works on the Carp River West Tributary include:

- enclosing the upper reach of the tributary from the outlet of the Granite Ridge SWM Facility to the proposed Carp River Headwater Pond (P1).
    - Outflows from the Granite Ridge tributary will be conveyed in a storm sewer and routed through the proposed headwater pond.
- lowering of a section of the Carp Tributary over a length of approximately 100 metres downstream of the proposed Carp River Headwater Pond (P1). The proposed lowering will occur where the existing channel has been straightened, outside of the area where the channel has a more natural planform.
- the delineation of a minimum 40 m wide riparian corridor to protect aquatic habitat and stream function in the lower reach of the tributary, from the Headwater Pond to the Carp River;
- removal of perched culverts and other barriers to fish passage;
- preservation of existing riparian vegetation; and
- additional riparian plantings on areas where the canopy is minimal.

11.8.3 Fish Habitat Enhancement

Additional works are proposed to enhance fish habitat along the lower reach of the Carp River West Tributary. The enhancement works will be considered in more detail as development applications in this area are brought forward. Next-stage studies in this area will include applications for Alterations to Watercourses through the Conservation Authority.

A plan and profile drawing showing the proposed Carp River Tributary enhancements & modifications is provided in **Appendix N**.

11.8.4 DFO Authorization

Enclosing the upper reach of the tributary constitutes a HADD (harmful alteration, disruption or destruction of fish habitat), and will require authorization under the *Fisheries Act*. MVC and DFO have provided approval in principal of the proposed works (refer to correspondence in **Appendix B**), but a HADD application to DFO will be required for authorization.

Compensation for any loss of habitat associated with enclosing the upper reach of the Carp River West Tributary will be provided through rehabilitation works within the MVC owned lands adjacent to the Carp River. Rehabilitation works should take into consideration the complimentary objective of providing additional floodplain storage within the Carp River corridor (as per the recommendations of the Third Party Review).

A conceptual plan showing potential rehabilitation works along the Carp River corridor is provided in **Appendix L**. A hydraulic analysis of any rehabilitation works within the Carp River corridor will be required to evaluate the impact of the proposed works (ie. change in channel roughness & cross-section) on flood elevations in the Carp River.

11.9 Monahan Drain

The main branch of the Monahan Drain has been straightened and serves as an agricultural drainage ditch. The straight channel, shallow water depth, no natural meanders, very sparse riparian cover and steeply cut channel banks limit the existing habitat potential of the watercourse. This reach supports intermittent forage fish habitat and is recommended for retention as mitigation for abandonment of the numerous tributary drains within the limits of the study area.

11.9.1 Proposed Works

Proposed modifications and enhancements to the Monahan Drain include:

- the delineation of a minimum 40 m wide riparian corridor to protect aquatic habitat and stream function;
- abandonment of the various tributary branch drains within the limits of the proposed study area;
- the SWM facility at the headwaters of the Monahan Drain will be designed to provide baseflow enhancement in the drain;
- all SWM facilities will be designed to mitigate increases in temperature;
- riparian plantings will be provided within the protected corridor to provide habitat and stream cover.
- Proposed crossings should use open footings with natural streambeds to enhance fish habitat.
- The main branch of the Monahan Drain will be realigned to a more naturalized state, which will include:
  - meander belts;
  - a bankfull channel for flows up to the 1:2 year event;
  - a floodplain for higher flows up to the 100-year event;
  - pool and riffle sections for fish habitat;
  - riparian plantings to create a canopy over the watercourse; and
  - removal of the gabion basket weir upstream of Terry Fox Drive.

11.9.2 Natural Channel Design

Parish Geomorphic was retained to provide a conceptual naturalized channel design for the Monahan Drain. The geomorphic analysis completed for as part of the design was based on the following process:

Riffle dimensions were sized to convey the design discharge through an iterative process using energy gradient, hydraulic roughness and maintaining a width to depth ratio close to 10. By contrast, pools were designed to have the same top dimension as the riffles, but have a higher average depth value. The increase in cross-sectional area should be sufficient to reduce flow speeds, and in base flow conditions provide pool habitat for fish and other aquatic organisms. Riffles were typically installed in the straight sections of the channel between each pool. Riffles are designed to ensure that each riffle creates a backwater effect upstream on the subsequent riffle under a range of flow conditions, thus acting as grade control points.

Based on the results of the detailed geomorphic field investigation, the design discharge (i.e., bankfull flow) was based on channel conditions, dimensions and gradients measured in the field, as well as verified by post-development peak flows modeled for the study area.

The appropriate substrate materials were sized based on a review of the hydraulic conditions (i.e., tractive force, flow competency, flood flow stages) within the typical channel cross-sections. Based on a review of the hydraulic conditions listed above, D50 stone sizing for a riffle was 100 mm and the pool substrate consisted of native materials.

Discussions with RVCA and DFO have confirmed that the proposed works to the Monahan Drain and the abandonment of the tributary branch drains will not constitute a HADD (refer to correspondence in **Appendix B**). The Monahan Drain is classified as a Municipal Drain and is regulated under the *Drainage Act*. The proposed modifications will require the completion of an Engineer's Report.

<u>Design Process</u>

The natural channel design will be a multi-disciplinary effort intended to minimize operations and maintenance requirements. At the detailed design stage, the design process will require integration of the following:

- Engineering (design flows, grading)
- Landscaping
- Fluvial Geomorphology (channel profile & cross-sections, bed material)
- Recreation (pathways)
- Operation & Maintenance (access, maintenance requirements)

A plan and profile drawing showing the proposed Monahan Drain enhancements & modifications is provided in **Appendix N**.

11.10 Flewellyn Drain

The existing Flewellyn Drain has an invert of approximately 103.50m at Fernbank Road. The drainage area upstream of Fernbank Road has a very flat topographic relief, and servicing of this area with storm sewers will require a considerable amount of earth moving to provide the required cover.

A potential cost-saving alternative would involve:

- lowering of the Flewellyn Drain by approximately 0.5 m at Fernbank Road, and tying back into existing grade approximately 375 m south.

Lowering of the Flewellyn Drain is not required for development, but it would reduce the amount of earth moving required for construction of the upstream storm drainage system, at an estimated cost savings of approximately $800,000.

The critical discharge for erosion is very low (0.20 m3/s) in this reach of the Flewellyn Drain. The proposed cross-section of the lowered Flewellyn drain provides a wider channel bottom and reduced side slopes. The lowered reach will also have a reduced channel slope. These modifications will reduce flow velocities, which will aid in mitigating the erosion potential in this reach.

Discussions with RVCA and DFO have confirmed that the proposed works to the Flewellyn Drain will not constitute a HADD (refer to correspondence in **Appendix B**). The Flewellyn Drain is classified as a Municipal Drain and is regulated under the *Drainage Act*. The proposed modifications will require the completion of an Engineer's Report.

A plan and profile drawing showing the proposed modifications to the Flewellyn Drain is provided in **Appendix N**.

11.11 Hazeldean Creek

Hazeldean Creek passes through the northwest corner of the site, just east of Iber Road, and is classified as a warm water fishery within the limits of the site. Recommendations for Hazeldean Creek Include:

- the delineation of a minimum 40 m wide riparian corridor to protect aquatic habitat and stream function;

11.12 Open Space / Hydro Corridors

The existing hydro corridors for high-voltage transmission lines must be maintained through the development lands. The hydro corridors provide grassland habitat for several breeding birds, and preservation of the existing natural features within the hydro corridors will help to preserve their ecological function.

Road crossings of open space corridors create a break in the continuity of these corridors and disrupt the wildlife linkages between natural areas. Consideration should be given to minimizing the number of road crossings of open space corridors, while still meeting the transportation requirements of the proposed development.

Hydro corridor lands are privately owned with an easement agreement in favour of Hydro One. The easement agreement does not permit specific development uses, but rather a request can be submitted to Hydro One for consideration on a case-by-case basis. Ownership of the Hydro Corridors will be turned over to the City as part of the Plan of Subdivision process. Land use within the corridors will be at the discretion of the City, within the restrictions of the easement agreement.

No more than 10% of the Hydro corridor should be used for parking and other ancillary uses. Proposed ancillary uses of the Hydro corridors include a wet pond, dry ponds, hydro-substation, OC Transpo facility, and roadway crossings.

<u>SWM Facilities</u>

There is an opportunity to integrate stormwater management facilities (dry ponds and wet ponds) into the hydro corridors. Hydro One has confirmed that the construction of SWM facilities within the hydro corridors on the Fernbank CDP lands is permissible, provided that the designs are reviewed and approved by Hydro One. Correspondence is provided in **Appendix B**.

- Dry ponds will only provide a stormwater management function during large storm events (> 1:5 year event) and should be designed to provide the same ecological characteristics as cultural meadow habitat.
- All wet ponds should be designed with natural features and riparian vegetation so as to provide additional natural habitat.

Under post-development conditions, recreational pathways will be provided in most of the open space corridors. The recreational pathways should be designed to blend in with the natural environment, and to ensure that they do not create any significant impediment to wildlife movement and other existing natural functions.

11.13 Protection and Preservation of Underlying Aquifers

Aquifer vulnerability varies across the Fernbank Community Study area depending on the surficial soil conditions. The aquifers underlying the Fernbank Community area have low to high vulnerability to contamination from land use and materials on the surface. The parts of the site which do not have thick cover of fine-grained materials (silts and clays) are more vulnerable to contamination from activities on the surface.

The Fernbank Community is comprised mainly of residential development, which represents a low risk of contamination of the underlying aquifers. Mixed use and commercial developments have been sited along arterial roadways. High-risk commercial uses would typically be associated with gas stations. Mitigation measures to prevent aquifer contamination from high-risk commercial land uses would need to be addressed as part of the site plan development.

11.14 Tile Drains

GIS data has been used to identify the known locations of tile drains within the vicinity of the Fernbank Community. The tile drain locations are shown on **Figure 3.6**. There may be additional tile drains within the study area which are not in the GIS database.

Agricultural tile drainage systems provide preferential pathways for subsurface flow. Tile drains encountered within the house excavations could be a source of significant volumes of water, which could impact on the basements of the houses:

- Any drainage tiles that are within about 2 metres horizontal distance to the dwellings should be removed and the excavation for the tiles backfilled with compacted silty clay to prevent any water flow through the tiles or trench;
- Any drainage tiles that are below proposed footings should be removed. The ends of the drains should be severed at least 2 metres outside of the proposed basement foundations to reduce the potential for post construction groundwater inflow into the basements. The excavation for the tiles should be backfilled with compacted silty clay as described above.

The location and extent of these tile drains should be identified and the tile drains removed or decommissioned to eliminate undesired pathways. The impact of partial removal of tile drainage systems during phased construction will be dependant on the location, and site-specific measures will need to be considered during detailed design and construction:

- If the upstream drainage area is small, and there is no appreciable baseflow in the tile drainage system, then the excavation for the drainage tiles can be backfilled with compacted silty clay.
- If there is a large tile drained area upstream of the proposed development, or if the tile drains provide a baseflow contribution, an outlet should be provided. The upstream tile drainage system can be tied into the proposed storm sewer system for the development, or a temporary outlet can be provided through the construction of a perimeter ditch or interceptor drain at the upstream limit of the proposed development. This will allow for the continued operation of the tile drainage system, and will ensure that drainage of the upstream area will not be adversely impacted by the proposed development.

11.15 Water Supply Wells

Regulation 903 of the *Ontario Water Resources Act* requires that all well owners maintain wells in a state that does not allow the entry of foreign matter or surface water into the well. Unused and unmaintained well are to be properly abandoned. Improperly abandoned wells can be direct connections between the ground surface and the aquifers). All unmaintained and unused water wells and abandoned septic systems within the study area require proper decommissioning.

11.15.1 Abandonment of Decommissioned Wells

Permanent well abandonment requires that the well be filled in such a manner that vertical movement of water within the well bore, or the annular space surrounding the casing is effectively and permanently prevented and the water is permanently confined to the specific zone in which it originally occurred. A well needs to be checked first before it is sealed to see that there are no obstructions to the sealing operation. Removal of well screens, liner pipes or casings may be necessary in some cases to obtain a permanent seal. Casing opposite zones which cannot be readily removed must be split with a casing ripper to insure subsequent sealing by grout above, and where applicable below, the aquifer zone. Unless the annular space around the outside of the casing was cemented when the well was drilled, the upper portion of the casing should be removed to prevent surface water from entering the water-bearing strata by following down the casing.

Because of the complexities involved in some cases of well abandonment, each case should be considered as an individual problem and the design, construction of the well and the hydrogeology must be considered and studied before final selection of materials, methods and procedures can be realized.

11.15.2 Protection of Existing Wells

It was noted in the geotechnical investigations report that during the construction of the Fernbank Community bedrock removal will likely require drilling and blasting; activities that can potentially cause groundwater level lowering and/or adverse water quality problems in nearby wells.

There are a limited number of wells in the vicinity of the proposed development. Nonetheless, a proactive approach to well protection should be taken with respect to mitigating the effects of blasting on local wells. The impact of blasting can be mitigated by using techniques to reduce the seismic wave velocities resulting from blasting in the vicinity of existing wells.

Preconstruction surveys and well inspections should be carried out on any existing nearby wells prior to construction by an independent qualified company. The well survey should include the acquisition of the well record and any historical well water quality information. Well inspections should include visual examination to determine and record the following information:

- age, type and depth of well;
- how accessible is the well;
- presence of well pit and if present condition of well pit;
- nature and condition of well extension above ground surface (height);
- condition of well cap;
- condition of well casing;
- integrity of annular seal;
- distance from surrounding structures (buildings, septic tanks, driveway, roadway) and other potential sources of contamination.

Well and well water testing should include:

- testing for current water quality and integrity of well seal.

Monitoring and mitigation of any adverse impacts on existing wells will be the responsibility of the developer. If any adverse problems are reported by the residents during and/or after construction, it is recommended that the quality/quantity issue be investigated by an independent qualified engineering company. One or more water samples should be obtained to check the water quality and, if necessary, a temporary water supply should be provided to the house. If the water quality or quantity issue is determined to be due to the construction, a new water supply well should be constructed or the house should be connected to the municipal water supply. The water from new wells should be equivalent to or better than the water that is available from the local bedrock aquifer.

11.16 Stormwater Best Management Practices (BMPs)

Preservation of the area's groundwater recharge potential will involve the maintenance of the infiltration potential inherent within the study area. Infiltration of surface runoff is best accomplished through lot level and conveyance controls. However care must be taken to ensure that infiltration measures are suitable for the proposed type of development and soil conditions:

- Infiltration of runoff containing high concentrations of sediment can result in clogging of the pores in the soil, thereby reducing its infiltration capacity.
- Infiltration should be avoided in areas where there is potential for surface spills, which would potentially result in contamination of groundwater.

The majority of the Fernbank Community will be low and medium density residential development. The most suitable practices for groundwater infiltration include:

- Infiltration of runoff captured by rearyard catchbasins.
- Direct roof leaders to rearyard areas.
- Infiltration trenches underlying drainage swales in park and open space areas.
- The use of fine sandy loam topsoil in parks and on residential lawns.

By implementing infiltration and other lot level and conveyance BMPs as part of the storm drainage design for the Fernbank Community, the impacts of development on the hydrologic cycle can be considerably reduced. Infiltration of clean runoff will have additional benefits for stormwater management. By reducing the volume of "clean" water conveyed to the SWM facilities, the performance of the SWM facilities will be increased.

11.16.1 Water Balance Targets

Development of the Fernbank lands will result in changes to the hydrologic cycle in this area. Changes in evapotranspiration can have an impact on climate over a very large area in conjunction with other factors, but will have negligible impact on local hydrologic conditions. Changes in runoff and infiltration can potentially have adverse impacts on ground and surface water resources. The following targets are recommended for runoff and infiltration:

<u>Runoff</u>

The increase in storm runoff will be accounted for by the proposed stormwater management facilities. The SWM facilities will control post-development flows to ensure that the outlet watercourses are not adversely impacted by the increase in runoff (water quality, peak flows, thermal impacts, flood risk, erosion potential). The increase in storm runoff will provide an opportunity for baseflow enhancement in the outlet watercourses.

<u>Infiltration</u>

The recommended infiltration target is to match pre-development infiltration rates for each of the subwatershed drainage basins within the Fernbank study area. The types, locations, and suitability of infiltration BMPs will be dependant on site specific details and land use. Water balance targets will need to be evaluated and confirmed on a case-by-case basis as development plans are brought forward.

Target (pre-development) infiltration values for each subwatershed are listed below.

- Carp River: 112 mm/yr
- Faulkner Drain: 109 mm/yr
- Flewellyn Drain: 107 mm/yr
- Monahan Drain: 110 mm/yr

11.17 SWM Facilities

11.17.1 Wet Ponds

The Environmental Management Plan has identified recommended locations and conceptual sizes for SWM facilities to service the proposed development. They have been oversized to provide flexibility in the design of the ponds, as well as to allow flexibility in any future changes to the land use plan.

The locations of the proposed SWM facilities are shown on the demonstration plan provided as **Figure 11.1**. Conceptual designs for the recommended SWM facilities are provided in **Section 9.0**.

11.17.2 Dry Ponds

Dry ponds are recommended to provide storage of major system overland flows in order to prevent major system flows from crossing arterial roads. Dry ponds would be located within the hydro corridors, and would release stored flows back into the minor system at a controlled rate. Accumulation of major system runoff would only occur for storms greater than the 1:5 year event.

The size and locations of dry ponds are identified in the Master Servicing Study.

11.18 Baseflow Temperature Maintenance

Urbanization commonly results in an increase in the temperature of storm runoff, most often due to extended detention within stormwater management facilities. Wet ponds have been found increase the temperature of runoff by approximately 5.1ºC (MOE, 2003).

Incorporating the following mitigation measures into the design of the proposed SWM ponds will result in reduced thermal impacts from the SWM facilities:

- Design of SWM facilities using narrow pond configurations with bank plantings to promote shading and inhibit temperature increases;
- Deeper permanent pools (1.5 - 2.0 m) combined with bottom draw baseflow outlets: There is a minimal difference in temperature within the top metre of a permanent pool, but temperatures decrease with increasing permanent pool depths.
- Baseflows should be routed through a stone-filled subsurface trench: The length of the trench should be maximized to increase the opportunity for heat transfer from the water to the stone (refer to conceptual SWMF outlet design provided as **Figure 9.10**).
- Establishing / preserving riparian cover for outlet watercourses will further help to reduce the temperature of runoff.

11.18.1 Carp River West Tributary

The Carp River West Tributary is the only watercourse within the limits of the study area that has a near continuous baseflow component. The source of the baseflow appears to be groundwater inflow from foundation drains within the Granite Ridge Subdivision, which are routed through the Granite Ridge SWM pond prior to discharging to the West Tributary.

Field investigations have been conducted along the existing watercourse, starting from the inlet to the Granite Ridge facility to the lower reach of the Carp Tributary. Temperature measurements were taken in 2007 at noon on September 5 and mid-afternoon on September 27. Additional temperature measurements were taken in 2008 at mid-afternoon on July 31 and August 18. The results of this analysis are as follows:

- The temperature of storm sewer inflows from the Granite Ridge Subdivision to the SWM facility is generally around 18º C.
- Detention of runoff in the Granite Ridge Pond raises the temperature of outflows to approximately 25º C.
- The water temperature remains near constant as it is conveyed through the full length of the upper reach of the Carp River West Tributary.

The Granite Ridge SWM Facility was not designed to incorporate any thermal mitigation techniques. Consequently, in the summer there is a significant temperature increase (approximately 7º C) in baseflow as it is conveyed through the pond. Temperature data is provided in **Appendix G**.

Applying the proposed temperature mitigation techniques to SWM Facility P1 will result in the Carp River West Tributary experiencing lower water temperatures than existing conditions.

Section 12.0 Project Listing

The Environmental Management Plan component of the Fernbank CDP, in conjunction with the Master Servicing Plan and the Transportation Master Plan, satisfies the requirements of Phase 1 and 2 of the Integrated EA & Planning Act Process.

12.1 EA Projects

The following projects fall under the *Environmental Assessment Act*:

- Stormwater Management Pond #1 and associated storm sewers (Schedule B)
- Stormwater Management Pond #2 and associated storm sewers (Schedule B)
- Stormwater Management Pond #3 and associated storm sewers (Schedule B)
- Stormwater Management Pond #4 and associated storm sewers (Schedule B)
- Stormwater Management Pond #5 and associated storm sewers (Schedule B)
- Stormwater Management Pond #6 and associated storm sewers (Schedule B)
- Stormwater Management Pond #7 and associated storm sewers (Schedule B)
- Stormwater Management Pond #8 and associated storm sewers (Schedule B)
- Enclosing a portion of the Granite Ridge Outlet in a storm sewer (Schedule B)

Review agencies and the public will have an opportunity to review the Class EA documentation being prepared for the Fernbank CDP, and have the ability to appeal to the OMB. The assessment and review process is being harmonized with the *Planning Act* as the development application process is occurring simultaneously. Notification of the conditions of planning approvals and the Class EA documents will be advertised through a **Notice of Completion** and there will be an opportunity to appeal to the Ontario Municipal Board (OMB).

Under the *Planning Act*, appeals to the OMB may be made to any of the Official Plan and zoning by-law amendments or to the approval of subdivisions. The deadlines for the appeals to each application are found in the *Planning Act*. For Draft Plans of Subdivision and Zoning By-law amendments, appeals are to be filed within 20 days after written notice of decisions are provided. In addition, the OMB may dismiss an appeal if the person does not submit either written or oral submissions before the approval authority has granted approval. Once approved, however, the Class EA documents and the preferred municipal infrastructure projects will not be subject to additional EA approval requirements with the submission of subsequent site plans or plans of subdivisions. Once the application is approved under the *Planning Act*, the requirements of the Class EA are met and projects identified in the Class Environmental Assessments for the Fernbank CDP are approved and can proceed to construction and no additional notification under the EA Act is necessary. This allows the integration of both planning processes while ensuring the intent and requirements of both Acts are met.

The implementation, over time, of the Fernbank CDP and the required supporting infrastructure will take place as *Conditions of Approval*. The approvals will be conducted under the *Planning Act*, and other acts as listed in **Section 12.2**

12.2 Other Approval Requirements

The Fernbank CDP satisfies the EA requirements under the *Planning Act*. Additional approvals will be required for implementation of the proposed development plan including, but not limited to, the following:

12.2.1 Ontario Water Resources Act

All stormwater facilities are regulated under the *Ontario Water Resources Act* and will require a *Certificate of Approval* from the Ministry of the Environment.

12.2.2 Drainage Act

Drainage works regulated under the *Drainage Act* are exempt from the Ontario *EA Act*. Engineer's Reports will be required for the projects which fall under the *Drainage Act*, which include the following:

- Naturalization and enhancement of the main branch of the Monahan Drain for approximately 700 metres upstream of Terry Fox Drive, and abandonment of the various tributary branches of the Monahan Drain within the limits of the study area
- Abandonment of the Flewellyn Drain upstream of Fernbank Road
- lowering of the Flewellyn Drain for approximately 375 meters downstream of Fernbank Road (optional)

12.2.3 Fisheries Act

Enclosing a portion of the Granite Ridge Outlet (upstream of Stormwater Management Pond #1) and the proposed compensation works in the MVC owned lands adjacent to the Carp River will constitute a harmful alteration, disruption or destruction (HADD) of fish habitat and will require authorization from DFO under the *Fisheries Act*.

12.2.4 Conservation Authorities Act

Proposed enhancements to watercourses are regulated under Section 28 of the *Conservation Authorities Act* – Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses

- Proposed enhancement works to the Monahan Drain will require an application to RVCA.
- Proposed enhancement works to the Carp River West Tributary will require an application to MVC.

12.2.5 Official Plan Policy

Natural Environment Area

Section 3.2.2 of the 2003 City of Ottawa *Official Plan* states that an Environmental Impact Statement is required for all new development, including new lot creation, within 30 metres of the boundary of a designated Natural Environment Area.

Urban Natural Features

Section 3.2.3 of the 2003 City of Ottawa *Official Plan* states that an Environmental Impact Statement is required for any development within 30 metres of the boundary of a designated Urban Natural Feature.

Section 13.0 Cost Estimates

13.1 Modifications & Enhancement to Watercourses

Preliminary cost estimates have been prepared for the proposed modifications and enhancements for watercourses outlined in Sections 11.6 - 11.10. Construction of drainage works which benefit multiple landowners could be completed by way of drainage area development charges, or through cost-sharing between landowners. Land costs will be a component of either approach.

Table 13-1: Cost Estimates - Watercourses

Item	Description	Quantity	Unit	Unit Price	Total Amount
Flewellyn Drain Lowering					
1	Excavation and Grading	720	m	$100.00	$72,000
2	Remove and Replace Existing Culverts	2	LS	$1,000.00	$2,000
3	Soft Costs/Contingency (±30%)				$26,000
				Flewellyn Subtotal	**$100,000**
Carp River West Tributary Enhancements					
1	Excavation and Grading	120	m	$100.00	$12,000
2	Remove Existing Culverts	2	LS	$500.00	$1,000
3	Landscaping	1	LS	$25,000.00	$25,000
4	Soft Costs/Contingency (±30%)				$10,000
				Carp Enhancement Subtotal	**$48,000**
Carp River HADD Compensation					
1	Landscaping	1	LS	$175,000	$175,000
2	Soft Costs/Contingency (±30%)				$75,000
				Carp Compensation Subtotal	**$250,000**
Monahan Drain Realignment / Restoration					
1	Excavation and Grading	770	m	$200.00	$154,000
2	Remove Existing Culverts	3	LS	$500.00	$1,500
3	Pathway	1590	m	$50.00	$79,500
4	Landscaping	1	LS	$150,000.00	$150,000
5	Drain Bed Treatment	770	m	$100.00	$77,000
6	Soft Costs/Contingency (±30%)				$138,000
				Monahan Subtotal	**$600,000**
				Total Watercourses	**$998,000**

13.2 Cost Estimates for SWM Facilities

Preliminary cost estimates have been prepared for each of the recommended SWM facilities based on the conceptual design drawings provided in Section 9.0.

Table 13-2: Cost Estimates - SWM Facilities

Item	Description	Quantity	Unit	Unit Price	Total Amount
Carp River Headwater SWMF (P1)					
1	Excavation and Grading	100,875	m³	$8.00	$807,000
2	Rock Excavation	1,400	m³	$40.00	$56,000
3	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
4	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
5	Outlet Structure	1	LS	$40,000.00	$40,000
6	Landscaping	1	LS	$150,000.00	$150,000
7	Service Access Road (3m width)	2500	m²	$30.00	$75,000
8	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
9	Soft Costs/Contingency (±30%)				$360,000
				Pond 1 Subtotal	**$1,572,000**
Carp River North SWMF (P2)					
1	Excavation and Grading	12,500	m³	$8.00	$88,000
2	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
3	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
4	Outlet Structure	1	LS	$40,000.00	$40,000
5	Landscaping	1	LS	$35,000.00	$35,000
6	Service Access Road (3m width)	1,200	m²	$30.00	$36,000
7	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
8	Soft Costs/Contingency (±30%)				$87,000
				Pond 2 Subtotal	**$382,000**
Carp River South SWMF (P3)					
1	Excavation and Grading	35,000	m³	$8.00	$280,000
2	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
3	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
4	Outlet Structure	1	LS	$40,000.00	$40,000
5	Landscaping	1	LS	$75,000.00	$75,000
6	Service Access Road (3m width)	2,100	m²	$30.00	$63,000
7	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
8	Soft Costs/Contingency (±30%)				$159,000
				Pond 3 Subtotal	**$701,000**

Table 13-2 (cont'd): Costing - SWM Facilities

Item	Description	Quantity	Unit	Unit Price	Total Amount
Faulkner Drain SWMF (P4)					
1	Excavation and Grading	34,975	m³	$8.00	$279,800
2	Rock Excavation	1,200	m³	$25.00	$30,000
3	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
4	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
5	Outlet Structure	1	LS	$40,000.00	$40,000
6	Import Clay Material for Liner (Provisional)	5,200	m³	$16.00	$83,200
7	Landscaping	1	LS	$125,000.00	$125,000
8	Service Access Road (3m width)	2,300	m²	$30.00	$69,000
9	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
10	Soft Costs/Contingency (±30%)				$209,000
				Pond 4 Subtotal	**$905,000**
Flewellyn Drain SWMF (P5)					
1	Excavation and Grading	121,000	m³	$8.00	$968,000
2	Rock Excavation	11,000	m³	$25.00	$275,000
3	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
4	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
5	Outlet Structure	1	LS	$40,000.00	$40,000
6	Import Clay Material for Liner (Provisional)	13,250	m³	$16.00	$212,000
7	Landscaping	1	LS	$250,000.00	$250,000
8	Service Access Road (3m width)	2,900	m²	$30.00	$87,000
9	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
10	Soft Costs/Contingency (±30%)				$766,000
				Pond 5 Subtotal	**$2,682,000**
Monahan Drain Headwater SWMF (P6)					
1	Excavation and Grading	101,500	m³	$8.00	$812,000
2	Rock Excavation	17,200	m³	$25.00	$430,000
3	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
4	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
5	Outlet Structure	1	LS	$40,000.00	$40,000
6	Landscaping	1	LS	$150,000.00	$150,000
7	Service Access Road (3m width)	2,400	m²	$30.00	$72,000
8	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
9	Soft Costs/Contingency (±30%)				$476,000
				Pond 6 Subtotal	**$2,064,000**

Table 13-2 (cont'd): Costing - SWM Facilities

Item	Description	Quantity	Unit	Unit Price	Total Amount
Monahan Drain North SWMF (P7)					
1	Excavation and Grading	75,000	m³	$8.00	$616,000
2	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
3	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
4	Outlet Structure	1	LS	$40,000.00	$40,000
5	Landscaping	1	LS	$150,000.00	$150,000
6	Service Access Road (3m width)	2,700	m²	$30.00	$81,000
7	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
8	Soft Costs/Contingency (±30%)				$308,000
				Pond 7 Subtotal	**$1,279,000**
Monahan Drain South SWMF (P8)					
1	Excavation and Grading	62,000	m³	$8.00	$496,000
2	Bypass Chamber c/w Outlet Piping	1	LS	$40,000.00	$40,000
3	Inlet Headwall Structure	1	LS	$40,000.00	$40,000
4	Outlet Structure	1	LS	$40,000.00	$40,000
5	Landscaping	1	LS	$100,000.00	$100,000
6	Service Access Road (3m width)	2,600	m²	$30.00	$78,000
7	Inlet/Outlet Structure Fencing	20	m	$200.00	$4,000
8	Soft Costs/Contingency (±30%)				$239,000
				Pond 8 Subtotal	**$1,037,000**
				Total SWM Ponds	**$10,641,000**

Section 14.0 Implementation and Phasing

A detailed implementation table will be prepared as a separate document to the EMP that summarizes all recommendations, requirements, design considerations, triggers, approvals, etc. This implementation plan will be required prior to commencement of any development within the Fernbank Community.

14.1 EA Project Amendment/Change Process

The Fernbank CDP demonstration plan has been developed through the Integrated EA process, and represents one possible development scenario for the CDP lands, based on the environmental constraints and opportunities identified through the environmental inventory and evaluated as part of the EMP and Master Servicing Study. The Demonstration Plan is intended to illustrate the feasibility of implementing the recommended environmental management strategy and municipal servicing design.

The intent of the Environmental Management Plan is to: consider the impacts of any land-use activities on natural features; develop a plan to mitigate adverse effects; and protect, enhance or restore the natural system for the pleasure of all. The EMP has created a blueprint for development while maintaining sufficient flexibility to allow for future changes to the land use plan.

It is prudent to develop a process to recognize that due to unforeseen circumstances, it may not be feasible to implement the projects as described in the environmental assessment reports. The following sets out the process to deal with changes which occur after filing and obtaining approval of the environmental assessments and prior to construction.

The change process distinguishes between minor and major changes. A major design change would require completion of an amendment to this EA, while a minor change would not. For either kind of change, it is the responsibility of the proponent, to ensure that all possible concerns of the public and affected agencies are addressed.

Minor Changes
Minor design changes may be defined as those which do not appreciably change the expected net impacts associated with the project. For example, a design change in lighting treatment, landscaping, noise attenuation, median width, pathway connections, and underground infrastructure sizes, would be considered minor. Slight changes in alignment or facility footprints, which to not affect more than 2 participating landowners, would also be considered as minor. All affected landowners and appropriate stakeholders will be provided details of the modification. The majority of such changes could likely be dealt with during the detailed design phase and would remain the responsibility of the proponent to ensure that all relevant issues are taken into account.

Major Changes
Major changes may be defined as those which change the intent of the EAs or appreciably change the expected net impacts associated with the project. An example of a major change would result from a proposed shift in a preferred design alignment or configuration which would warrant changes in mitigation as described in the EA and affect 3 or more landowners. If the proposed modification is major the recommendations and conclusions in this report would require updating. An addendum to the EA would be required to document the change, identify the associated impacts and mitigation measures and allow related concerns to be addressed and reviewed by the appropriate stakeholders.

14.2 Phasing

The overall phasing plan for development is determined by a number of factors including:

- Early construction of the North-South Arterial Road;
- Approved planning status of the lands;
- Location relative to the existing sanitary sewer pump station and the existing watermain distribution system which will service the lands;
- Road access opportunities; and,
- Physical site characteristics and initial pond locations dictated by topography

As demonstrated in the Master Servicing Plan, Transportation Master Plan and the Existing Conditions Report, development can generally proceed from any location within the Study Area. As opposed to a geographically defined phasing plan, development will be governed by the availability of capital to pay for the installation key infrastructure components including the arterial road, trunk water and wastewater infrastructure, stormwater management facilities, and the like.

It is anticipated that development will occur incrementally through Plans of Subdivision with associated infrastructure and services being installed. Details of proposed works and improvements are set out in the accompanying **Table 14-1** and will be influenced by the future development rate, municipal budgeting priorities, and front-ending agreements. In any scenario, the proposed Arterial will be constructed to a 2-lane cross-section between Fernbank Road and Abbott Street as part of the first phase of development.

Dependant upon confirmation of satisfactory front-ending agreements, Neighbourhood and Community Parks are to be built concurrently with Draft Plans of Subdivision. Options for front-ending by developers will be explored by proponents in order to secure appropriate timing for both construction and repayment.

Table 14-1: Key Infrastructure Requirements for Development Phasing

Infrastructure Requirement	Development Capacity
Sanitary Servicing	
Hazeldean Pump Station capacity (with Glen Cairn forcemain returned to service)	+ 3,900 units
Hazeldean Pump Station upgrade (Third submersible pump)	+ 3,300 units
Hazeldean Pump Station upgrade (Replace 4 dry pumps and impellers) Assumption: KWPS online	+ 7,400 units
Water Servicing	
Trunk water mains and distribution	No constraints to development phasing
Stormwater Management	
Stormwater management facilities	By sub-watershed
Transportation	
N-S Arterial Road: Two lanes between Fernbank Road and Abbott Street (including collector road connection to Iber Road)	3,000 units
N-S Arterial Road: Two lanes between Abbott Street and Hazeldean Road Hazeldean Road: Four lanes	+ 5,000 units
Terry Fox Drive: Four/six lanes as per 2008 Transportation Master Plan	Balance of the planned development of the Fernbank CDP
N-S Arterial Road: Four lanes	As travel demands warrant

Section 15.0 References

The following reports were used as reference material to provide background information used in the development of the Environmental Management Plan.

- Carp River Watershed/Subwatershed Study (Robinson Consultants / Aquafor Beech)
- Jock River Reach 2 Subwatershed Study – Existing Conditions Report (Marshall Macklin Monahan, 2006)
- Kanata West Development Area Class EA's (City of Ottawa, 2006)
- Carp River, Poole Creek and Feedmill Creek Restoration Class EA (TSH/Parish Geomorphic/Stantec/Beacon, 2006)
- Post-Development Flow Characterization and Flood Level Analysis for Carp River, Feedmill Creek and Poole Creek (CH2MHill, 2006)
- Monahan Drain Master Drainage Plan (Gore and Storrie, 1993)
- Fish Habitat Classifications done for the Monahan Drain and Tributaries by the Rideau Valley Conservation Authority
- Engineer's Report – Repair and Improvements to the Flewellyn Municipal Drain (Novatech Engineering, 1982)
- Engineer's Report – Monahan Creek Municipal Drain Modifications and Improvements (Robinson Consultants, 2002)
- Treatment of Stormwater for the Bridlewood Community and Kanata South Business Park – Environmental Study Screening Report (Gore and Storrie, 1993)
- Monahan Drain Constructed Wetlands Final Design Report (J.L. Richards, 1993)
- Monahan Drain Constructed Wetlands – Phase 2 Final Design Report (Novatech Engineering, 2006)
- City of Ottawa 2003 Official Plan – Section 4.7.3 (1)
- City of Ottawa - Urban Natural Areas Environmental Evaluation Study (Muncaster & Brunton, 2005)
- Hazeldean Road Environmental Study Reports (Brunton, 2002; Ecotec, 2001)
- Third Party Review - Carp River Restoration Plan (Greenland, March 2009)

Prepared by:

NOVATECH ENGINEERING CONSULTANTS LTD

Michael Petepiece, P. Eng.
Project Manager

Reviewed By:

NOVATECH ENGINEERING CONSULTANTS LTD

John Riddell, P. Eng.
President