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Hamilton Conservation Authority
Ancaster, Ontario

Project Plan

Crooks' Hollow Dam Class Environmental Assessment

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1. Introduction

1.1 Explanation of Project Plan

This Project Plan has been prepared pursuant to the requirements of Conservation Ontario's (CO's) Class Environmental Assessment (Class EA) for Remedial Flood and Erosion Control Projects (Conservation Ontario, 2002). The CO's Class EA is an 'approved' Class EA under the Environmental Assessment Act (EAA), which allows Conservation Authorities (CAs) to undertake remedial flood and erosion control projects without applying for formal approval under the EAA.

This Project Plan forms part of the overall Class EA Project File and serves to document the environmental assessment planning process that was followed. That process, which is documented herein, has resulted in the selection of the preferred alternative (i.e., 'the undertaking') to remove the Crooks' Hollow Dam. The Crooks' Hollow Dam is owned and operated by the Hamilton Conservation Authority (HCA) who is the proponent of the undertaking. HCA retained Hatch in May 2005 to assist with the planning of the project.

This Project Plan has been made available for public and agency review as part of a 30-day review period. Subject to comments received on this Project Plan and the receipt of necessary approvals and funding, the HCA is expected to proceed with the implementation of the project. The implementation phase of the project will involve the preparation of detailed plans and specifications, contractor selection and construction.

1.2 Description of Undertaking

The proposed undertaking consists of the decommissioning and removal of the existing Crooks' Hollow Dam and appurtenant structures, restoration of the damsite and the waterway including the management (i.e., selected removal) of previously deposited river sediments, stabilization of shoreline areas susceptible to erosion and the creation/enhancement of fish habitat. Removal of the dam will revert the small reservoir back to its natural 'pre-dam' riverine condition.

1.3 Purpose and Rationale

The Crooks' Hollow Dam was constructed in 1913 and is over 95 years old. Although various repairs have been periodically carried out over the years, no significant rehabilitation work has been done. The dam, now nearing its useful life expectancy is in substandard condition. Recent engineering studies have confirmed that the dam requires corrective rehabilitation to ensure its safe operation under major storm events or it should be decommissioned and either removed or modified into an overflow weir.

Given the high costs to reconstruct a new operable replacement dam and the fact that the existing operable structure does not provide significant flood control benefits, decommissioning and removal of the dam is considered to be the most effective solution for the long-term disposition of the facility. The removal of the dam will address safety concerns regarding the dam's deteriorated condition, eliminate long-term operating and maintenance costs and enhance local and downstream environmental conditions with no net long-term negative impacts to the environment.

1.4 Study Area

The Crooks' Hollow Dam is located on Spencer Creek, Lot 8, Concession 2, in the community of Greensville within the City of Hamilton (Figure 1.1). The study area is defined as the geographical area upstream and downstream of the dam that could be affected by the various dam rehabilitation/decommissioning alternatives.

The study area includes the Crooks' Hollow Dam, Spencer Creek and associated shoreline areas extending approximately 500 m upstream and 300 m downstream of the dam. Included in this study area are remnants of the former early 1800s Morden's Mill Dam and earth embankment, approximately 350 m upstream of the Crooks' Hollow Dam.

1.5 Environmental Assessment

As noted, the project to remove the Crooks' Hollow Dam was subject to the Ontario Environmental Assessment Act (EAA), namely Conservation Ontario's Class Environmental Assessment for Remedial Flood and Erosion Control Projects (Conservation Ontario, 2002). Application of the Conservation Ontario's Class EA to the Crooks' Hollow Dam project was premised on meeting the intent of the following project requirements as defined in Conservation Ontario's Class EA:

- *"The project is undertaken by a Conservation Authority (as the proponent).*
- *The project is remedial in nature and is required to protect human life and property from flooding or erosion.*
- *The project is situated within a previously developed area and will not facilitate or anticipate development.*
- *The project requires a solution that is structural in nature and/or requires capital works."*

Figure 1.2 depicts the principal steps associated with the planning and design process associated with Conservation Ontario's Class EA. Application of Conservation Ontario's Class EA process to the project to remove the Crooks' Hollow Dam has resulted in the preparation of this Project Plan Report based on the assessment findings herein that significant, adverse, residual environmental effects can be adequately mitigated.

1.6 Project Selection Subcommittee

HCA formed a subcommittee comprised of staff and selected members of the HCA Board whose role was to review environmental assessment study documentation prepared by Hatch and recommend a preferred project solution to the HCA Board for approval. During the Class EA process, the subcommittee met on several occasions to review and discuss project related information including the identification and comparison of alternatives. On two separate occasions, Hatch conducted presentations to the subcommittee. The subcommittee also reviewed Hatch's open house presentation material as well as public and agency comments.

On July 10, 2008, the subcommittee recommended that the HCA Board endorse the removal of the Crooks' Hollow Dam as the preferred solution. The HCA Board of Directors ratified the endorsement on September 4, 2008. Following the January 23, 2009 Notice of Filing and the receipt of Part II Order Requests, the Board deferred final approval of the project until the Minister's decision, which occurred on May 13, 2009. Final approval is now expected to occur in August 2009 at the next HCA Board meeting.

Figure 1.1
Hamilton Conservation Authority
Crooks' Hollow Dam Class EA
Location of Crooks Hollow Dam

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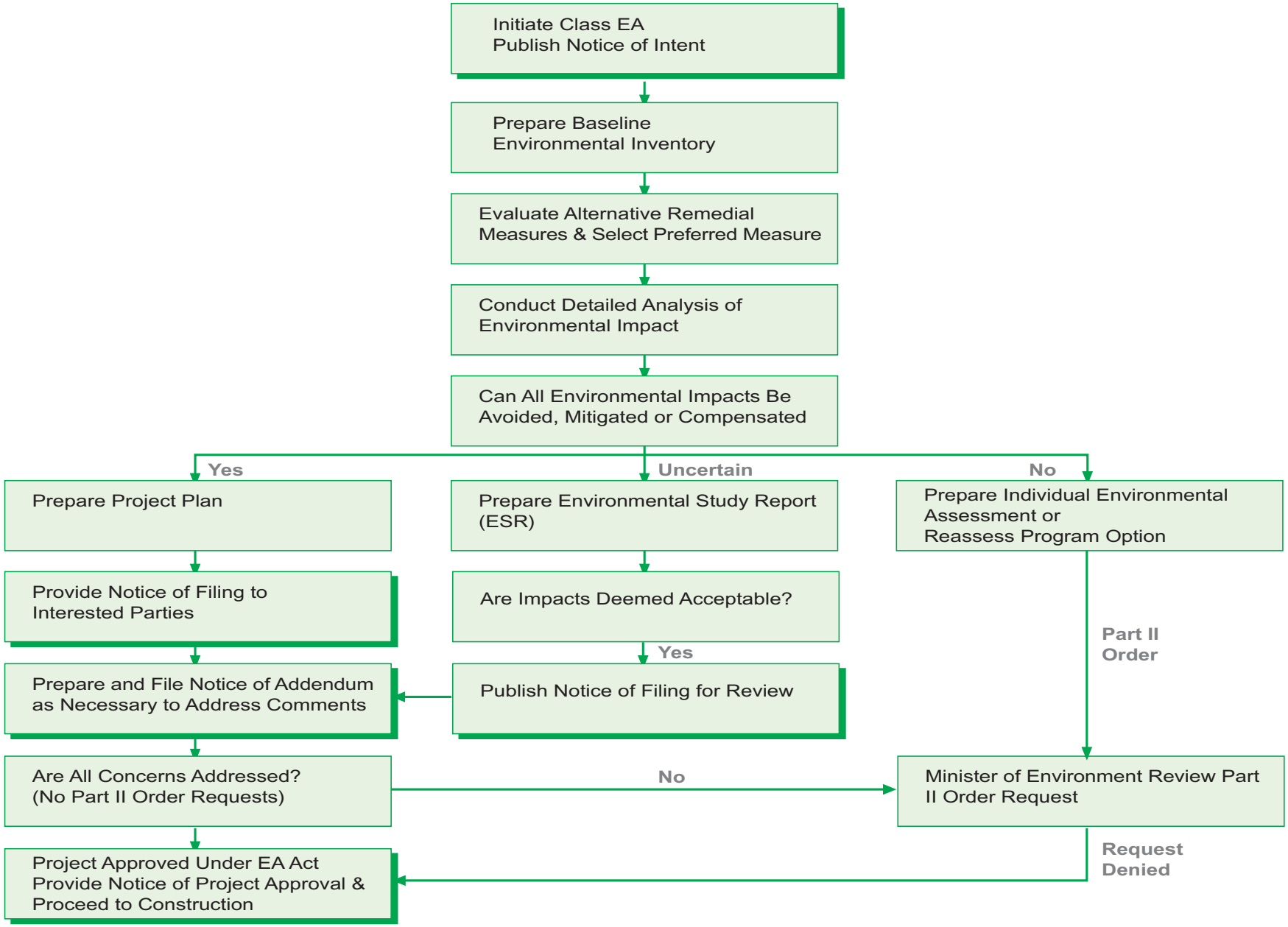

Figure 1.2
Hamilton Conservation Authority
Crooks' Hollow Dam Class EA

Conservation Ontario Class EA Planning and Design Process

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2. Public and Agency Consultation

The following public and agency consultation activities were conducted as part of the Class EA process:

- Stakeholder Identification
- Notice of Intent
- Open House
- Notice of Filing
- Part II Order Requests
- Minister's Decision
- Notice of Project Approval.

Consultation activities were coordinated by the HCA with assistance from Hatch.

2.1 Stakeholder Identification

During the Class EA process, the following federal, provincial and municipal agencies and First Nations (but not limited to) were consulted:

- Canadian Environmental Assessment Agency (CEA Agency)
- Fisheries & Oceans Canada (DFO), Ontario-Great Lakes Area
- Transport Canada - Marine, Navigable Waters Protection
- Environment Canada
- Health Canada
- Natural Resources Canada
- Indian and Northern Affairs Canada
- Ontario Secretariat for Aboriginal Affairs
- Conservation Ontario
- Ministry of Natural Resources
- Ministry of the Environment (including the Environmental Assessment and Approvals Branch)
- Ministry of Culture
- Ministry of Transportation
- Ministry of Municipal Affairs and Housing
- Ministry of Tourism and Recreation

- Ministry of Agriculture and Food
- City of Hamilton
- Hamilton Conservation Authority
- Hamilton Harbour Remedial Action Plan
- Royal Botanical Gardens
- Niagara Escarpment Commission
- Six Nations of the Grand River
- Mississaugas of New Credit First Nation
- Trout Unlimited Canada
- Hamilton Area Fly Fishers and Tiers
- Optimist Club of Greensville
- Members of Public.

2.2 Notice of Intent

Notice of Intent Newspaper Advertisement

The Notice of Intent was published in the Hamilton Spectator on September 17, 2005. The notice served to notify the public of the study, including its purpose and status under the EAA. A copy of the notice is provided in Appendix A.

Stakeholder, First Nations and Government Agency Letter Mail Out

A direct letter mailing of the Notice of Intent was completed during the week of September 15, 2005 to two First Nations, local community groups and relevant government agencies. A total of 28 letters were mailed. A sample copy of the mail out letter and mailing list is provided in Appendix A.

Seven responses were received from government agencies (refer to Appendix A, Table A1). Responses noted general policy concerns and provided advice for various environmental aspects to be considered in the Class EA process.

Public Letter Mail Drop

A house-to-house mail drop of the Notice of Intent to local residents in proximity of the dam was completed on September 29, 2005. A total of 34 copies of the notice were dropped off.

Only one response was received from a member of the public (refer to Appendix A). The respondent noted concerns regarding the potential for environmental impacts if the dam was to be removed.

Information Postings on HCA's Website

During the Class EA process, study information, including the Notice of Intent, Notice of Open House and Notice of Filing along with downloadable copies of some of the environmental assessment report documentation was posted on the HCA's website at www.conservationhamilton.ca.

2.3 Open House

Notice of Open House

A public open house was held at the HCA's Christie Lake Conservation Area (Marina Pavilion) on April 30, 2008. Notice of the open house was provided by newspaper, HCA's website and a letterbox drop to local residents.

The purpose of the open house was to provide study information to the public regarding the operation of the existing Crooks' Hollow Dam, the environmental features within the study area and the Class EA process steps. At the open house, the various dam rehabilitation/decommissioning alternatives, including a comparison of their advantages and disadvantages, environmental effects and costs were displayed to the public. Public input on the various alternatives in the form of comment sheets was used to assist with the selection of the preferred option. Several staff from HCA and Hatch participated and answered questions from the public.

Open House Responses

Approximately 35 people attended and 20 comment forms and one email response (person did not attend the open house) were received. Subsequent to this, two additional letters were received from Trout Unlimited and the Royal Botanical Gardens. A copy of the open house newspaper advertisement, HCA website notice and the presentation materials is provided in Appendix A. Public and agency concerns/comments identified from the comment forms are presented in Appendix A.

Review of the open house responses identified the following:

- Major interests in the Crooks' Hollow Dam include hiking/walking/jogging, bird watching and wildlife viewing (17 respondents), followed by fishing (11 respondents) and canoeing (5 respondents). Other identified uses (8 respondents) included scenic and tranquility benefits, historic association of the dam, picnicking and sailing model boats. Only 2 respondents identified swimming as a major interest.
- Seven (7) respondents supported the preferred option to Decommission and Remove the Dam.
- Fourteen (14) respondents indicated a preference to see the existing head pond retained either by repairing the existing dam or by converting the dam into an overflow weir (9-dam repair, 1-weir, 4-dam repair or weir).
- Of the 7 respondents that identified a preference to remove the dam, two persons identified themselves as a resident in the community of Greensville. Of the 14 respondents that identified a preference to retain the existing head pond (i.e., repair dam or convert to weir), 12 persons identified themselves as a resident in the community of Greensville.
- The Ministry of Natural Resources (open house comments), Trout Unlimited and the Royal Botanical Gardens (follow-up letter responses), all expressed strong support for the dam removal option.

2.4 Notice of Filing

Notice of Filing Newspaper Advertisement

The Notice of Filing to the public was published in the Hamilton Spectator and the Dundas Star News on January 23, 2009. The notice served to notify the public and agencies of the selection of the preferred alternative and to inform them of a 30-day review period for interested parties to review

the Project Plan at HCA's offices. The Notice of Filing was also placed on HCA's website along with a (downloadable) copy of the Project Plan report. A copy of the notice is provided in Appendix A.

Stakeholder and Agency Letter Mail Out

A direct letter mailing of the Notice of Filing was completed during the week of January 19, 2009 to local community groups, government agencies, and to members of the public that responded to the first notice and/or attended the public open house. A total of 47 letters were mailed. A sample copy of the mail out letter and mailing list is provided in Appendix A.

Public Letter Mail Drop

A house-to-house mail drop of the Notice of Filing to local residents in proximity of the dam was completed on January 14, 15 and 20, 2009. A total of 535 copies of the notice were dropped off.

Responses to Notice of Filing

Following issuance of the Notice of Filing, a total of four letters and several emails were received from members of the public and government agencies. All public and agency concerns/comments identified from the responses are presented in Appendix A.

Review of the responses identified the following:

- Four (4) members of the public commented that they were not supportive of the preferred option to Decommission and Remove the Dam. Concerns cited were the loss of recreational use of the small head-pond, loss of fish and waterfowl habitat, loss of an historic structure, degradation of the scenic beauty of the area, contaminated sediment, and a lost opportunity to rebuild the dam to provide flood control and hydroelectric generation.
- The Niagara Escarpment Commission expressed support for the dam removal option and noted that a Development Permit would be required for the proposed works.
- The Public Works Department of the City Hamilton identified several information clarification requirements and suggested revisions to the draft Project Plan Report. The suggested revisions have been incorporated into this final Project Plan Report.
- Transport Canada, Marine noted that no work is to commence on the dam until approval under the Navigable Water Protection Act is obtained.

In addition, following the Notice of Filing, several newspaper articles appeared in the Flamborough Review, Dundas Star News and the Hamilton Spectator. Copies of these notices are provided in Appendix A.

2.5 Part II Order Requests

Following issuance of the Notice of Filing, three letters requesting a Part II Order were submitted by members of the public to the Minister of the Environment between February 14 and 22, 2009. Copies of the letters are contained in Appendix A.

During March and April 2009, the Environmental Assessment and Approvals Branch (EAAB) of MOE conducted a review of the Part II Order requests that resulted in a report to the Minister of the Environment.

During this time, the EAAB requested information from the HCA to assist the EAAB in their review of the project with respect to the Part II Order requests.

2.6 Minister's Decision

On May 13, 2009, the Minister of the Environment, the Honourable Mr. John Gerretsen, proclaimed that the project to remove the Crooks' Hollow Dam would not be subject to an Individual EA under the EAA.

With this decision, the Minister stated that the HCA could proceed with the project, subject to the following conditions:

1. *"The HCA must prepare a sediment management plan that addresses all aspects related to the removal of the sediment, including method and amount of excavation, removal and final disposal of sediment and all measures to ensure that sediment release does not occur during the course of removal.*
2. *As part of the preparation of this [sediment management] plan, the HCA must undertake further consultation with any other agencies, particularly the Ministry of Natural Resources, and Fisheries and Oceans Canada, who share a mandate for water quality and fishery resource protection.*
3. *The HCA must submit the sediment management plan to the Technical Support Section of the Ministry of the Environment's West Central Region Office for technical review.*
4. *No physical activities related to sediment management and dam decommissioning may take place until the Technical Support Section of the Ministry of the Environment's West Central Region Office has confirmed in writing that the sediment management plan is acceptable.*
5. *The HCA shall indicate in the sediment management plan, as described in the above conditions and provided to the satisfaction of the Technical Support Section of the Ministry of the Environment's West Central Region Office, that the sediment management plan has been conducted in order to satisfy the above conditions."*

2.7 Notice of Project Approval

Following final endorsement of the project by the HCA, expected in August 2009, a Notice of Project Approval will be posted in the Hamilton Spectator and on HCA's website. A copy of the notice will be mailed to Conservation Ontario and all 'interested parties' (as identified from the previous consultation steps). A copy of the Notice of Project Approval is included in Appendix A.

3. Background

3.1 History of the Crooks' Hollow Dam

The Crooks' Hollow Dam was originally constructed in 1913 to supply potable water to the community of Dundas. Years later, this use ceased after an alternate municipal supply of water was established for village. Between 1959 and 2001, the Dundas Valley Golf and Curling Club used the reservoir as a source for irrigation water.

In 1964, the Public Utilities Commission leased the Crooks' Hollow Area, including the dam to the Hamilton Conservation Authority (formerly the Spencer Creek Conservation Authority[1]) for a term of 50 years. The Conservation Authority paid an annual rental fee and was responsible for the maintenance and development costs for use of the area for general conservation.

In 1972, the Christie Lake Dam and reservoir were constructed upstream of the Crooks' Hollow Dam to provide flood protection for the community of Dundas, water related recreation activities and low flow augmentation during periods of low flow to Spencer Creek.

On February 7, 2000, the Dundas Council approved the transfer of ownership for the approximately 9.9 ha of land to the HCA. The Crooks' Hollow Dam and it small upstream reservoir currently provides recreational opportunities that include hiking, fishing and limited boating.

3.2 Dam Condition

Condition assessments of the dam carried out in 1968 and 1976 (William L. Sears) identified enough concern about the integrity/stability of the dam that the normal operating water level was lowered to reduce the loads on the structure during major storm events. Subsequent assessments in 1993 (Peto MacCallum Ltd.) identified the poor condition of the concrete and notably, the spillway piers, which exhibited severe concrete delamination and cracking. The dam was considered to be stable under current operating conditions (see above) and for short-term increases in water levels up to 1.5 m above spillway Nos. 1, 3 and 4 (elev. $\pm$218.82 m) in the event of a major storm event. However, the dam was not considered to be able to withstand the force of a major storm event if the normal operating water level was maintained at its original design operating level of 1.8 m above the top of spillways Nos. 1, 3 and 4 (elev. $\pm$219.12 m).

As a result, to ensure the integrity of the dam, the HCA modified the operating procedure by reducing the normal (summer) operating level to elev. $\pm$216.58 m. Various repairs to the dam have been completed since the 1970s including concrete repairs in 1977, shotcrete resurfacing in 1987-88, installation of an upstream membrane in 1994 and repairs to the catwalk decking in 1995. No major rehabilitations to the structure has been conducted to date and HCA has continued to operate the dam at the lowered normal (summer) level since 1993.

In summer 2005, Hatch initiated a dam stability and condition assessment study of the dam. Photographs of the dam are presented in Figure 3.1. The condition of the dam is considered to be fair. Noted deficiencies included the poor condition of the concrete surface on the below-water upstream side and on portions of the downstream spillway end wall, fill settlement associated with the north abutment, dislodgement of the downstream spillway wall and seepage. Based on stability

[1] The Spencer Creek Conservation Authority was formed in 1958.

calculations, the dam's concrete structures do not meet current stability criteria for the load cases when the original design water level is applied. The structure is however, considered to meet criteria for the reduced water levels as currently operated (Hatch, 2007).

The Crooks' Hollow Dam is now over 95 years old and although minor repairs have been periodically carried out over the years, no significant rehabilitation work has been done. The dam, now nearing its useful life expectancy is in substandard condition and recent engineering studies have confirmed that the dam requires corrective rehabilitation to ensure its safe operation under major storm events or it should be decommissioned and either removed or modified into an overflow weir.

3.3 Previous Study and Reports

A complete listing of previous studies and background reports related to the operation and condition of the dam, and the environmental features within the study area are listed at the end of this report. Specific studies prepared in conjunction with this Class EA (under separate cover) include

- Reservoir Sediment Study, Crooks' Hollow Dam Class EA by Hatch Acres, April 2006.
- Sediment Transport Study, Crooks' Hollow Dam Class EA by Hatch Acres, June 2006 – This report was subsequently reformatted (February 2009) and included in this report as Appendix E.
- Crooks' Hollow Dam Stability and Condition Assessment, by Hatch Energy, March 2008.

3.4 Justification of Conservation Authority Involvement

HCA's involvement with the planned removal of the Crooks' Hollow Dam is clearly justified given their ownership of the dam and their legislative authority pursuant to the *Conservation Authorities Act*.

Under the *Act*, the HCA has prime responsibility for water management, in terms of water quantity and hazards related to flooding and erosion within areas under its jurisdiction. Section 21(1) of the *Act* provides administrative powers to the Conservation Authority to, among other things, construct dams, control the flow of surface waters and divert or alter watercourses in order to prevent hazards related to flooding and erosion. The construction, operation, maintenance and retirement (i.e., decommissioning) of dams are valid activities pursuant to HCA's mandate and are consistent with its' Water Management Policy in the Flood and Erosion Control Program Areas.

Further, the Crooks' Hollow Dam is situated within the Crooks' Hollow Conservation Area, a 41-ha park owned and managed by the HCA with facilities for picnicking, hiking and historical interpretation. HCA's management direction for the Conservation Area is guided by the Crooks' Hollow Master Plan which was approved in 1993.

Upstream face of dam.

Downstream face of dam.

View of Crooks' Hollow Reservoir looking upstream from dam.

View of Spencer Creek looking downstream from dam.

View of remnant Mill Dam at mid-point in reservoir.

View of creek channel and riparian wetland looking upstream from remnant Mill Dam.

Note: Photographs taken May 19, 2005 prior to reservoir filling to the normal summer water level.

Figure 3.1
Hamilton Conservation Authority
Crooks' Hollow Dam Class EA
Site Photographs

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4. Baseline Inventory – Existing Environment

4.1 Description of Existing Dam

4.1.1 Dam Configuration and Operation

The Crooks' Hollow Dam is a concrete structure approximately 6.1 m high and 36.6 m long. The dam has four ogee-shaped overflow spillways, which can be fitted with stop logs, varying in width from 3.66 to 4.27 m. There are two wingwall segments located on either side of a raised steel deck. The maximum top of stop log elevation is ±218.24 m and the deck elevation is ±219.33 m. The sill elevation of spillway No. 2 is ±214.15 m and the sill elevation of spillways Nos. 1, 3 and 4 is ±217.32 m.

The dam spans an approximate channel width of 20 m and creates a small reservoir approximately 600 m long and 80 m wide based on the normal summer operating water level of ±216.58 m. Although provision exists for stop logs in all four bays, only spillway No. 2 is used to insert and remove stops. Spillways Nos. 1, 3 and 4 are left open to their sill elevations to minimize reservoir levels and reduce loads on the dam. The stop logs in spillway No. 2 are lifted by two hand cranked winches.

Pedestrian access across the top of the dam is not restricted and therefore serves to connect a residential subdivision on the south side of the river to Crooks' Hollow Road and the HCA trail system on the north side of the river.

Operationally, the Crooks' Hollow Dam functions as a run-of-the-river structure and does not provide any significant active storage for flood control and has never been operated by HCA with that objective in mind. The upstream Christie Lake Dam, constructed in 1972, provides this function. As a result, the dam passes all upstream flow released through the Christie Lake Dam with no reduction in peak flows. The dam is only operated on a seasonal basis. In the fall, 5 of the 8 stop logs[1] are removed from the dam (spillway No. 2) to provide flood passage capability for the spring freshet. Currently, this operation involves lowering the reservoir by approximately 1.52 m to the winter operating level of ±215.06 m. In the spring following the freshet, the 5 stop logs are replaced into spillway No. 2 and the reservoir is maintained at ±216.58 m during the summer.

4.1.2 Dam Condition

Based on the findings of the dam stability and condition assessment report for the Crooks' Hollow Dam (Hatch Energy, 2008), the following aspects are noted:

- The Crooks' Hollow Dam is classified to be SMALL height with a SMALL storage reservoir according to the draft Ontario Dam Safety Guidelines (ODSG) (MNR, 1999).
- Based on a review of dam break modeling carried out for the Christie Dam by others it appears that the incremental effects of a sunny day dam breach would be minimal and no loss of life is expected. The incremental effects of a dam breach during the IDF (i.e., regulatory flood) would be minimal and no incremental loss of life is expected. On the basis of the consequences of

[1] Spillway No. 2 has provision for 9, 0.30-m thick stop logs. In 2002, 1 stop log was stolen and not replaced, hence only 8 stop logs are currently used operationally in the dam.

dam failure (as estimated by dam break modeling), the dam is classified as having a SIGNIFICANT incremental hazard potential (IHP).

- The draft ODSG indicates that for a SMALL dam with a SIGNIFICANT hazard potential, the IDF will be between the 1:100-yr flood and the regulatory flood. For the Crooks' Hollow Dam, which would be considered to be at the low end of the range, the 1:100-yr flood is specified with an inflow of 34 m^3/s. This dam benefits from the flow regulation offered by the Christie Dam immediately upstream. The dam has adequate spillway capacity to safely pass the IDF and the freeboard criteria are satisfied for both the normal and flood conditions.
- The concrete structures are generally in fair to poor condition. Cracking and general deterioration of the remedial shotcrete layer was observed on various surfaces.
- Based on stability calculations, the dam's concrete structures do not meet current stability criteria for the load cases when the original design water level is applied. The structure is however, considered to meet criteria for the reduced water levels as currently operated.

4.1.3 Potential Waterpower Considerations

In response to public questions raised on the Open House, the potential for the installation of a small hydro facility at the Crooks' Hollow dam was examined. The head at the dam (if it were restored to the original dam condition and water levels) would be approximately 6 m. The available flow however is quite modest and the dam relies exclusively on flow releases from the upstream Christie Dam. During certain times of the year (summer periods), flows are minimal and the Crooks' Hollow reservoir is considered too small to store and release flows effectively.

A previous study reportedly concluded that hydroelectric generation was not feasible at the Crooks' Hollow dam. The MNR's (1985) report, *"Ontario's Water Power Sites"* inventory of potential generation sites identifies a hydro potential of about 34 kW (50% availability factor) at this site. A project of this size is far too small to be economic in today's market and would not have the revenue stream to support the various studies, approvals, permitting, licensing, connection and metering costs that are in addition to the generation equipment and design costs. Based on these considerations, it is concluded that hydroelectric generation at the Crooks' Hollow damsite would not be economically viable.

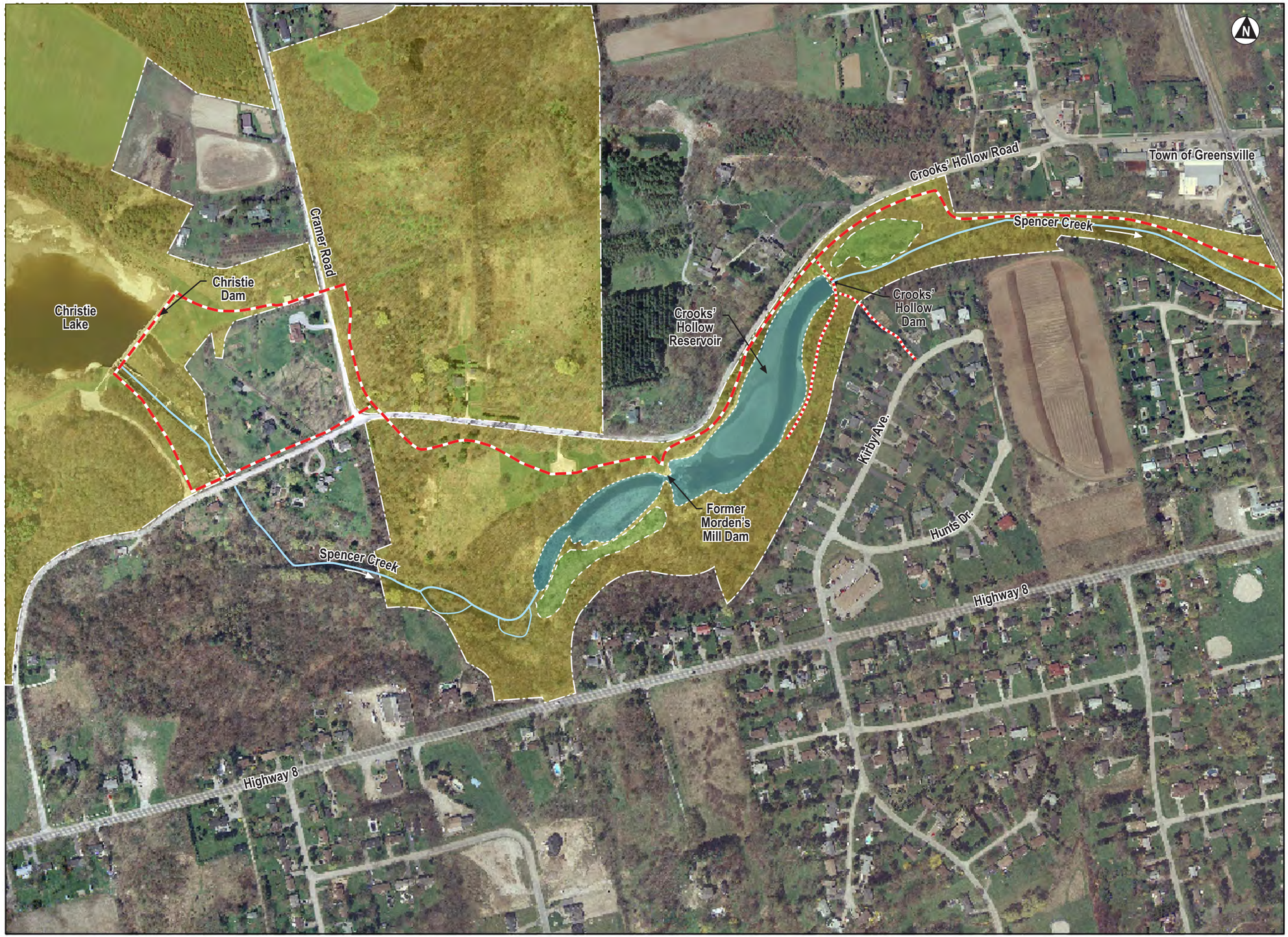
4.2 Natural Environment

Key environmental features associated with the Crooks' Hollow Dam study area are depicted in Figure 4.1 and discussed in the following sections.

4.2.1 Climate

The nearest climate station to the study area is situated at the Royal Botanical Gardens (RBG) in Burlington. During the period 1971 to 2000, annual average temperature[1] at this station was 8.5ºC, with a maximum of 22.0ºC in July and a minimum of -4.9ºC in January (Environment Canada, 2004).

[1] Temperature data from this climate station may not be entirely representative of conditions in the Crooks' Hollow area, which is situated above the Niagara Escarpment at an elevation approximately 100 m higher and set back farther from Lake Ontario than the RBG station. However, data from this station provides a general indication of long-term climatic conditions.



Legend

- Reservoir Boundary at Normal Summer Level (el 216.28m)
- Wetlands
- Conservation Lands
- Local Trails
- Crooks' Hollow Historic Trail

Note: Aerial photograph shows reservoir at drawn down fall/winter level (~ el 215.06m).

0 75 150 225 300 Meters

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Figure 4.1
Hamilton Conservation Authority
Crooks' Hollow Dam Class EA
Existing Environment Features

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Precipitation in the study area, characterized by data obtained at the Christie Lake Conservation Area, averages 872 mm/yr, 11% of which falls as snow. September and August are typically the wettest months, while January and February are the driest months (Environment Canada, 2002).

4.2.2 Air Quality

In Ontario, the primary parameters used to measure air quality, through the Air Quality Index (AQI), include sulphur dioxide (SO2), ozone (O3), nitrogen dioxide (NO2), total reduced sulphur compounds, carbon monoxide (CO) and fine particulate matter. These parameters are measured by the Ministry of the Environment (MOE) at one long-term monitoring station in the City of Burlington, situated on Northshore Boulevard East.

At the Burlington air quality monitoring station in 2007, there were no instances of Very Poor air quality and five occurrences of Poor air quality between May 24 and June 26 (due primarily to ozone), based on the daily AQI ratings. Air quality was rated as Moderate for 45 days of the year, with the first instance occurring on March 10 and the last occurring in October. Ozone and fine particulate matter were typically the main causes of the Moderate ratings. All other days of the year were rated as Good or Very Good (MOE, 2008).

4.2.3 Physiography

The Crooks' Hollow Dam study area lies within Norfolk Sand Plain physiographic region. Bedrock in the area consists of the contact area between the bituminous dolostone of the Eramosa member of the Lockport formation and the brown dolostone of the Guelph Formation. This contact point is exposed at a site on the north side of Crooks' Hollow Road, directly across from the Conservation Area. Overburden in the area typically consists of thick sand deposits south of the Spencer Creek valley, grading into a gently sloping glaciolacustrine sand plain north of the valley (Heagy, 1993).

4.2.4 Hydrogeology

Based on review of Ministry of Environment (MOE) water well records located within a radius of 500 m of the Crooks' Hollow Dam, there are an estimated 72 domestic water wells records in proximity to the dam (refer to Appendix D). The well records were provided by the HCA and supplemented by additional records from the MOE. The water wells vary in depth from 6.4 to 60 m with an average depth of 25.5 m, and have been completed in both overburden deposits and limestone bedrock.

Two north-south oriented cross-sections (A-A' and B-B') were prepared along a line extending from the north shore of the creek, through the reservoir and on through the subdivision located on the south side of the creek (refer to Appendix D). The cross sections show that overburden wells are generally completed in gravels just above the bedrock or at the bedrock/overburden contact. For wells completed in the bedrock, the groundwater level was found close to the bedrock surface.

Based on the stratigraphy and static water levels shown on the cross sections, local groundwater is expected to flow toward Spencer Creek from the topographically higher surrounding areas.

4.2.5 Fish and Fish Habitat

Spencer Creek, with a watershed size of approximately 279 km^2 and a total stream length of approximately 40 km (Ecotec, 2000), is the largest watershed draining into Hamilton Harbour. Spencer Creek originates from a number of seepage areas north of Flamborough and flows southeast, through two HCA operated flood control reservoirs Valens and Christie Lake dams) situated upstream of the Crooks' Hollow Dam. Downstream of the Crooks' Hollow Dam, Spencer Creek passes over

the Niagara Escarpment at Webster's Falls, following into Cootes Paradise, a 220-ha coastal marsh at the extreme western end of the harbour.

The upper reaches of Spencer Creek and its tributaries (e.g., Fletcher Creek, Flamborough Creek) provide cold-water habitat for a variety of resident aquatic species including brook trout, which have been the subject of several ongoing aquatic habitat restoration programs administered by the HCA. The two large reservoirs support a number of warmwater sport fish, including largemouth bass and northern pike, as well as a variety of coarse and bait fish. The lower reaches of Spencer Creek, below the Niagara Escarpment, support a resident community of cool/warm water sport and baitfish and provide spawning and nursery habitat for a variety of migratory species from Lake Ontario including cold water species such as rainbow trout.

The Crooks' Hollow reach of Spencer Creek, located downstream from the Christie Lake reservoir and upstream of Webster's Falls, is a relatively isolated reach of the creek. Movement of aquatic fauna in the creek system is blocked on the downstream end of the reach by the Crooks' Hollow Dam and at the upstream end by the Christie Lake Dam. Both dams are impassable barriers to upstream fish movement. Therefore, the aquatic population of the Crooks' Hollow reach is limited to the self-sustaining resident community and any individuals that wash out of the 60-ha Christie Lake reservoir.

Fish species captured in Crooks' Hollow Reservoir, Christie Lake and the surrounding reaches of Spencer Creek are identified in Table 4.1 (Holmes, 1986; HCA 1999; HCA 1998; HCA 1993; HCA 1989; MOE 2000 and Department of Lands and Forests, 1970). HCA monitoring programs have identified a total of nine species residing in the Crooks' Hollow reservoir. Common species include pumpkinseed, bluntnose minnow and Johnny darter, while largemouth bass and common carp are also found in the reservoir. The riverine reaches of Spencer Creek upstream and downstream from Crooks' Hollow contain a more typical cool water riverine fish community.

In their letter of June 19, 2008, the Royal Botanical Gardens indicated that warm water and eutrophic conditions in the Crooks' Hollow reservoir caused by the presence of the dam, contributes to the mass production of algae which depletes oxygen in the water column which contributes to algae bloom in Cootes Paradise. Also, the habitat created in the reservoir is conducive to non-native fish, the common carp, some of which are carried downstream to Cootes Paradise where an intensive carp removal program is in place. The letter noted that *"extensive time, money and effort are put forth every year to remove and keep carp out of the recovering 220-hectare Cootes Paradise marsh, having an upstream breeding ground only delays recovery of the marsh."*

4.2.6 Life Science Sites

A 7.5-km long segment of Spencer Creek ('the Christie Stream Valley'), including Christie and Crooks' Hollow reservoirs, has been identified as a Life Science Site by Ministry of Natural Resources (MNR) (MNR, 1998). The Christie Stream Valley has also been identified as a significant site in the Hamilton-Wentworth Natural Areas Inventory (Heagy, 1993). Significance is based on the presence of two significant earth science features (Guelph and Lockport Formations Earth Science Site, located near the Christie Dam and the Guelph-Lockport Contact Earth Science Site located along a road-cut north on Crooks' Hollow Road north of the Crooks' Hollow Conservation Area) and habitat for a few significant vegetation species (their presence within the study area is unconfirmed).

Table 4.1 Fish Species in Spencer Creek, Crooks' Hollow and Christie Lake

Common Name	Scientific Name	Location				
			Spencer Creek			
		Crooks' Hollow	350 m d/s from Crooks	400 m u/s from Crooks	200 m d/s from Christie	Christie Lake
Salmonidae						
Rainbow trout	*Onchorynchus mykiss*				X	
Esocidae						
Northern pike	*Esox lucius*					X
Catostomidae						
White sucker	*Catostomus commersoni*	X		X	X	X
Northern hog sucker	*Hypentelium nigricans*					X
Black redhorse	*Moxostoma duquesnei*					X
Cyprinidae						
Northern redbelly dace	*Phoxinus eos*				X	
Finescale dace	*Phoxinus neogaeus*			X		
Common carp	*Cyprinus carpio*	X		X	X	X
Hornyhead chub	*Nocomis biguttatus*	X				
River chub	*Nocomis micropogon*		X		X	
Common shiner	*Notropis cornutus*	X		X	X	X
Rosyface shiner	*Notropis rubellis*					X
Mimic shiner	*Notropis volucellus*		X			
Bluntnose minnow	*Pimephales notatus*	X		X	X	X
Fathead minnow	*Pimephales promelas*			X	X	X
Blacknose dace	*Rhinicthys atratulas*		X	X	X	
Longnose dace	*Rhinicthys cataractae*		X	X	X	
Creek chub	*Semotilis atromaculatus*	X	X	X	X	
Ictaluridae						
Brown bullhead	*Ictalurus nebulosus*	X			X	X
Percopsidae						
Trout perch	*Percopsis omiscomaycus*					X
Centrarchidae						
Pumpkinseed	*Lepomis gibbosus*	X		X	X	X
Bluegill	*Lepomis macrochirus*				X	
Largemouth bass	*Micropterus salmoides*	X	X		X	X
Percidae						
Johnny darter	*Etheostoma nigrum*	X		X		X
Blackside darter	*Percina maculata*	X		X	X	X
	Species Richness	11	6	12	16	15

The study area lies within the Niagara Section of Rowe's Deciduous Forest Region (Rowe, 1972) and Hill's Site Region 7E in Site District 7-3, which forms part of the Eastern Deciduous Forest Region which is also known as the Carolinean Life Zone (Conservation Halton, 2004). This region generally supports a higher diversity of plant and animal species than any other ecosystem in Canada (Conservation Halton, 2004). The forest communities of this region are dominated by broadleaved trees with typical associations consisting primarily of American beech (*Fagus grandifolia*) and sugar maple (*acer saccharum*), together with basswood (*Tilia americana*), red maple (*Acer rubrum*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and bur oak (*Quercus macrocarpa*) (Rowe, 1972).

4.2.7 Vegetation

Vegetation and wildlife communities within the study area were surveyed as part of the Nature Counts inventory of the Christie Stream Valley ESA area (Nature Counts, 2002). The Site Summary Report and species listing, including vegetation and wildlife for the Christie Stream Valley are provided in Appendix B of this report and summarized in the text below.

Upland slopes and riparian areas around the reservoir and creek upstream and downstream from the dam are forested with a mixture of hardwood community associations including sugar maple – black cherry and sugar maple – oak deciduous forest, white cedar – sugar maple mixed forest and black walnut – white ash successional forest. Other common species present include American beech, yellow birch (*Betula alleghaniensis*), hemlock (*Tsuga canadensis*), white birch (*Betula papyrifera*), red oak, red maple and black cherry (*Prunus serotina*). Common ground cover species in forested areas include zig-zag goldenrod (*Solidago flexicaulis*), jack-in-the-pulpit (*Arisaema triphyllum ssp. triphyllum*), false Soloman's seal (*Maianthemum recemosum spp. racemosum*) and meadow rue (*Thalictrum dioicum*). The shoreline around the reservoir upstream from the dam is comprised of mostly exposed bedrock shoreline with an abundance of willow and dogwood thicket and riverbank grape (*Vitis riparia*).

Wetland areas existing along the periphery of the reservoir at its upstream end are dominated by tall shrub and meadow marsh communities including rice cut grass shallow marsh, tall cattail shallow marsh and raspberry, willow and dogwood thicket. A moist seepage area at the base of the adjacent slopes south of the creek is dominated by alder thicket swamp with a ground cover of sedges (*Carex sp.*), ferns and forbs including spotted touch-me-not (*Impatiens capensis*), skunk cabbage (*Symplocarpus foetidus*), horsetails (*Equisetum sp.*) and occasionally, rough-leaved goldenrod (*Solidago patula*). The overstorey includes black alder (*Alnus glutinosa*), white birch, tamarack (*Larix laricina*), yellow birch and balsam poplar (*Populus balsamifera ssp. balsamifera*).

The wetland area immediately upstream from the former Morden's Mill dam consists of a seasonally inundated marsh and thicket community including emergents such as broad-leaved arrowhead (*Sagittaria latifolia*), rice cut grass (*Leersia oryzoides*) and bur reed (*Sparganium eurycarpum*), wet meadow species such as spotted touch-me-not, spotted joe-pye-weed (*Eupatorium maculatum*), reed canary grass (*Phalaris arundinacea*), tall meadow rue (*Thalictrum polygamum*) and boneset (*Eupatorium perfoliatum*), and scattered tall shrubs including red-osier dogwood (*Cornus stolonifera*), speckled alder (*Alnus incana*) and American elder (*Sambucus canandensis*).

4.2.8 Wildlife and Birds

Wildlife communities within the study area were surveyed as part of the Nature Counts inventory of the Christie Stream Valley ESA area (Nature Counts, 2002). A total of 14 herpetile (amphibian and reptile) species have been recorded in the Christie Stream valley with three being observed in 2002. These included common species such as American toad (*Bufo americanus*), green frog (*Rana clamitans*) and northern leopard frog (*Rana pipiens*), which are likely present along the shores and

riparian areas within the study area. Wetlands are likely used as breeding and foraging habitats for these species.

A total of 45 breeding bird species were observed by Nature Counts in the Christie Stream Valley in 2001/2002 including one locally rare species [common snipe (*Gallinago gallinago*)], a species of marshes, wet meadows and swamps (Hughes, 2001). A total of 26 species of butterflies were recorded, including six locally uncommon, one locally rare and Special Concern species [monarch (*Dannius plexippus*)]. Six mammals, including big brown bat *(Eptesicus fuscus)*, eastern chipmunk *(Tamias striatus)*, gray squirrel *(Sciurus carolinensis)*, little brown bat *(Myotis lucifugus)*, white footed mouse *(Peromyscus leucopus)* and white-tailed deer *(Odocoileus virginianus)* were also recorded.

4.2.9 Species at Risk

Species at risk in Ontario are protected under the federal *Species at Risk Act* (SARA) and the provincial *Endangered Species Act*. The list of species observed in the Christie Stream Valley during the 2002 Nature Counts inventory was cross referenced with the SARA and the *Endangered Species Act* species lists to identify if any federal or provincial species at risk were known to reside within the study area. Table 4.2 summarizes this information.

Table 4.2 Summary of Species at Risk Known to Reside in Christie Stream Valley

Species		SARA Designation	Endangered Species Act Designation
Common Name	**Scientific Name**		
American chestnut	*Castanea dentata*	Endangered – Schedule 1	Endangered
Butternut	*Juglans cinerea*	Endangered – Schedule 1	Endangered
Eastern milksnake	*Lampropeltis triangulum*	Special Concern – Schedule 1	Special Concern
Monarch	*Dannius plexippus*	Special Concern – Schedule 1	Special Concern

American chestnut typically resides in well drained, upland deciduous forests on sandy acidic soils, typically in association with oak, black cherry, sugar maple and American beech (COSEWIC, 2004). COSEWIC (2004) notes that only one individual has been observed in the Christie Stream valley.

Butternut trees are typically found in riparian areas, but are also known to grow in rich, moist, well drained loams and gravels, particularly those originating from limestone (COSEWIC, 2003; Nielsen et al., 2003). Based on this habitat associated, butternut could potentially reside within the project study area, in proximity to Spencer Creek.

Eastern milksnake typically resides in a variety of habitats, including old field, swamps and open woodlots (Fisher, 2002). In Ontario, this species is more common on heavily forested areas with a mix of deciduous and coniferous trees, but is also known to reside in rural, agricultural areas, including farms, sheds and barns (Fisher, 2002). Based on this, milksnakes could potentially reside within the study area, but are unlikely to be found within the grassed area immediately adjacent to the Crooks' Hollow Dam.

Monarch butterflies reside throughout Ontario and can be found wherever milkweed (Asclepia syriaca) or other wildflowers are found, such as abandoned old fields, along roadsides or other open

meadow areas (Government of Canada, 2008). Some wet meadow type wildflowers are present along the Spencer Creek riparian area, particularly in the area upstream from Morden's Mill Dam. Monarchs could potentially use these areas for foraging and breeding. There are no significant accumulations of wildflowers in the immediate vicinity of the Crooks' Hollow Dam.

4.2.10 Reservoir Sediment and Quality

As part of this Class EA, a Reservoir Sediment Study (April 2006, issued under separate cover) and a Sediment Transport Study (June 2006, refer to Appendix E) were conducted by Hatch. The purpose of these studies was to ascertain the potential quantity and quality of previously deposited sediments upstream of the dam and to assess its potential for mobilization and transport, including its potential effect on the environment if the dam were to be removed. The results of these studies are summarized below.

Collection of reservoir sediment and bathymetry data as part of the Reservoir Sediment Study (2006) indicated measured sediment depth in the reservoir was found to reach a maximum of 1.87 m and typically decreased to a depth of 0.27 m moving upstream from the Crooks' Hollow Dam toward the Morden's Mill Dam. The substrate of the reservoir is typically characterized by a thick layer of sediment consisting of a mixture of decomposed organic material and fine-grained inorganic material that was deposited on the underlying bedrock or granular materials. Grain size analysis indicated that the clay/silt fraction formed the dominant component of all samples obtained, with fine sand being the second most dominant particle size. The majority of the channel upstream from Morden's Mill Dam is composed of exposed bedrock with a veneer of rocky material (cobble and gravel). Based on interpretation of the sediment depth measurements, it was estimated that approximately 5000 m^3 of unconsolidated fine sediments exist in the Spencer Creek channel (Hatch Acres, 2006).

The results of the chemical analysis of reservoir sediments were compared to the Provincial Sediment Quality Guidelines (PSQG) (MOE, 1993), and found to exceed the Lowest Effect Level (LEL) and the Severe Effect Level (SEL) for a number of chemical parameters (Hatch Acres, 2006). Eight parameters including arsenic, cadmium, lead, copper, mercury, nickel, zinc, total phosphorus, and total Kjeldahl nitrogen exceeded the LEL indicating that at these observed levels, benthic invertebrate populations may be impacted. One parameter (zinc) was found to exceed the SEL at two locations, indicating heavily impacted sediment likely to affect the health of sediment dwelling organisms. Chemical concentrations were typically higher in the lower sediment layers, however, the upper sediment layer immediately upstream from the dam exhibited higher chemical concentrations than did the lower layer. In general, chemical concentrations were highest in front of the dam, decreasing toward the upstream end of the reservoir.

The Sediment Transport Study (Appendix E) confirmed that the previously deposited sediments in the reservoir would be highly susceptible to mobilization and downstream transport if the Crooks' Hollow Dam was completely removed. In addition to the potential impacts associated with the quantity of sediment that could be transported, the chemical make-up (i.e., poor sediment quality) could create sediment contamination problems in areas where deposition occurs; potentially impacting benthic invertebrate use of the sediment. Given this, the Reservoir Sediment Study concluded that, if the dam removal option were to be pursued, some form of sediment management (e.g., dredging and/or on-site containment and/or off-site disposal) would be necessary to prevent environmental degradation.

4.3 Social Environment

4.3.1 Historical Setting

The Crooks' Hollow area has a significant historical past. Early pioneers, drawn by the waterpower and associated industrial opportunities provided by Spencer Creek, colonized the area in the late 1700s. In the early 1800s, notables, including Jonathon Morden and James Crooks established several buildings including a sawmill, general store, barrel factory, blacksmith's shop, woolen mill, distillery and tannery. During this period, the Crooks' Hollow area flourished and was the site of the first operational paper mill in Upper Canada. Much of the former settlement has since disappeared, although some remnants of former dams, mills and residences can still be found in the area.

The Crooks' Hollow Dam was originally constructed in 1913 to supply potable water to the community of Dundas. Years later, this use ceased after an alternate municipal supply of water was established for village. Between 1959 and 2001, the Dundas Valley Golf and Curling Club used the reservoir as a source for irrigation water. In 1964, the Public Utilities Commission leased the Crooks' Hollow Area, including the dam to HCA for a term of 50 years. In 2000, the Dundas Council approved the transfer of ownership for the approximately 9.9 ha of land to the HCA.

4.3.2 Land Use

There are no private developments along the reservoir's shoreline, although adjacent residential developments exist along the tablelands atop the valley slopes to the south and to a lesser extent on the north side of Crooks' Hollow Road. The nearby Community of Greensville (within the City of Hamilton) is situated less than 500 m to the east.

The Crooks' Hollow Dam is situated within the Crooks' Hollow Conservation Area, a 41-ha park owned and managed by the HCA with facilities for picnicking, hiking and historical interpretation. The Conservation Area is one of 131 such parks and open space areas that constitute the Niagara Escarpment Parks and Open Space System (NEPOSS) and is designated under the NEPOSS as a "Historic Park".

The Crooks' Hollow Master Plan was approved in 1993 with a mandate that the Area contribute to the mission of the HCA by providing protection, restoration and public enjoyment of the natural environment. The key focus of the Plan was to provide for the development of a trail system that would link Christie Lake Conservation Area with the Spencer Gorge Wilderness Area and the Bruce Trail. The trail system also serves as a method to connect the numerous historic sites that are found in this area for interpretive purposes.

Based on information provided by HCA planning staff, the Master Plan does not provide any specific direction on the Crooks' Hollow Dam and reservoir with respect to its long-term direction or day-to-day management. There is no historic component to the dam that requires protection or restoration. Thus, the only role the dam plays with respect to the trail system is as a connector between the main trail on the north side and the access trail on the south side leading to Kirby Drive.

4.3.3 Planning Designations

The Niagara Escarpment Plan (NEP) designates the Spencer Creek floodplain through the Crooks' Hollow Conservation Area as "Escarpment Natural Area". According to the Plan (NEC, 2005), this designation reflects the presence of important escarpment features which are in a relatively natural state and associated stream valleys, wetlands and forests which are relatively undisturbed. These areas contain important plant, animal habitats, geological features and/or cultural heritage features and are the most significant natural and scenic areas of the Escarpment.

Under the 1985 Town of Flamborough Official Plan, the lands around the reservoir are identified as Settlement Open Space; the Spencer Creek areas upstream and downstream of the dam are identified as Hazard Lands. Subject to finalization of the new City of Hamilton's Official Plan, it is expected this land use designation may change to Open Space and Conservation, but the Spencer Creek valley will continue to be categorized as Hazard Lands.

The HCA has prepared floodplain and fill line mapping for Spencer Creek through the Crooks' Hollow Dam study area identifying areas of natural hazards associated flooding and erosion. Non-conservation authority works within these areas are subject to HCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses: Regulation 161/06 under Ontario Regulation 97/04.

4.3.4 Current Dam Uses

The Crooks' Hollow Dam, the small water impoundment and the adjoining parklands and trail system provides uses that include recreation (hiking, fishing and limited boating), pedestrian access across the river and a source of water for fire fighting.

In terms of recreational uses, both local residents and visitors to the Crooks' Hollow Conservation Area enjoy these activities. The HCA maintains a 1.5-km long self-guided walking trail through the Crooks' Hollow area allowing visitors to view the remnants of historical dams, sawmills and residences (HCA, unknown date).

Although some limited boating by canoes and small boats occurs on the reservoir, it is unlikely that this reach of Spencer Creek is considered a 'navigable waterway' by Transport Canada Marine. Excellent recreational boating opportunities are provided a short distance upstream on the 60-ha Christie Lake, situated within HCA's Christie Lake Conservation Area. The Conservation Area is 336 ha in size and offers year-round recreational benefits that include swimming, fishing, picnicking, hiking and canoeing.

Based on the 20 comment forms received at the April 2008 open house, major public interests in the Crooks' Hollow Dam and vicinity include

- hiking/walking/jogging, bird watching and wildlife viewing (17 respondents)
- fishing (11 respondents) and canoeing (5 respondents)
- other identified uses (8 respondents) which included scenic and tranquility benefits, historic association of the dam, picnicking and sailing model boats
- only 2 respondents identified swimming as a major interest.

Based on discussions with attendees at the April 2008 open house and feedback provided on several of the comment forms, it is apparent that many of the individuals living near the dam and/or frequenting the area, highly value the area. Several individuals felt that the water impoundment feature created by the dam is directly linked to the scenic and historical value of the area, enhances the local bird and wildlife communities, and provides unique recreational and other opportunities that would not exist if the small reservoir was removed. Several respondents characterized the water impoundment as "jewel" to the area.

Pedestrian access across the top of the dam is not restricted and therefore serves to connect a residential subdivision on the south side of the river to Crooks' Hollow Road and the HCA trail

system on the north side of the river. Access to the dam from the residential subdivision is via a fenced walkway and short trail. Public responses received at the April 2008 open house indicated that access across the dam is used frequently by the public on their way to the bus stop, schools, the Greensville library and other destinations.

Information provided by the City of Hamilton's Emergency Services indicated that the Crooks' Hollow Dam reservoir is identified by the Fire Services Division as a water source for rural water operations (i.e., fire fighting). The actual use of the reservoir for fire fighting is very infrequent; discussions with the Director of Fire Operations/Deputy Fire Chief indicated that it was last used during the Steetly Repair Shop fire in 1990. In the event of fire, portable pumps would be used to draw water from the pond to fill up the tanker trucks, however, this activity is not conducted during the winter due the lower reservoir levels.

5. Project Alternatives and Evaluation

The identification of project alternatives for the Crooks' Hollow Dam was based on the requirements to address the problem (Section 1.3). This included the need to establish a solution to address the final disposition of the dam given its deteriorated and potentially, unsafe condition and the fact that the dam does not provide a significant flood control benefit.

5.1 Identification of Project Alternatives

The following project alternatives for the Crooks' Hollow Dam undertaking were considered:

Alternative 1 - Do Nothing (Status Quo)

Alternative 2 - Repair and maintain the existing dam

Alternative 3 - Modify the dam and convert to an overflow weir

Alternative 4 - Decommission and remove the dam.

Alternative 1 – Do Nothing

This alternative would involve the continuance of the existing Crooks' Hollow Dam in its current condition, with no changes to the nature of the dam itself, or its management. This conceptual alternative provides a baseline condition with which to compare each of the other alternatives and also considers the potential ramifications of undertaking no present-day rehabilitation to the existing dam.

Alternative 2 – Repair and Maintain the Existing Dam

This alternative would involve remedial repairs to the existing dam to ensure its structural stability and provide for continued safety of the public in the vicinity of the dam. Once repaired, the dam would continue to be maintained and operated by the HCA for the foreseeable future. Based on the recommendations provided in the dam stability and condition assessment report (Hatch Energy, 2008), remedial measures to the dam are anticipated to include

- installation of warning signs for upstream boaters
- installation of signage for pedestrians
- installation of light riprap on right embankment
- concrete repairs/replacement for sluiceway sills, apron slab and abutments, piers and sluiceway downstream face and downstream wingwalls
- installation of post-tensioned rock anchors for enhanced stability.

Alternative 3 – Modify the Dam and Convert to an Overflow Weir

This alternative would involve demolition of the upper portion of the existing dam deck and spillway piers, and conversion of the remaining structure to a self-regulating overflow weir. The provision of an overflow weir would still allow for the upstream impoundment of water, thereby maintaining the upstream reservoir level at the existing summer water level of ±216.58 m, but would require no manual operation and reduced maintenance. This option would require confirmation that the existing dam foundation is (or can be modified to be) structurally sound and that any hydraulic concerns regarding passage of flood flows can be adequately addressed. An absolute weir level of

±215.06 m was also considered. In both cases a steel foot bridge would be provided to maintain access across the dam.

Alternative 4 – Decommission and Remove the Dam

This alternative would involve the decommissioning and removal of the existing dam and appurtenant structures, removal and disposal of an estimated 5000 m^3 of sediments in the low flow channel, restoration of the damsite and the waterway including stabilization of shoreline areas susceptible to erosion and the potential creation/enhancement of fish habitat. The removal of the dam would eliminate the small upstream reservoir; reverting approximately 350 m of the upstream Spencer Creek reach back to its natural 'pre-dam' riverine state. Removal of the dam would eliminate concerns over structural stability and associated environmental and public safety. The dam removal would eliminate a barrier to fish movement and improve water quality and environmental conditions within the former reservoir area and downstream reaches of Spencer Creek. For the purpose of this study it is assumed that a steel foot bridge would be provided to maintain access across Spencer Creek.

5.2 Environmental Effects Screening

For each alternative, a screening of the potential environmental effects was conducted. The purpose of the screening was to identify alternatives that could result in significant, net negative environment impacts (i.e., with mitigation in place), which if identified, could indicate that a particular alternative should be discounted (i.e., screened from further consideration), or that the project should be subject to an Individual Environmental Assessment.

The screening process involved an identification of the types and extent of impacts according to a series of environmental factors (i.e., screening criteria). Both positive and negative effects were considered, as well as an assessment of whether the impact would be temporary during construction or permanent (long-term) due to operation and maintenance (CO, 2002). The significance of each potential effect was classified as high, medium or low based on a qualitative assessment of the magnitude and severity of effect. Where appropriate, environmental mitigation measures were identified.

The results of the screening are presented in Table 5.1 and key points are discussed in Section 5.3. Based on the findings of the screening it was concluded that none of the alternatives, with the exception of the Do Nothing option (i.e., in the event of a dam failure) would result in significant net negative environmental impacts that would preclude their consideration as a viable project alternative.

5.3 Evaluation of Alternatives

To identify the most appropriate solution for the Crooks' Hollow Dam, the project alternatives were compared in terms of their overall effectiveness (safety, 50-yr life cycle cost, environmental), net environmental effects and mitigation requirements. This process is summarized in Table 5.2 and discussed below.

Preliminary 2009 construction cost and life cycle cost estimates for each alternative are provided in Table C-1 of Appendix C. In addition, in order to provide a balanced comparison of the life cycle costs of Alternatives 2 and 3 to Alternative 4 - Dam Removal, costs to address sediment management (i.e., removal and disposal) were also included for Alternatives 2 and 3. These cost are tabulated in Table C-2 of Appendix C.

Table 5.1 Environmental Effects Screening
Crooks' Hollow Dam Alternatives

Screening Criteria	Rating of Potential Net Effect							Comments, Rationale and Mitigation
	–H	–M	–L	Nil	+L	+M	+H	
Physical								
Unique Landforms				**1, 2, 3, 4**				None identified in the immediate study area.
Existing Mineral/Aggregates Resources Extraction Industries				**1, 2, 3, 4**				None identified in the immediate study area.
Earth Science Site/Areas of Natural and Scientific Interest (ANSI)				**1, 2, 3, 4**				No impact to local Earth Science Sites.
Specialty Crop Areas				**1, 2, 3, 4**				None identified in the immediate study area.
Agricultural Lands or Production				**1, 2, 3, 4**				None identified in the immediate study area.
Niagara Escarpment				**1, 2, 3, 4**				No impact to the defining features of the Niagara Escarpment, specifically to Spencer Creek through the Crooks' Hollow CA, which is designated as Escarpment Natural Area.
Oak Ridges Moraine				**n/a**				Not located in the study area.
Environmentally Sensitive/Significant Areas (physical)				**1, 2, 3, 4**				No impact to the defining features of the 7.5-km long Christie Stream Valley identified as a significant site in the Hamilton-Wentworth Natural Areas Inventory.
Air quality			**2, 3, 4 Short Term**	**1**				Short-term, localized effects to air quality associated with fugitive dust and vehicle emissions during construction. Standard construction management measures such as minimizing disturbed areas, water spraying for dust suppression and minimizing vehicle engine idling would minimize these effects, which are not anticipated to be significant in magnitude to have an influencing effect on local air quality.
Agricultural Tile or Surface Drains				**1, 2, 3, 4**				None identified in study area.
Noise Levels and Vibration			**2, 3, 4 Short Term**	**1**				Short-term, localized impact to noise and vibration associated with construction vehicles and activities. Restricting construction to daytime hours would minimize noise impacts and inconvenience to nearby residents.
High/Storm Water Flow Regime (refer to Flood Risk for water level effects)				**1, 2, 3, 4**				No impact to high flow regime for any of the alternatives since there is minimal upstream storage in head pond and dam does do not provide any appreciable flow attenuation (i.e., it operates as run-of-river facility). High flow regime along Spencer Creek will be the same whether the dam is repaired, modified or removed.
Low/Base Water Flow Regime				**1, 2, 3, 4**				No impact to low flow regime for any of the alternatives since there is minimal upstream storage in head pond and dam operates as run-of-river facility. Low flow regime along Spencer Creek will be the same whether the dam is repaired, modified or removed.
Existing Surface Drainage and Groundwater Seepage				**1, 2, 3, 4**				No impact to surface water drainage to Spencer Creek since it is largely influenced by upstream Christie Lake dam, which will not be altered.
Groundwater Recharge/Discharge Zones				**1, 2, 3, 4**				No impact since existing dam does not significantly influence these functions.
Littoral Drift				**1, 2, 3, 4**				None identified in study area. Potential effects of increased sediment transport and shoreline erosion are discussed under Engineering/Technical.
Other Coastal Processes				**1, 2, 3, 4**				None identified in study area.
Water Quality	**1, if dam fails**		**1, 2, 3 Long Term** **2, 3, 4 Short Term**			**4 Long Term**		Potential significant impact to Spencer Creek water quality resulting from uncontrolled release of sediments for Alternative 1 if dam was to fail. Alternatives 1, 2 or 3 would continue to have negative long-terms effects to water quality associated with on-going sediment and nutrient trapping, water warming and low flow stagnation since a dam would remain. Potential short-term, localized water quality impairment to Spencer Creek for Alternatives 2, 3 and 4 associated with in-stream construction, sediment transport and increased turbidity. Standard construction management practices for sediment and water control, such as installation of sediment and erosion control measures, safe storage and handling of vehicle fuel, cofferdam construction and adherence to fisheries timing widows for in-water works would minimize these effects. Potential long-term improvement in water quality conditions for Alternative 4 associated with the return of the river to a natural, free-flowing, pre-dam state. Removal and disposal of contaminated sediments associated with implementing Alternative 4 would contribute to the long-term improvement to water quality in this reach.
Soil/Fill Quality				**1, 2, 3, 4**				No impact to soils/fill quality since standard construction management practices to be employed for safe storage and handling of vehicle fuel and no new fill material is required for construction other than possible need for a cofferdam associated with Alternative 2, 3 or 4. Cofferdam construction if required would be constructed of clean fill material.
Contaminated Soils/Sediment Seeps			**4 Short Term**	**1, 2, 3**		**4 Long Term**		No impact to existing river sediments in upstream headpond which were found to be marginally to significantly impacted based on Provincial Sediment Quality Guidelines (PSQG) based on elevated levels of several parameters (e.g. arsenic, cadmium, lead, zinc, etc.) for Alternatives 1, 2 and 3 since these sediments would remain in situ and would not be disturbed. Some potential for minor amounts of contaminated sediment to be transported downstream following dam removal (Alternative 4). However, implementation of a proper sediment management/containment/disposal plan dealing with existing river sediments prior to dam removal would minimize risk of any significant effects to water quality, fish and benthic organisms. Removal and disposal of contaminated sediments associated with implementing Alternative 4 would improve the quality of river sediments in this reach, improving the aquatic ecosystem health and water quality.

Table 5.1 Environmental Effects Screening
Crooks' Hollow Dam Alternatives

Screening Criteria	Rating of Potential Net Effect							Comments, Rationale and Mitigation
	–H	–M	–L	Nil	+L	+M	+H	
Existing Transportation Routes			**4 Short Term**	**1, 2, 3**				No impact to transportation routes since the numbers of construction vehicles associated with Alternatives 2 and 3 are unlikely to significantly affect existing transportation routes in study area vicinity. Off-site haulage of contaminated sediments by heavy trucks (if required) for Alternative 4 would result in a short-term increase in number of vehicles on local roads which could cause minor traffic delays. Mitigation measures would include use of flag persons, signage, scheduling of hauling to avoid peak traffic periods and observing any half-load restrictions if applicable.
Constructed Crossing (e.g. bridges, culverts)				**1, 2, 3, 4**				No impact since construction access associated with Alternative 2, 3 and 4 is currently available at dam site and is not required.
Geomorphology			**4 Short – Mid Term**	**1, 2, 3**	**4 Long Term**			Short to mid-term localized changes to fluvial geomorphology within Spencer Creek study reach for Alternative 4 as river reestablishes its original 'pre-dam' morphological regime. Spencer Creek reach upstream of dam can be expected to cut down and become narrower following reservoir draining as channel evolves and flood plain stabilizes.
Biological								
Wildlife Habitat				**1, 2, 3**	**4 Long Term**			Extent of wildlife habitat will increase with Alternative 4 as exposed shoreline areas re-vegetate providing additional habitat for small mammals and birds.
Habitat Linkages or Corridors				**1, 2, 3**	**4 Long Term**			Extent of habitat linkages and wildlife corridors may increase and improve with Alternative 4 as exposed shoreline areas revegetate providing additional opportunity and area for wildlife movement.
Significant Vegetation Communities				**1, 2, 3**	**4 Long Term**			No significant vegetation communities identified in study area. However, the extent of existing vegetative communities will increase as exposed shoreline areas re-vegetate.
Environmentally Sensitive/Significant Areas (biological)				**1, 2, 3, 4**				None identified in study area.
Fish Habitat	**1, if dam fails**	**4 Short Term**	**1 Long Term** **2, 3 Short Term**			**4 Long Term**		Potential impact to downstream fish habitat resulting from uncontrolled release of sediments could occur for Alternative 1 if dam was to fail. Alternatives 1, 2 or 3 are unlikely to have any long-term impact on fish or fish habitat since no new in-water structures would be built. However, a barrier to fish movement would remain thereby perpetuating ongoing negative effects of restricting fish movement for the long-term. Some short-term, localized impacts could occur for Alternatives 2 and 3 including temporary disruption/displacement of fish habitat during in-water works, cofferdam construction and/or temporary reservoir lowering during construction. Alternative 4 dam removal would result in the permanent loss of fish habitat associated with the lowering of the reservoir and associated decrease in overall wetted surface area. However, the return of the river to a natural, free-flowing, pre-dam state is considered to be a long-term improvement to the productive capacity of Spencer Creek due to improved water flow, improved sediment and nutrient movement, increase in aquatic habitat diversity, lower water temperatures and removal of a barrier to fish movement. Removal and disposal of contaminated sediments associated with implementing Alternative 4 would improve the quality of river sediments in this reach, improving the aquatic ecosystem health to bottom dwelling organisms.
Species of Concern (e.g. species at risk, vulnerable/threatened/endangered species, conservation priorities – either flora or fauna)			**2, 3, 4 Short Term**	**1**	**4 Long term**			Butternut and American chestnut could potentially reside within the project study area. However, no clearing is anticipated to be required for any of the alternatives. Mitigation will be implemented to ensure that trees around the construction work area are protected from damage by the installation of limit of work devices (e.g, snowfence, sediment fence) beyond the dripline of any trees. Therefore no impacts on these tree species, if they are present in the study area, are anticipated to occur. Eastern milksnake could potentially reside within the general study area, but is not likely to occur within the area immediately on either side of the Crooks' Hollow Dam. Some minor disturbance could occur during construction due to noise at the construction site. The dam removal option would result in the creation of wet meadow habitat that could be utilized by milksnake. Monarch butterflies could also potentially be found in the study area, although no significant accumulations of wildflowers or milkweeds are found in the proposed construction area adjacent to the Crooks' Hollow Dam. Therefore some minor disruption could occur during construction, but monarchs would be capable of finding suitable undisturbed habitat adjacent to the construction site. The dam removal would result in the creation of wet meadow habitat which could provide additional foraging and reproductive habitat for this species.
Exotic/Alien and Invasive Species				**1, 2, 3**	**4 Long Term**			Alternatives 1, 2 and 3 not likely to have an impact on exotic/invasive species. Alternative 4 may result in a decrease in habitat suitability for the exotic common carp, which is known to reside in the existing reservoir area. A decrease in habitat suitability and range of this species in Spencer Creek would be beneficial, particularly for wetland restoration efforts currently occurring in the lower portion of the watershed. Exotic and/or invasive vegetation species may colonize the newly exposed area following dam removal, but no change in regional distribution or propagation of such species would result.
Wildlife/Bird Migration Patterns				**1, 2, 3, 4**				None identified in the immediate study area. The small Crooks' Hollow Dam reservoir is unlikely to be a significant staging/resting area for migratory birds, which would likely utilize the larger, nearby Christie Lake reservoir.

Table 5.1 Environmental Effects Screening
Crooks' Hollow Dam Alternatives

Screening Criteria	Rating of Potential Net Effect							Comments, Rationale and Mitigation
	–H	–M	–L	Nil	+L	+M	+H	
Wildlife Population				**1, 2, 3**	**4 Long Term**			No change to wildlife populations for Alternatives 1, 2 and 3. For the dam removal Alternative 4, the increase in shoreline area, once revegetated, would increase the area of wildlife habitat, which could result in a small increase in the local wildlife population.
Wetlands			**4 Long Term**	**1, 2, 3**				No change to wetland areas for Alternatives 1, 2 and 3. For the dam removal Alternative 4, existing wetland marsh area along the periphery of the shoreline would likely be altered to a seasonally inundated wet meadow with the lowering of the reservoir and the restoration of the river. No impact on wetlands upstream from Morden's Mill dam as dam will remain and associated seasonal flooding will still occur.
Microclimate				**1, 2, 3, 4**				No change to microclimate.
Life Science Sites/ANSI's				**1, 2, 3, 4**				No impact to MNR identified Christie Stream Valley Life Science Site.
Unique Habitats				**1, 2, 3, 4**				No unique habitats have been identified in the study area.
Cultural								
Traditional Land Uses				**1, 2, 3, 4**				There are no First Nations reserves in the study area. INAC and OSAA state there are no specific or comprehensive land claims, nor active litigation in the vicinity of the Crooks Hollow dam site
Aboriginal Reserve or Community				**1, 2, 3, 4**				
Outstanding Native Land Claim				**1, 2, 3, 4**				
Transboundary Water Management				**n/a**				Not applicable in study area.
Riparian Uses				**1, 2, 3, 4**				None identified in the study area associated with the existing Crooks' Hollow Dam reservoir. Riparian users of Spencer Creek downstream of the existing dam will not be impacted since peak flows and water levels downstream of the dam will be unchanged with any of the alternatives.
Recreational or Tourist Uses of a Water Body and/or Adjacent Lands			**4 Long Term**	**1, 2, 3**	**4 Long Term**			No impact to recreational/tourism uses for Alternatives 1, 2 and 3 since existing recreational and tourism uses will be unchanged. Alternative 4 dam removal would reduce recreational opportunities associated with canoeing and fishing on the small reservoir since it would be lowered and reduced in size. This is not considered a significant loss since these opportunities are present at nearby Christie Lake, although some local residents and visitors to the area may perceive that the recreational value of the area and their personal enjoyment of the area will be diminished with removal of the small reservoir. Further, with the restoration of the river at the dam site, recreational activities associated with scenic viewing and hiking may improve.
Recreational or Tourist Uses of Existing Shoreline Access Locations				**1, 2, 3, 4**				No impact anticipated since existing shoreline access locations and access to existing hiking trail would be unaffected by any alternatives.
Archaeological Resources, Built Heritage Resources and Cultural Heritage Landscapes			**4 Long Term**	**1, 2, 3**				Low likelihood of cultural resources at the dam site, which has been disturbed in the past. The existing dam is not considered to be of historical or cultural significance so the repair, modification or removal thereof is not anticipated to result in a significant impact. Alternative 4 lowering of the reservoir will change the landscape associated with the upstream reach of Spencer Creek into more of a riverine setting. This is not considered to be a significant impact since the upstream reach has not been designated as a Cultural Heritage Landscape, although some local residents and visitors to the area may perceive that the local historical setting will be diminished with the removal of the dam since it has been there for 95 years.
Historic Canals				**1, 2, 3, 4**				None identified in the study area.
Federal Property				**1, 2, 3, 4**				None identified in the study area.
Heritage River System				**1, 2, 3, 4**				None identified in the study area. Spencer Creek is not a designated Historical River System.
Socioeconomic								
Surrounding Neighbourhood or Community				**1, 2, 3, 4**				No impact to surrounding neighbourhood/community since none of the alternatives will displace or disrupt existing neighbourhoods.
Surrounding Land uses or Growth Pressures				**1, 2, 3, 4**				No impact to surrounding land uses or growth pressure since none of the alternatives will displace or disrupt existing residential land uses or limit land availability for future growth in proximity of the reservoir.
Existing Infrastructure, Support Services, Facilities				**1, 2, 3, 4**				No impact to infrastructure since none of the alternatives will displace or disrupt existing infrastructure, roads, utilities, services, etc. in proximity of the reservoir.
Pedestrian Traffic Routes			**2, 3, 4 Short Term**	**1, 2, 3, 4 Long Term**				No impact to pedestrian traffic routes for Alternatives 1 and 2 since local access across the dam will remain, although dam access may be temporarily restricted during construction activities associated with Alternative 2, 3 and 4 for reasons of public safety. Alternatives 3 and 4 would eliminate pedestrian access across the dam from one side of the river to the other. As such, an elevated deck (Alternative 3) or a pedestrian footbridge (Alternative 4) would be constructed to maintain existing local access across Spencer Creek.
Property Values or Ownership				**1, 2, 3, 4**				No impact to property values or ownership since dam and reservoir is situated on HCA-owned lands (Crooks' Hollow Conservation Area) and does not encroach onto private lands.
Existing Tourism Operations				**1, 2, 3, 4**				None identified in the immediate study area.
Property/Farm Accessibility				**1, 2, 3, 4**				No impact to property/farm accessibility since dam does not currently provide an essential linkage for property/farm accessibility.

Table 5.1 Environmental Effects Screening
Crooks' Hollow Dam Alternatives

Screening Criteria	Rating of Potential Net Effect							Comments, Rationale and Mitigation
	–H	–M	–L	Nil	+L	+M	+H	
Public health and/or safety	**1, if dam fails**	**1 Mid Term**	**2, 3 Long Term** **4 Short Term**		**4 Long Term**			Significant potential impact to public safety for Alternative 1 if dam was to fail. Moderate potential impact to public safety for Alternative 1 if dam is not repaired, modified or removed since dam will continue to deteriorate over the long-term, thereby increasing the risk to public safety. Alternatives 2 and 3 could have a short-term public safety risk during construction. Standard construction site safety and best management practices would limit this risk. Alternatives 2 and 3 would still have long-term potential risk of personal injury since a water control structure would remain, presumably with public access allowed across the top of the structure. Proper signage and restricted access to dam (if warranted) would reduce this risk. The elimination of the water source for firefighting associated with Alternative 4 could increase the potential risk to public safety during short term until a suitable replacement site (i.e., Christie Lake) is established. Alternative 4 dam removal would eliminate risk of public injury since the dam would be removed.
Engineering/Technical								
Rate of Erosion in Ecosystem		**1, if dam fails**	**1, 2, 3, 4**					None of the alternatives are considered to significantly affect the long-term rate of natural erosion or sediment deposition processes in the context of the Spencer Creek ecosystem. Potential significant, localized impact to accelerated rates of erosion/sedimentation could occur for Alternative 1 if dam was to fail. Alternatives 1, 2 or 3 would continue to have negative long-terms effects associated with on-going sediment trapping since a dam would remain. Some short-term, localized erosion and/or sedimentation could occur for Alternatives 2 and 3 during construction activities associated with cofferdam construction, vegetation clearing, dam construction, etc. Construction best management practices and site restoration measures employed as required during construction would minimize these effects. Alternative 4 could result in short-term, localized increased erosion and/or sedimentation rates following the dam removal and reservoir draining as the river re-establishes itself. Implementation of a staged reservoir drawdown, implementation of sediment management measures, shoreline stabilization measures and environmental monitoring during and following construction would minimize the movement of significant quantities of sediments.
Sediment Deposition Zones in Ecosystem		**1, if dam fails**	**1, 2, 3, 4**					
Flood Risk in Ecosystem		**1, if dam fails**		**1, 2 Long Term**	**3 Long Term**	**4 Long Term**		None of the alternatives are considered to significantly affect existing flood risk in the context of the Spencer Creek ecosystem. Potential flood risk to public safety and downstream property damage (i.e., shoreline erosion) could occur for Alternative 1 if dam was to fail during a major storm event. Potential flood risk conditions would remain the same for Alternative 2 since the rehabilitated dam would operate the same as the existing structure. Alternative 3 would reduce the flood risk locally due to the lower weir crest and improved discharge capacity, which would lower 100-yr flood levels 1.0 to 1.5-m over a distance of 300-m upstream of the dam. Alternative 4, dam removal provides the greatest reduction in flood risk, lowering the 100-yr flood levels 2.0 to 3.0-m over 300-m upstream of the dam. No significant adverse impacts on downstream flooding in Spencer Creek for Alternative 4 given the existing dam does not provide any significant flood control (i.e., peak flow attenuation of major flood events) due to the reservoir's small size and storage volume relative to the runoff volume associated with large flood producing events. Further, the dam has never been operated by HCA for the purpose of flood control; the upstream Christie Lake Dam, constructed in 1972, provides this function. Thus, removal of the dam is not expected to result in significant increase in downstream peak flows under major storm events.
Slope Stability		**1, if dam fails**		**1, 2, 3, 4**				None of the alternatives are considered to significantly affect the long-term slope stability of the existing Spencer Creek valley. Potential impact to local downstream slope stability (i.e., potential washouts) could occur for Alternative 1 if dam was to fail during a major storm event.
Existing Structures		**1, if dam fails**		**1, 2, 3, 4**				None of the alternatives are considered to significantly affect existing structures. Potential structural impacts to existing dam and downstream shorelines and road crossing at Brock Road (i.e., potential washouts) could occur for Alternative 1 if dam was to fail during a major storm event.
Hazardous Lands				**1, 2, 3, 4**				None identified in the immediate study area. Consideration of potential natural land hazards such as flooding and erosion are discussed above.
Hazardous Sites				**1, 2, 3, 4**				Not identified in study area.

Alternatives
Alternative 1 – "Do Nothing" (status quo)
Alternative 2 – Repair and maintain the existing dam
Alternative 3 – Modify the dam and convert to an overflow weir
Alternative 4 – Decommission and remove the dam

Table 5.2 Evaluation of Alternatives

Alternative Solution and Estimated [1]Life Cycle Cost	Effectiveness (Safety, Cost, Environmental)		Net Environmental Effects		Required Mitigation Measures
	Advantages	**Disadvantages**	**Natural Environment**	**Social Environment**	
1 - Do Nothing Maintain the status quo. Estimated Life Cycle Cost: $737,000	Least life-cycle cost of all alternatives. No disruption to existing natural and social environs due to construction. Existing land and water-based recreational uses of the reservoir would continue for the near term.	Operator and public safety concerns associated with deteriorated condition of the dam would not be addressed. As the dam deteriorates further, the risk of failure and associated impacts to biological communities both upstream/downstream from the dam increases. Negative environmental effects (i.e., fish barrier, sediment trapping, poor water quality, etc.) would continue, thereby reducing the aesthetic and recreation appeal at the damsite. **Not a viable alternative since the dam must be rehabilitated or removed due to its' current unsafe condition.**	Existing sediment trapping, water temperature warming and poor water quality conditions in the reservoir would persist due to water impoundment created by dam. Dam will continue to be a barrier to fish movement between Webster's Falls and the Christie Lake Dam. Environmental impacts of dam failure include disruption of fish communities upstream and downstream from the dam, loss of habitat in the pond, and possible harmful alteration of downstream fish habitat and water quality through sedimentation.	Continued degradation of the dam could lessen the aesthetic appeal and local recreational value at the damsite. Potential continued degradation of reservoir water quality and sediment build-up, due to the presence of the dam, could lessen the recreational use of the reservoir for canoeing, fishing, hiking and wildlife viewing.	Install warning signs advising public of unsafe dam conditions.
2 - Repair and maintain existing dam. Estimated Life Cycle Cost: $1,359,000	Operator and public safety concerns associated with deteriorated condition of the dam would be resolved. Risk of negative environmental impacts to biological communities as a result of dam failure would be reduced. Existing land and water-based recreational uses of the reservoir would continue for the foreseeable future.	Repaired dam would not have the same life span as an entirely new structure, thereby resulting in escalating operational and maintenance costs. Negative environmental effects (i.e., fish barrier, sediment trapping, poor water quality, etc.) would continue. Highest life-cycle cost of all alternatives.	Existing sediment trapping, water temperature warming and poor water quality conditions in the reservoir would persist due to water impoundment created by dam. Dam will continue to be a barrier to fish movement between Webster's Falls and the Christie Lake Dam. Temporary loss of fish habitat upstream and downstream from the dam, due to cofferdam construction and flow diversion around the worksite. Some vegetation clearing at the dam site likely required.	Land and water-based recreational uses of the reservoir would continue to be the same for the foreseeable future. Potential continued degradation of reservoir water quality and sediment build-up, due to the presence of the dam, could lessen the recreational use of the reservoir for canoeing, fishing, hiking and wildlife viewing. Construction at the damsite would temporarily prevent public access across the dam Construction at the damsite would result in temporary noise and public safety concerns for the local community.	Construct temporary cofferdam upstream of the existing dam to allow work to proceed in a dry condition. Construct, maintain and carry out standard sediment, erosion and water control measures during construction Provide slope regrading and stabilization, including rip rap protection for areas subject to erosion from flowing water. Implement vegetative plantings of native specimen trees and ground species removed or disturbed at the damsite and conduct general site restoration. Observe a fisheries construction-timing window to restrict in-water construction between July 1 to September 14 to protect fish reproduction. Implement construction site best management practices to minimize impacts on local community (e.g., limit construction to daytime hours, install warning signs or safety fencing around work site).

Table 5.2 Evaluation of Alternatives

Alternative Solution and Estimated [1]Life Cycle Cost	Effectiveness (Safety, Cost, Environmental)		Net Environmental Effects		Required Mitigation Measures
	Advantages	**Disadvantages**	**Natural Environment**	**Social Environment**	
3 - Modify the dam and convert to an overflow weir. Estimated Life Cycle Cost: $1,000,000 to $1,034,000	Operator and public safety concerns associated with deteriorated condition of the dam would be resolved. Lower estimated life-cycle cost than Alternatives 2 or 4. Stop logs would be eliminated with an overflow weir. Long-term operation and maintenance costs would be less than Alternatives 1 and 2. Risk of negative environmental impacts to biological communities as a result of dam failure would be significantly reduced. Existing land and water-based recreational uses of the reservoir would continue for the foreseeable future.	Some short-term, localized environmental impacts during construction period. Negative environmental effects (i.e., fish barrier, sediment trapping, poor water quality, etc.) would continue.	Existing sediment trapping, water temperature warming and poor water quality conditions in the reservoir would persist due to water impoundment created by dam. Dam will continue to be a barrier to fish movement between Webster's Falls and the Christie Lake Dam. Temporary loss of fish habitat upstream and downstream from the dam, due to cofferdam construction and flow diversion around the worksite. Flow changes due to dam operation and negative impacts due to fall drawdown would cease.	Land and water-based recreational uses of the reservoir would continue to be the same for the foreseeable future. Potential continued degradation of reservoir water quality and sediment build-up, due to the presence of the dam, could lessen the recreational use of the reservoir for canoeing, fishing, hiking and wildlife viewing. Overflow weir would eliminate public access across the dam unless a walkway is constructed across top of dam. Overflow weir may create a public safety hazard for boats in proximity to weir crest and a danger to children if they attempt walk across the weir crest. Construction at the damsite could result in temporary noise and public safety concerns for the local community.	Construct temporary cofferdam upstream of the existing dam. Construct, maintain and carry out standard sediment, erosion and water control measures during construction. Provide slope regrading and stabilization, including rip rap protection for areas subject to erosion from flowing water. Implement vegetative plantings of native specimen trees and ground species removed or disturbed at the damsite and conduct general site restoration. Observe a fisheries construction-timing window to restrict in-water construction between July 1 to September 14 to protect fish reproduction. Construct pedestrian walkway across top of dam to maintain existing public access). Installation of warning signs, possible restricted access (fencing) to weir crest, and installation of a safety boom upstream would address safety concerns with weir crest. Also, constructed of raised walkway on piers would prevent persons from walking across weir crest. Implement construction site best management practices to minimize impacts on local community (e.g., limit construction to daytime hours, install warning signs or safety fencing around work site).

Table 5.2 Evaluation of Alternatives

Alternative Solution and Estimated [1]Life Cycle Cost	Effectiveness (Safety, Cost, Environmental)		Net Environmental Effects		Required Mitigation Measures
	Advantages	**Disadvantages**	**Natural Environment**	**Social Environment**	
4 - Decommission and remove the dam. Estimated Life Cycle Cost: $1,160,000	Public and operator safety concerns due to dam failure would be eliminated. Risk of environmental impacts due to dam failure would be eliminated. Lower estimated life-cycle cost than Alternative 2. Dam operation and maintenance costs would be eliminated. Approximately 350 m of Spencer Creek would be restored to its natural, pre-dam riverine state. This would result in long-term improvement in water quality conditions in the former reservoir and downstream reach of Spencer Creek and allow for fish passage upstream and downstream of the former damsite.	Higher short-term environmental impacts during and following construction than other alternatives. Draining of reservoir would eliminate recreational uses such as canoeing. Some local residents and visitors to the area may perceive that the recreational value of the area and their personal enjoyment of the area will be diminished with the reservoir. Elimination of the reservoir as a water source for rural firefighting would require that an alternation location at Christie Lake reservoir be established. Marginally higher estimated life-cycle cost than Alternative 3.	Long-term improvement in water quality (e.g., lower temperatures, natural sediment transport processes, improved flow and less stagnation within pond) as Spencer Creek returns to its pre-dam state. During re-adjustment period following the draining of the reservoir, suspended solids will be mobilized by high flow events and transferred downstream, thereby reducing water quality (short term impact until new equilibrium is established) and potentially resulting in downstream sedimentation of fish/invertebrate habitat. Increased fish movement between Webster's Falls and the Christie Lake Dam. Overall loss of aquatic habitat surface area and change in the fish/benthic community from a lacustrine type to more cool water riverine type. Increase in early successional wetland/ terrestrial vegetation, and potentially floral and wildlife habitat diversity, in the floodplains of the creek. Loss of habitat for waterfowl (e.g., geese and ducks) within the pond area, but increase in wildlife habitat once shoreline areas become revegetated.	Draining of reservoir would eliminate/restrict recreational uses such as canoeing. Some local residents and visitors to the area may perceive that the recreational value of the area and their personal enjoyment of the area will be diminished with removal of the reservoir. Draining of reservoir would eliminate its use a water source for firefighting in Greensville area/community. Removal of the dam would eliminate its use as a scenic viewing platform and public access point across the river unless a footbridge is constructed across river. Aesthetics of the existing pond area would be temporarily deteriorated prior to re-vegetation of the exposed bank areas. Construction at the damsite could result in temporary noise and public safety concerns for the local community.	Use the existing dam to perform a staged draw down of the reservoir over two growing seasons to minimize shoreline erosion, sediment transport and promote natural regeneration along exposed shorelines. HCA to provide emergency access to nearby Christie Lake reservoir to local fire department. Conduct dredging and disposal of $\pm$ 5,000 m^3 of previously deposited reservoir sediments upstream of dam. Construct, maintain and carry out standard sediment, erosion and water control measures during construction. Provide shoreline stabilization and erosion protection measures where necessary using natural channel techniques, such as live stakes, fascines and other shoreline protection measures. Implement vegetative plantings of native specimen trees and ground species removed or disturbed at the damsite and conduct general site restoration. Observe a fisheries construction-timing window to restrict in-water construction between July 1 to September 14 to protect fish reproduction. Possible fish habitat compensation measures required. Construct a pedestrian foot bridge across Spencer Creek at former damsite to maintain existing public access. Implement construction site management practices to minimize impacts on local community (e.g., limit construction to daytime hours, install warning signs and safety fencing around work site).

[1]Life cycle costs estimated based on a 50-year planning period and include allowances for construction, engineering and construction management, operations and maintenance and environmental mitigation measures (refer to Appendix C, Table C-1).
For the estimation of life-cycle costs, the following costs were included for each alternative:
Alternative 1: Complete dam reconstruction at Year 30.
Alternative 2: Major dam maintenance at Year 30.
Alternative 3: Major dam maintenance at Year 30.
Alternative 4: No future life-cycle works required. Cost for sediment removal and disposal based on assumption that sediment is non-hazardous.

Alternative 1 – Do Nothing

The Do Nothing alternative is not an effective solution to address the long-term operator and public safety risks associated with the poor condition of the dam, nor does it address the environmental risk to biological communities associated with a possible dam failure as the dam continues to deteriorate. If a dam failure was to occur, the rapid, uncontrolled release of water and accumulated sediments in the reservoir could have a detrimental effect on fish habitat, wildlife communities and water quality in the reservoir and in the downstream reach of Spencer Creek.

No mitigation measures other than erecting signs warning the public of the unsafe dam conditions and fencing to restrict public access across the dam have been identified to minimize/eliminate the potential impacts associated with this alternative. Provincial (MNR) dam safety criteria for stability are not met under this scenario.

Since no present-day major rehabilitation works have been assumed for this alternative, other than continued operation of the dam and basic annual maintenance costs, the condition of the dam will continue to deteriorate to the point that it will have to be completely replaced/rebuilt during the 50-yr life cycle. To adequately reflect this in the 50-yr life cycle cost, a cost allowance for the complete reconstruction of the dam was included at year 30 resulting in an estimated life cycle cost of $737,000.

Alternative 2 – Repair and Maintain the Existing Dam

Alternative 2 was identified as a moderately effective solution as a means to repair the currently deteriorated condition of the dam. Once rehabilitated, the dam would meet the ODSG, resolving any concerns regarding its flood passage capability and structural stability. Thus, operator and public safety concerns would be resolved and the potential biological impacts associated with a dam failure would be addressed. Existing land and water based recreational uses of the reservoir would continue for the foreseeable future. This alternative has the highest estimated life cycle cost, estimated at $1,359,000, compared to the other alternatives due to the higher capital costs (e.g., construction and engineering) associated with rehabilitating the dam. Also included in the life cycle cost are those costs associated with operating the dam, including routine maintenance, which will still be required for the long-term. In addition, a cost allowance was included at year 30 to reflect that major maintenance work will be required at least once during the dam's 50-yr life cycle.

Environmental effects, including potential changes to the recreational uses of the upstream and downstream Spencer Creek reaches are expected to be minimal since the river levels and flows would not change over existing conditions. However, since the dam would remain, it would continue to be a barrier to fish movement and would continue to affect water quality conditions due to ongoing sedimentation, low flow stagnation and warming effects. Some short-term impacts to fish habitat and vegetation within the construction area may occur during construction, but with the implementation of standard mitigation and restoration measures, permanent impacts could be avoided.

Construction at the site may present short-term noise and public safety concerns for the local community, necessitating standard site measures to limit construction activities to daytime hours and provision of on-site safety measures such as warning signs site fencing.

Implementation of this alternative would require the installation of a temporary cofferdam upstream from the dam to allow the repairs to proceed under a dewatered condition. A small sandbag cofferdam may be required downstream from the dam to completely dewater the construction area. Cofferdam construction and the associated dewatering of the work area would result in a temporary loss of approximately 240 m^2 of fish habitat, although this habitat is not considered to represent any

significant reproductive, foraging or cover habitat for any of the species in the reservoir. As a mitigation measure, in accordance with MNR's guidelines, in-water construction would only be allowed to proceed from July 1 to September 30 to protect local fish community reproduction.

Alternative 3 – Modify the Dam into an Overflow Weir

Alternative 3 was identified as a moderately effective solution as a means to rehabilitate the deteriorated condition of the dam. Modification of the dam to an overflow weir would meet the ODSG for flood passage capability and structural stability. Thus, operator and public safety concerns would be resolved and the potential environmental impacts associated with a dam failure would be addressed. Existing land and water based recreational uses of the reservoir would continue for the foreseeable future. Compared to Alterative 2 (Repair Dam), this alternative has lower life cycle costs, estimated at $1,000,000 to $1,034,000 and will result in reduced maintenance costs and eliminate operating costs. As with the previous options, a cost allowance was included at year 30 to reflect that major maintenance work will be required at least once during the weir's 50-yr life cycle.

Environmentally, provision of an overflow weir would still allow for the upstream impoundment of water, thereby maintaining the existing summer reservoir water levels, environmental features, biophysical processes and summer recreation uses presently associated with the reservoir. However, since a water impounding structure would still remain, it would continue to be a barrier to fish movement and would continue to affect water quality conditions due to ongoing sedimentation, low flow stagnation and warming effects.

Converting the existing dam to an overflow weir would eliminate its use as a cross-river access point and viewing location. Public responses received at the April 2008 open house indicated that the walkway across the top of the current dam is frequently use by the public and if discontinued would negatively impact them. In order to maintain these uses, a new walkway (or possibly, reuse of the existing walkway) is proposed to be constructed across the proposed weir.

Construction of an overflow weir may create a public safety hazard for boats in proximity to weir crest and a danger to children if they attempt walk across the weir crest. Installation of warning signs, possible restricted access (fencing) to weir crest, and installation of a safety boom upstream would address safety concerns with weir crest. Also, if the proposed walkway is constructed on piers across the top of the weir crest, this would prevent persons from walking across weir crest.

Some short-term impacts to fish habitat and vegetation within the construction area may occur through the construction phase; however with the implementation of standard mitigation and restoration measures, permanent impacts could be avoided. Construction may pose short-term noise and public safety concerns for the local community, necessitating standard site measures to limit construction activities to daytime hours and provision of on-site safety measures such as warning signs site fencing.

As with Alternative 2, implementation of this alternative would require the installation of a temporary cofferdam upstream from the structure and possibly, a small sandbag cofferdam downstream to completely dewater the construction area. Cofferdam construction and the associated dewatering of the work area would result in a temporary loss of approximately 240 m^2 of fish habitat, which is not considered to represent any significant impact. As a mitigation measure, in-water construction would only be allowed to proceed during July 1 to September 30 in order to protect local fish community reproduction.

Alternative 4 – Decommission and Remove the Dam

This alternative would be a moderately effective solution to resolve the existing public safety and environmental concerns associated with the dam's deteriorated condition and would eliminate long-term operating and maintenance costs. The estimated life cycle of $1,160,000, is lower that Alterative 2 (Repair Dam) and comparable to Alternative 3 (Modify Dam).

Environmentally, removal of the dam would result in the restoration of approximately 350 m of Spencer Creek to its natural, pre-dam riverine state, once the creek has had an opportunity to revert to its original narrow and shallow channel and obtain a more natural dynamic equilibrium with respect to biophysical processes (e.g., sediment transport, channel morphology). This process will be progressed and managed by the removal of the previously deposited sediments (i.e., dredging) and the stabilization and restoration of the former low flow channel. The restoration of flowing water through this reach of Spencer Creek will result in a long-term improvement in water quality and aquatic habitat conditions in the areas both upstream and downstream from the dam by eliminating stagnation and improving flow conditions, lowering water temperatures and restoring the natural sediment transport processes.

Environmental effects associated with the dam removal and lowering of the reservoir would reduce the extent of the existing (shoreline) fish habitat, but the anticipated improved flow and water quality conditions are considered to result in a long-term improvement to the overall productive capacity to this portion of Spencer Creek. Over time, the resulting fish community of the creek would likely revert back to a more riverine cool water community dominated by small species, similar in composition to creek areas upstream of the former Morden's Mill dam. Such changes would eliminate the undesirable habitat conditions currently associated with the presence of common carp, a non-native species in the reservoir. This in turn is expected to contribute to the reduction of carp in the downstream Cootes Paradise marsh, the presence of which has been identified by the Royal Botanical Gardens as diminishing the recovery of the marsh.

The project is unlikely to have an adverse effect on either of the listed species at risk tree species (butternut and American chestnut) since no tree clearing is anticipated to be required. Nor is the project likely to adversely affect the habitat of the listed species a risk wildlife species (monarch butterfly and eastern milksnake), although it could potentially have a minor, short-term effect on individuals of these species if they are located in close proximity to the damsite, due to construction noise and/or disturbance. However, it is not anticipated that there would be any long-term adverse effect and in fact, the project may enhance the amount of habitat available for these species.

The draining of the reservoir and resulting exposure of shoreline sediments would result in the rapid vegetation of the area with early successional wetland/terrestrial vegetation. This would likely increase floral and wildlife habitat diversity in the area, but the decreased aquatic surface area would likely result in a loss of habitat for waterfowl such as geese and ducks. During the readjustment period following the reservoir draining, previously deposited sediments would be mobilized and transported downstream as the watercourse re-establishes itself to its original narrow and shallow channel. The amount of sediment potentially mobilized would be minimized by the planned dredging program and site restoration measures discussed below.

The Sediment Transport Study (Appendix E) confirmed that the deposited reservoir sediments in what would become the restored Spencer Creek low flow channel would be highly susceptible to mobilization and downstream transport if the Crooks' Hollow Dam was completely removed. In addition to the potential impacts associated with the quantity of sediment that could be transported, the degraded quality of the sediment (refer to Section 4.2.10) could create sediment contamination problems in areas where deposition occurs; potentially impacting benthic invertebrate use of the

sediment. Mitigation, in the form of sediment management (e.g., dredging and on-site containment and/or off-site disposal) and shoreline stabilization, combined with fish habitat restoration measures (e.g., root wads, boulder clusters, shoreline bio-engineering) would be necessary.

In terms of the current land use planning designations (e.g., Niagara Escarpment Plan, City of Hamilton Official Plan) and HCA's management objectives for the Crooks' Hollow Conservation Area, removal of the dam and reservoir would not impact these. Staff of HCA have reviewed the dam removal option within the context of the Crooks' Hollow Conservation Area Master Plan and concluded that there is no historic component to the dam that requires protection or restoration. Construction of a pedestrian bridge, if the dam were removed, would maintain a functional linkage to the established trail system within the area. From both an ecological and recreational perspective, the HCA has recognized that it would be advantageous if the riparian corridor in the Crooks' Hollow Conservation Area was restored to a creek system rather than the existing reservoir.

No significant adverse impacts on downstream flooding in Spencer Creek are expected as a result of dam removal. The existing Crooks' Hollow Dam does not provide any significant flood control (i.e., peak flow attenuation of major flood events) due to the reservoir's small size and storage volume relative to the runoff volume associated with large flood producing events. Further, the dam has never been operated by HCA for the purpose of flood control; the upstream Christie Lake Dam, constructed in 1972, provides this function. Thus, removal of the dam is not expected to result in significant increase in downstream peak flows under major storm events.

Socially, the dam removal and lowering of the reservoir levels is not expected to impact privately owned shorelines and/or infrastructure since the Spencer Creek shoreline through the study area is entirely owned by the HCA. Removal of the reservoir would eliminate/restrict recreational uses such as canoeing on the former small reservoir since it would be lowered and reduced in size. This is not considered a significant loss since these opportunities are present at nearby Christie Lake. Further, with the restoration of the river at the damsite, recreational activities associated with scenic viewing and hiking are expected to improve with the eventual regeneration of the plant community within the exposed floodplain/riparian area.

Dam removal and lowering of the reservoir levels is not expected to have a significant impact on nearby domestic water wells situated in proximity to the dam based on the finding of a hydrogeological assessment of existing water well records (refer to Appendix D). Removal of the dam would lower the reservoir level by up to 1.0 m relative to the average winter reservoir level. In comparison, the available drawdown in the wells located within 100 m of the reservoir area varies from about 5.5 m to 13.7 m with an average of 8.8 m. Since the available drawdown in the area is 5 m or more compared to the expected 1 m lowering of the reservoir, significant impacts on area water wells are considered unlikely.

Based on discussions with attendees at the April 2008 open house and feedback provided on several of the comment forms, it is apparent that many of the individuals living near the dam and/or frequenting the area felt that the water impoundment created by the dam is directly linked to the scenic and historical value of the area, enhances the local bird and wildlife communities, and provides recreational opportunities that would not exist if the small reservoir was removed. Thus, from a social perspective, some users may perceive the dam removal as reducing the area's value, possibly affecting their personal enjoyment of the area.

Removal of the dam would eliminate its use as a cross-river access point and viewing location. Public responses received at the April 2008 open house indicated that access across the dam is used frequently by local residents and visitors to the area and if discontinued would negatively impact to

them. In order to maintain these uses and avoid impacting current users, a footbridge is proposed to be constructed across Spencer Creek at the damsite.

Draining of the reservoir would eliminate its use a potential water supply for rural firefighting. This loss is not considered significant since the actual use of the reservoir for firefighting is very infrequent; last used in 1990 (refer to Section 4.3.4). Follow-up discussions with the City of Hamilton's Director of Fire Operations/ Deputy Fire Chief indicated that if the reservoir was eliminated, an alternate source of fire fighting water would have to be established. In response, HCA indicated that the nearby Christie Reservoir could provide this function and would be willing to work with the Fire Services Division to coordinate any special provisions in this regard. The Fire Service Division noted that they were familiar with the Christie Reservoir, having used it in the past for training and emergency response water supply, although the Director of Fire Operations had some concerns regarding the additional distance between the Crooks' Hollow Dam and the Christie Reservoir. Based on these discussions, elimination of the Crooks' Hollow reservoir as an emergency source of fire fighting water is not considered to pose a significant impact.

During the construction period associated with the dam removal, some short-term noise and public safety concerns would be present for the local community. Standard construction site measures to limit noise to daytime hours and provide an appropriate level of public safety at the site by means of warning signs and site fencing would limit the nuisance effects to nearby residents. During the dam removal and prior to the completion of the pedestrian footbridge, it is anticipated that, for reasons of public safety, pedestrian access across the creek would be restricted. This is expected to result in temporary, but minor inconvenience to current users who use the existing dam to cross Spencer Creek. No long-term residual impacts are expected.

5.4 Selection of Preferred Project

Based on the results of the comparative evaluation of alternatives as well as after having given due consideration to the comments, input and concerns expressed by members of the public and government agencies, a preferred alternative was selected by the HCA subcommittee for endorsement by the HCA Board.

The following section documents reasons for the selection of the preferred project as well as reasons for the rejection of the remaining alternatives.

The preferred solution is Alternative 4 – Decommission and Remove the Dam – This alternative is considered the most effective solution in terms of resolving the current operator and public safety concerns associated with the deteriorated condition of the dam and addressing the environmental concerns of a potential dam failure by removing a structure that provides no significant benefit in terms of flood or erosion control. This alternative provides an opportunity to restore the river to natural free-flowing watercourse while minimizing disruption/negative impacts to the existing natural features and ecological processes. Identified benefits to the natural environment will include improved water and sediment quality, improved nutrient and sediment movement, improved wildlife movement, creation of upstream/downstream fish passage, and the elimination of undesirable habitat conditions (i.e., stagnant, warm, shallow water) for non-native fish (e.g., carp) and vegetation growth (algae). Socially, the construction of a pedestrian access bridge at the location of the removed dam will ensure that the public's use of the area for access, recreation and scenic viewing; consistent with HCA's management objectives for Spencer Creek and the Crooks' Hollow Conservation Area, will continue for the long term. Overall, significant, adverse environmental effects with implementation of this alternative can be mitigated by proper management of deposited river sediments, standard construction site best management, as well as implementation of an ecologically friendly site restoration plan.

Alternative 1 (Do Nothing) was rejected for reasons pertaining to safety and environmental risk of failure. The moderately high public use associated with the structure (as a bridge, trail link and viewing platform) necessitates that it be in a safe condition. Although this option has the lowest life-cycle costs, it is not a feasible option since the dam must be rehabilitated or removed due to its' poor condition.

Alternative 2 (Repair and Maintain Existing Dam) would be effective in resolving the currently deteriorated condition of the dam and the associated operator and public safety concerns, as well as the environmental consequences of failure. This alternative was rejected due to its high life cycle costs associated with escalating operational and maintenance costs. Also, since the current operable dam does not provide a significant flood or erosion control benefit, there is no need to repair and maintain the structure with this operational capability. Moreover, maintaining a dam and water impoundment feature would continue to perpetuate ongoing negative environmental effects (i.e., water quality deterioration through warming and stagnation, sedimentation, interruption of natural biophysical processes and acting as a barrier to fish movement).

Alternative 3 (Convert to an Overflow Weir) would be effective in resolving the deteriorated condition of the dam, public safety concerns and the environmental consequences of failure. However, maintaining a dam and water impoundment feature would, as with Alternative 2, continue to perpetuate ongoing negative environmental effects (i.e., poor water quality, sedimentation, barrier to fish passage). The minor recreational and aesthetic benefits of retaining a water impoundment are not considered to be significant within the context of the Crooks' Hollow Conservation Area management objectives. This option was rejected on the basis of its lack of long-term functional benefits, propagation of ongoing environmental degradation and higher overall capital cost.

5.5 Net Environmental Effects and Mitigation

Table 5.3 provides a detailed listing of the predicted environmental effects, recommended mitigation measures and net effects associated with the implementation of the preferred solution to remove the Crooks' Hollow Dam.

Overall, the construction related effects of the dam removal on the existing natural and social environments can be mitigated by the implementation of standard construction site best management practices, a sediment management plan for the dredging and removal of sediments, and implementation of a restoration plan involving measures for floodplain/shoreline restoration, and fish habitat restoration/enhancement. These aspects are discussed further in Section 6

Overall, no significant, adverse residual environmental effects are anticipated with implementation of the project.

Table 5.3 Preferred Option – Crooks' Hollow Dam Removal
Potential Environmental Effects, Mitigation Measures and Net Effects

Potential Environmental Effect	Mitigation Measures	Net Effects
Natural Environment Effects		
Air Quality Potential localized effects to air quality associated with fugitive dust during construction.	Minimize extent and duration of exposed soils by restricting construction vehicle access to properly demarked work areas by fencing, signage, flagging. Conduct staged reservoir drawdown to maximum opportunity for natural regeneration of exposed floodplain and shoreline areas. Cover, cap and seed dredged sediments following dewatering and spreading on floodplain. Use dust suppression (e.g. watering) along access road to limit dust mobilization.	Slight, localized, short-term increase in dust levels at construction site. No long-term residual effects.
Potential localized effects to air quality associated with vehicle emissions during construction.	Construction vehicles not to idle for extended periods of time. All vehicles and equipment to use standard emission control devices. Monitoring to identify vehicles expelling excessive exhaust.	Slight, localized, short-term increase in vehicle emissions during construction. No long-term residual effects.
Soil Quality Potential impacts on soil quality due to accidental spills or releases of fuels, oils or other hazardous materials associated with the construction process.	Hazardous materials to be stored in designated containment areas. Emergency spill response procedure to be developed by contractor and spill clean up material to be maintained throughout the construction period. In the event of a spill, any contaminated soil to be removed from the site and disposed of at an approved disposal facility. MOE Spills Action Centre to be informed of any spills that have the potential to impact the environment.	Some risk of low magnitude, localized soil contamination during the construction period if accidental spill/release was to occur. No long-term residual effects following implementation of clean-up measures in the event of a spill incident.
Potential impacts on soil (and water) quality due to improper containment and leaching of sediments dredged from creek and disposed of on floodplain.	Dredged sediments to be properly dredged, dewatered, and tested according to MOE Standards for acceptable use prior to on-site disposal on floodplain. Otherwise, off-site disposal to be used. If necessary, construct sediment containment area, cap and seed to ensure no long-term leaching or erosion of material.	No long-term adverse residual effects following implementation of proper on-site disposal plan and constructed containment area since sediments will be categorized as non-hazardous. In-stream sediment quality is expected to exhibit long-term positive improvement following dredging.

Table 5.3 Preferred Option – Crooks' Hollow Dam Removal
Potential Environmental Effects, Mitigation Measures and Net Effects

Potential Environmental Effect	Mitigation Measures	Net Effects
Water Quality		
Potential impacts on water quality due to increases in turbidity associated with reservoir drawdown, shoreline or floodplain construction works, including effects from sediment erosion.	Utilized existing dam to fullest extent possible for water and sediment control during construction. Implement a sediment and erosion control plan including standard measures such as cofferdams, silt curtains, silt fences, to minimize potential for sediment erosion and transport. Use only clean fill material for in-water construction works. Construction monitoring of water quality conditions (e.g. turbidity). Site restoration of disturbed areas to ensure long-term erosion does not occur.	Slight, localized, short-term increase in water turbidity for areas immediately affected by in-water construction works due to disturbance of local riverbed/shoreline sediments. No long-term adverse residual effects. In-stream local water quality conditions are expected to exhibit long-term positive improvement following dredging and dam removal.
Potential impacts on water quality due to accidental spills or releases of fuels, oils or other hazardous materials associated with the construction process.	Vehicle/equipment refueling and maintenance activities to occur at least 30 m from the watercourses or any drainage channels. Hazardous materials to be stored in a designated area away from the watercourse. Only clean, well-maintained equipment to be allowed to enter the watercourse. Emergency spill response procedure to be developed by contractor and spill clean up material available throughout the construction period. MOE Spills Action Centre to be informed of any spills that have the potential to impact the environment.	Some risk of low magnitude, localized surface water contamination during the construction period if accidental spill/release was to occur. No long-term residual effects following implementation clean-up measures in the event of a spill incident.
Terrestrial Habitat/Wildlife		
Loss of small amount of terrestrial vegetation associated with construction staging area, secondary access road construction (if required) and dam demolition.	Vegetation to remain to be protected from disturbance during construction activities (e.g., flagging, fencing). Vegetation removal to be minimized to greatest extent possible and all altered areas to be restored (e.g. seeding, replanting) following construction completion.	No long-term residual effects following site restoration of disturbed areas at damsite.
Disruption to local wildlife populations from construction equipment noise and human presence.	No mitigation identified since site has reduced wildlife presence since site abuts existing urban uses. Wildlife populations in the vicinity of the dam site are likely somewhat more tolerant of human disturbance.	Short-term, localized disturbance to local wildlife populations resulting in some wildlife avoidance of site during construction. No long-term adverse residual effects.
Improvements in terrestrial vegetation and habitats following site restoration of exposed floodplain and shoreline areas following dam removal.	Site restoration to include natural regeneration of exposed floodplain and shoreline areas combined with seeding using a mix of native species and selective plantings established as part of overall site restoration plan.	Long-term, overall improvement in terrestrial vegetation and habitats as area continues to regenerate and mature over time.
Aquatic Species/Habitat		
Permanent conversion of existing pond type aquatic habitat to free flowing riverine habitat will result in	No specific mitigation required since this effect is considered positive. However, creek restoration measures,	Positive long-term effect on local fish community and aquatic habitat following restoration.

Table 5.3 Preferred Option – Crooks' Hollow Dam Removal
Potential Environmental Effects, Mitigation Measures and Net Effects

Potential Environmental Effect	Mitigation Measures	Net Effects
an overall reduction in wetted surface area and aquatic habitat, but will restore conditions more conducive to the native fish community of Spencer Creek. Habitat suitability for species including common carp will be significantly reduced.	including shoreline stabilization (e.g., planting, grading and bioengineering), floodplain plantings, instream habitat enhancement and fine sediment removal will be implemented to enhance environmental conditions following dam removal.	
Positive environmental effects following dam removal and site restoration measures including restoration of natural sediment and nutrient transport processes, elimination of surface water warming, elimination of stagnation conducive to excessive algal growth, restoration of more natural fish movement conditions, removal of contaminated sediments and elimination of changes in downstream flow and water level due to dam operations.	No specific mitigation required since this effect is considered positive.	Positive long-term effect following restoration.
Localized disruption of aquatic biota due to in-water construction in the vicinity of the dam and shoreline/instream construction activities and temporary losses of habitat due to reservoir dewatering.	Work to proceed according to MNR's Work-In-Water Timing Guidelines to ensure protection of fish communities during sensitive life stages (i.e., reproduction). In-water works may proceed between July 1 and September 14.	Localized, short-term disruption of the local community in the vicinity of the dam removal and creek enhancement works. Effect not significant since critical reproductive processes will not be impacted.
Health impacts on aquatic biota and habitat due to water quality impairment resulting from accidental spills of fuel or erosion and sedimentation from the construction site.	Mitigation measures to eliminate or minimize effects of spills and erosion and sedimentation on water quality will minimize potential for impacts on fish/aquatic biota health.	Some fish movement out of the impacted area if spill or erosion occurs. No long-term residual effects anticipated.

Table 5.3 Preferred Option – Crooks' Hollow Dam Removal
Potential Environmental Effects, Mitigation Measures and Net Effects

Potential Environmental Effect	Mitigation Measures	Net Effects
Socioeconomic Environment		
Land/Water Use		
Displacement of local land use (passive recreation) in the immediate vicinity of the dam during the construction period due to equipment/vehicle staging, laydown areas.	Site fencing, warning signs will be used to direct recreational users away from the construction site, as required.	Minor, short-term, displacement of recreational use and enjoyment of area at damsite during construction. Existing Crooks' Hollow trails will not be affected. No residual effects.
Displacement/loss of local recreational water use associated with elimination of reservoir.	No mitigation, elimination of reservoir is direct result of dam removal and can not be avoided. Alternate water based recreational activities (boating, swimming, fishing) are readily available at nearby Christie Lake.	Some local residents and visitors to the area may perceive a loss of recreational enjoyment with the elimination of the reservoir. With creek restoration, recreational activities with scenic viewing and hiking may improve.
Elimination of the reservoir as a source of water for rural firefighting would require that an alternate location at Christie Lake reservoir be established.	HCA to provide emergency access to nearby Christie Lake reservoir to local fire department.	Slightly increased travel time for fire trucks to Christie Lake reservoir which is less than 1 km away from Crooks' Hollow Dam.
Loss of access across dam for local residents and recreational users during construction.	Construct a pedestrian foot bridge across Spencer Creek at former damsite to maintain existing public access.	Minor, short-term inconvenience to residents and recreational users until replacement footbridge is constructed. No residual effects.
Disruption to local residential communities or passive recreation activities in damsite vicinity due to noise and vibration generated from construction equipment.	Construction will be limited to between the hours of 0700 and 1900. Contractor to ensure that all construction vehicles and equipment incorporate noise emission control devices (e.g. mufflers).	Minor, localized, short-term increase in ambient noise and vibration levels at damsite during construction. No residual effects.
Temporarily decreased aesthetics at the construction site and dewatered reservoir area upstream.	Construction site best management practices to be implemented to ensure the construction area remains as tidy as possible. Site restoration measures to include natural regeneration of vegetation combined with seeding and planting of dewatered reservoir areas.	Minor, localized, short to mid-term decrease in aesthetics at construction site and dewatered reservoir area until regeneration of vegetation communities. No long-term residual effects.
Potential impacts on local traffic due to construction vehicle and equipment/material transportation.	Significant impacts are not expected to occur due to low volumes of traffic anticipated. Flag persons will be used, if required to ensure minimal disruption on main roads.	Minor, short-term disruption to local traffic. No residual effects.
Public Safety		
Increased public safety due to dam removal.	None required.	Long-term positive impact.
Increased public safety risks associated with construction activities.	Construction site best management practices (e.g., site fencing, warning signage) employed to ensure public cannot access the construction work area.	Slight short-term safety risk. No residual effects.

Table 5.3 Preferred Option – Crooks' Hollow Dam Removal
Potential Environmental Effects, Mitigation Measures and Net Effects

Potential Environmental Effect	Mitigation Measures	Net Effects
The elimination of the water source for firefighting could increase the potential risk to public safety during short term until a suitable replacement site (i.e., Christie Lake) is established.	HCA to provide emergency access to nearby Christie Lake reservoir to local fire department.	Slight short-term safety risk. Slightly increased travel time for fire trucks to Christie Lake reservoir which is less than 1 km away from Crooks' Hollow Dam.

6. Project Plan

The following section outlines a preliminary plan for the implementation of the preferred solution to decommission and remove the Crooks' Hollow Dam. The purpose of this section is to provide information to be used as guidance during detailed design, specifically in terms of the recommended mitigation measures, follow-up monitoring and environmental approvals. Further specific details, plans and specifications for the construction and monitoring of the environmental mitigation and restoration measures will be established as part of detailed design.

6.1 Project Description and Schedule

Project Description

The preferred solution involves a project to completely remove the Crooks' Hollow Dam including the draining of the reservoir, demolition of the structure, removal of concrete rubble/debris from the watercourse and subsequent disposal of material.

Implementation of the project would revert the reservoir back to a natural river condition.

The project will also include dredging portions of the original low flow channel to remove previously deposited sediments, on shore disposal of dredged material (if feasible, otherwise off-site disposal), natural channel restoration of dredged areas, floodplain and shoreline stabilization, and construction of fish habitat restoration and enhancement works.

Schedule

The proposed schedule for implementing the Crooks' Hollow Dam removal is provided in Table 6.1.

The schedule currently shows a two-step approach to reservoir draining/sediment removal and dam removal starting in Fall 2009 and completing in Fall 2010. Subject to the findings of the Sediment Management Plan and MOE's endorsement (refer to Minister's conditions; Section 2.6) planned for August 2009, the schedule may be revised to reflect a strategy to completely drain the reservoir in Fall 2009 and then remove the sediment and dam in during Winter 2009/2010.

6.2 Project Implementation

The following provides an overview of the principal activities associated with implementing the Crooks' Hollow Dam removal project, including general guidance for environmental permitting and approvals, construction activities and recommended mitigation measures. Figure 6.1 provides a depiction of a conceptual environmental management plan for the construction.

6.2.1 Environmental Permits and Approvals

The implementation of all project activities is premised on the assumption that all necessary federal, provincial and municipal permits, approvals and/or authorizations will be obtained prior to initiating the project works. The following provides guidance on known or anticipated approvals required.

Cultural Heritage Assessment

Given that the damsite has been previously disturbed and given the limited area of potential disturbance associated with the planned repair works, the need to conduct a Stage I/II Archaeological Assessment is not anticipated.

Table 6.1 Project Schedule

Project Environmental Assessment Approval Notice of Filing (beginning of comment period) Notice of Filing (end of comment period) Minister's Decision	 January 23, 2009 February 23, 2009 May 13, 2009
HCA Board Endorsement Notice of Project Approval	August 2009
Sediment Management Plan (dredging and disposal) Preparation of SMP SMP review and approval by MOE	 August 2009 September 2009
Reservoir Draining (Stage 1: as per normal HCA dam operating procedure)	Fall 2009
Detail Design, Plans and Specifications Dam demolition and disposal plan Sediment management plan Floodplain and shoreline restoration plan Fish habitat restoration plan Follow-up monitoring plan	Fall/Winter 2009
Environmental Permitting and Approvals	Winter/Spring 2010
Tendering and Award	Spring 2010
Reservoir Draining (Stage 2)	May to June 2010
Construction Mobilization and Staging	June 2010
Dam Demolition, Sediment Management, Fish Habitat Restoration Construction	June to September 2010
Site Cleanup and Restoration, Demobilization	October 2010
Follow-up Monitoring: Years 1, 2 and 5	2011 to 2016

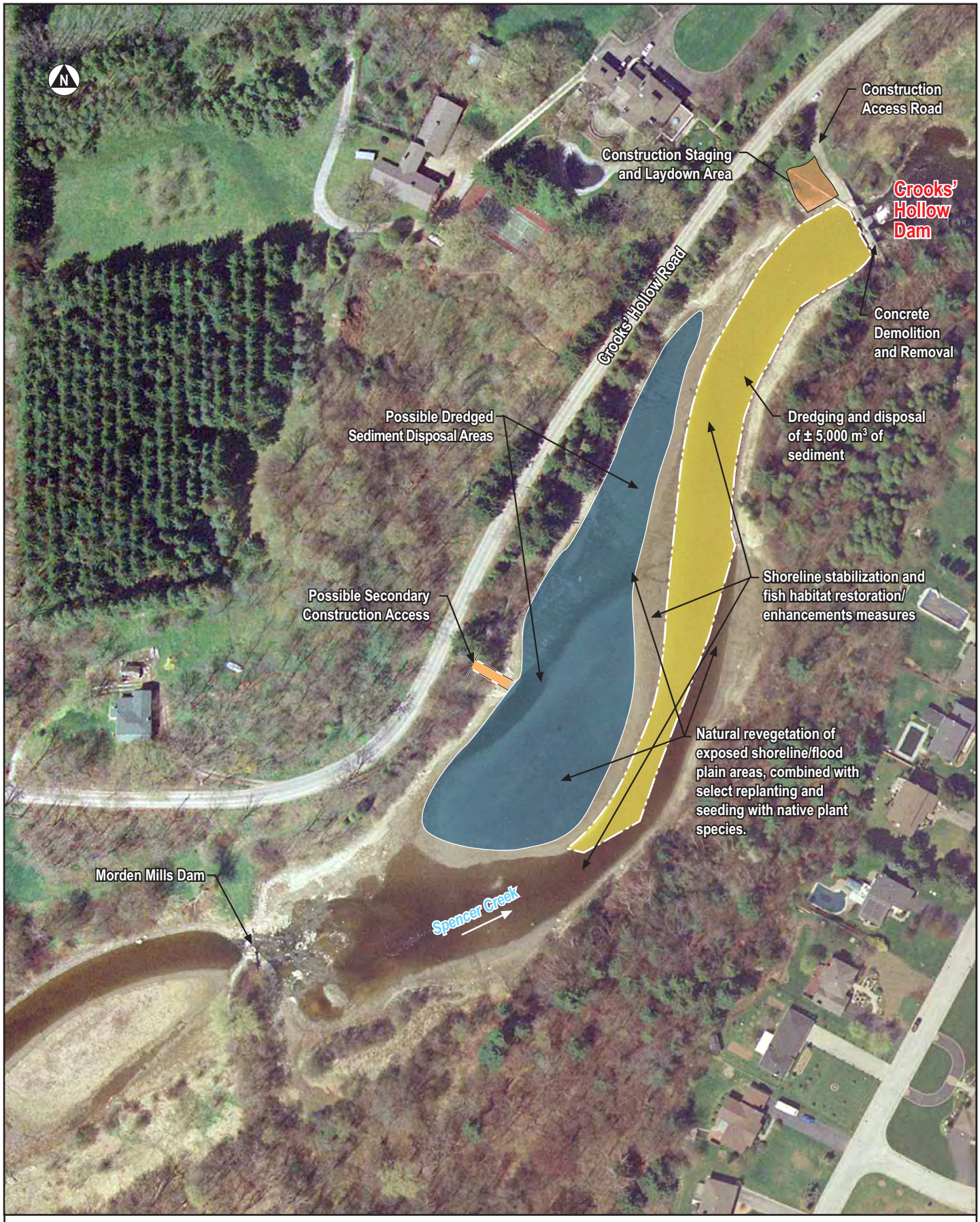

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Figure 6.1
Hamilton Conservation Authority
Crooks' Hollow Dam Class EA
Conceptual Environmental Management Plan

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However, copies of the proposed design drawings should be provided to the Ministry of Culture prior to the start-up of construction to ascertain their approval requirements in regards to the potential for archaeological resources.

Niagara Escarpment Commission

The Niagara Escarpment Commission, following their review of the Draft Project Plan stated in their letter correspondence of February 17, 2009 (Appendix A) that, *"…in principle staff support the project [dam removal]…and that it appears consistent with the objectiveness of the NEC; specifically to enhance the quality and character of the Escarpment's natural streams"*. NEC advised that a Development Permit will likely be required from the NEC for construction aspects pertaining to vegetation preservation, restoration and pedestrian bridge. In this regard, NEC stated that, *"…detailed construction drawings addressing the following will be required to the satisfaction of the NEC:*

- *Vegetation inventory, assessment and preservation plan for the area to be impacted by the demolition of the dam, reservoir excavation & filling and new bridge installation. The NEC has a guideline for the preparation of this document.*
- *Restoration planting plan; please note that the drawings must include detailed information regarding the stabilization of the sediment disposal areas and exposed shoreline identified in Figure 6.1 Conceptual Environmental Management Plan.*
- *Bridge installation details such as the staging area for the installation of a steel (assumed prefabricated bridge) and abutments.*
- *Define access (haul road), staging and storage areas.*

In addition to the above, while not identified as a NEC permit requirement, the NEC recommended consideration of the following:

- "That the design incorporates principles of universal accessibility for the bridge and the approach path.
- That the design incorporates a viewing platform, given the existing one will be lost with the demolition of the dam catwalk.
- That a temporary interpretative sign be installed near the work site to inform the public of the proposed demolition works, timing as well as the design and ecological benefits. A sample of a sign utilized in Stanley Park is included with these comments."

Fisheries and Ocean Canada

Fisheries and Oceans Canada (DFO) administers the fish habitat protection provisions of the *Fisheries Act*. Dam removal could constitute a Harmful Alteration, Disruption or Destruction (HADD) of fish habitat due to the overall loss of wetted aquatic area and the disruption involved during dam removal. If so, HCA will be required to obtain an authorization from DFO under Section 35(2) of the *Fisheries Act* to authorize the HADD.

Overall, it is anticipated that the restoration of a more natural creek channel following dam removal will improve the long-term productivity of the former reservoir and downstream reach of Spencer Creek with associated benefits including improved water quality and downstream flow conditions

and improved diversity of aquatic habitats and channel/habitat forming biophysical processes. Given this, DFO may consider that the works do not constitute a HADD, preferring instead to provide their advice by means of a Letter of Advice. DFO should be consulted further to establish their specific approval requirements.

To ensure that no long-term adverse impacts occur due to dam removal (e.g., bank erosion and downstream sedimentation) and to enhance aquatic habitat conditions, a fish habitat restoration plan should be prepared as part of detailed design. If directed by DFO, such a plan may require the creation of new/enhanced fish habitat to compensate for the HADD.

MNR Approval

The proposed dam removal will require approval from the MNR under Section 16 of the *Lakes and Rivers Improvement Act*, namely the alteration to an existing dam and/or modification to a watercourse channel. In this regard, MNR will seek to review and approve the plans and specifications for the dam removal. In addition, a Work Permit(s) issued under the Public Lands Act (administered by MNR) will be required for works within a waterbody (i.e., dam demolition, channelization), and/or for any new roads, trails or water crossings (i.e., culvert replacements) required in conjunction with the dam decommissioning works.

Fisheries timing windows defined by the MNR for cold-water fish communities will be used to establish the allowable construction work period for any in-water works. In this regard, it is expected that in-water construction works will be required to proceed between the defined dates of July 1 and September 14. This mitigation will prevent disruption of fish species during their sensitive reproductive periods.

Navigation

The dam removal is not expected to constitute a requirement for formal approval under Section 5(1) of the *Navigable Waters Protection Act* (NWPA). Transport Canada, Marine in their January 21, 2009 letter advised that no work on the dam may commence until approval is received under the NWPA.

Federal Species at Risk Act

The federal *Species at Risk Act* provides legal protection for the species listed on Schedule 1 of the *Act*. The *Act* makes it a federal offence to kill, harm, harass, capture, take, possess, buy, sell, collect or trade an individual of any of species designated as Endangered, Threatened or Extirpated in Schedule 1 of the *Act*. The *Act* also makes it an offence to damage or destroy the critical habitat of the listed species (i.e., habitat necessary for the survival and recovery of the listed species). All EAs conducted under federal legislation such as the CEAA require that species listed under the *Act* and their critical habitat within the study area must be identified. If the project has the potential to affect a listed species and/or its critical habitat, the *Act* requires that the competent minister (i.e., the federal minister of the department responsible for the particular species) be notified immediately. The *Act* also requires that the potential adverse effects of the project on the species and/or habitat be assessed in the EA, that mitigation measures are implemented to prevent/lessen those effects and that the effects must be monitored. If the project has the potential to have an adverse effect on a listed species or its critical habitat, if the effect cannot be prevented, a permit or agreement to authorize the activity can potentially be obtained under Section 73 of the *Act*.

As noted in Section 4.2.9, there are four species listed on Schedule 1 of SARA that have been observed within the Christie Stream Valley ESA, which includes the Crooks' Hollow area. As discussed in Table 5.1, the project is unlikely to have an adverse effect on either of the listed tree species (butternut and American chestnut) since no tree clearing is anticipated to be required.

However, it is recommended that if any tree clearing is required, an inventory of the species to be cleared should be undertaken. If butternut or American chestnut is found in areas that requiring clearing, and adverse effects cannot be avoided, HCA will be required to obtain a permit or agreement under the Act to authorize the adverse effects to these individual trees.

Further, the project is not likely to adversely affect the habitat of the listed wildlife species (monarch butterfly and eastern milksnake), but it could potentially have a minor, short-term effect on individuals of these species if they are located in close proximity to the damsite, due to construction noise and/or disturbance. However, it is not anticipated that there would be any long-term adverse effect and in fact, the project may enhance the amount of habitat available for these species. During detailed design (i.e., prior to initiating any construction activities), HCA should consult with Environment Canada (which has legislative authority for non-aquatic wildlife species under SARA) to determine their requirements (if any) under SARA.

Provincial Endangered Species Act

The *Ontario Endangered Species Act* provides legal protection for species and their habitat for those listed in the Regulation as Endangered, Threatened or Extirpated. The *Act* makes it an offence to kill, harm, harass, capture, take, possess, buy, sell, collect or trade an individual of any of species designated as Endangered, Threatened or Extirpated. Damaging or destroying the habitat of Endangered or Threatened species is also prohibited under the *Act*. It is possible to enter into an agreement or obtain a permit to engage in an activity that would otherwise be prohibited under the *Act*.

Butternut and American chestnut are both listed as Endangered under the *Act* and are subject to full legal protection as noted above. However, no adverse effects on either of these species are anticipated to occur due to the project, since no tree clearing is anticipated to be required. However, it is recommended that if any tree clearing is required, an inventory of the species to be cleared should be undertaken. If butternut or American chestnut is found, and adverse effects cannot be avoided, HCA will be required to obtain a permit under the Act.

Canadian Environmental Assessment Act

The issuance of a federal approval under the *Fisheries Act* (or NWPA) will trigger the *Canadian Environmental Assessment Act* (CEAA). In the case of the Crooks' Hollow Dam removal, if CEAA is triggered, it is anticipated that DFO would act as the Responsible Authority and conduct the federal screening based on the information provided in this report. The screening process would include the posting of project notices on the Canadian Environmental Assessment Registry website. Conversely, if DFO issues a Letter of Advice as opposed to formal authorization under the *Fisheries Act* and there are no other federal approval triggers, CEAA would not apply.

In August 2005, a project description was prepared and submitted to the Canadian Environmental Assessment Agency (CEA Agency). At that time, the project description identified the dam repair, weir modification and dam removal alternative as potential options under consideration, but did not indicate a specific preference. As such, a copy of this report should be provided to the CEA Agency to facilitate their review of the proposed project to remove the dam to enable a final decision on the applicability of CEAA to the project.

6.2.2 Construction Access and Management

Construction Access

Construction vehicle access to the damsite will be via Crooks' Hollow Road and direct access to the north side of the dam is available via a gated road maintained by HCA. Sufficient area is present at

the damsite for vehicle parking, construction loading and unloading, staging, and storage of equipment and material. Warning signs of the construction site entrance should be placed along Crooks' Hollow Road and flag persons used to direct trunks backing-up or exiting onto Crooks' Hollow Road. Provision of a possible secondary construction access from Crooks' Hollow Road to the upstream end of the reservoir (Figure 6.1) is available if required.

Construction Site Management

The following standard site management measures and construction practices (but not limited to) should be employed (by the Contractor) to minimize environmental disturbances during the construction:

- establishment of defined working areas for construction, staging and lay down areas, temporary construction access, equipment storage, refueling, stockpiling, wastes, etc., by means of perimeter fencing, flagging and signage
- confirmation that the local road is capable of handling the loading and volumes of truck traffic that would result from the work
- a photographic record and documentation should be maintained to confirm site conditions for both pre-construction and post-construction
- the identification and protection of trees and vegetation from construction equipment
- proper storage of equipment, construction material, debris and fuel away from sensitive areas and open waters; all hazardous materials should be stored in a designated area away from the watercourse
- vehicle and equipment refueling and maintenance should occur at least 30 m from the watercourse or any drainage channels
- no-in water work unless properly scheduled and supervised by HCA staff or their designate; only clean, well-maintained equipment should be allowed to enter the watercourse
- the implementation and maintenance of standard erosion and sediment controls for disturbed areas
- the implementation of proper construction practices/scheduling to minimize noise, dust and vehicle/equipment exhaust emissions, construction should be limited between the hours of 0700 and 1900
- proper waste management practices and disposal of all construction debris, garbage, rubble and stockpiles
- maintenance and restoration of access roads, site construction and staging areas during and following completion of the works.

6.2.3 Reservoir Draining

As general guidance, the existing dam should be used for water and sediment control throughout the dam removal process, continuing until its' final demolition. The reservoir should be slowly drained in a controlled fashion and then appropriate time allowed for conditions in the reservoir to stabilize, including the natural revegetation of exposed floodplain and shoreline areas. During the draining,

conditions in the reservoir and along the shoreline should be closely monitored for signs of increased turbidity, soil erosion and/or flushing of sediments.

The following specific approach to the reservoir draining is recommended.

- Fall 2009 – Reservoir draining would initiate with HCA's typical operating procedure involving the removal of five of the eight stop logs in sluiceway No. 2 to drawdown the reservoir 1.52 m to the winter operating level of ±215.06 m. This elevation corresponds to a reservoir depth of ±0.91 m just upstream of the dam reducing to ±0.4 m depth downstream of the former Morden Mill's dam.
- Following a stabilization period of 2 to 3 weeks, it is recommended that HCA consider removing one, possibly two, of the three remaining stop logs in sluiceway No. 2. Doing so would dewater an additional 0.3 to 0.6 m of reservoir depth, thereby allowing exposed shoreline sediments to dry out and stabilize naturally by vegetation growth. In addition, this would permit observations of the upstream channel form and structure to identify locations for fish habitat restoration measures. For each successive log removal, it is recommended that reservoir levels should be allowed to stabilize over a period of ±10 days, prior to removal of the next stop log.
- The above noted additional 0.3 to 0.6 m drawdown would allow a portion of the upstream low flow channel (i.e., ±100 m reach downstream of the former Morden Mill's dam) to begin reforming by allowing some natural bed erosion and sediment transport to occur. The sediments identified in this vicinity are not significantly contaminated or in significant quantity to present a concern if mobilized. Also, the dam would still continue to act as a sediment trap, minimizing the potential that excessive quantities of sediment would be flushed downstream. Sediments deposited upstream of the dam would help in the subsequent removal process (i.e., dredging) since they would become concentrated in the same area as the other sediments slated for removal.
- This entire 2009 fall drawdown process should be closely monitored by HCA staff,[1] especially during any high flow events resulting from large fall rainfalls to ensure that excessive erosion and flushing of sediments downstream of the Crooks' Hollow dam does not occur. If necessary, stop logs should be immediately reinstalled in sluiceway No. 2 if there is any evidence of increased turbidity and sediment transport at the dam.
- May/June 2010 – In order to complete the reservoir drawdown to the sill level of the dam (±214.15 m), the remaining stop logs should be removed once the spring freshet has resided. This process should be undertaken in a controlled fashion with one stop log being removed at a time, and conditions allowed to stabilize over a period of ±10 days, prior to removal of the next stop log. In this manner, it is anticipated that all stop logs would be removed by the end of the June and reservoir would have stabilized at this lower water level prior to implementation of the dam removal activities.
- As with the fall 2009 drawdown, the May/June 2010 drawdown should be closely monitored by HCA for signs of erosion and sediment transport during any high flow events. If necessary, stop

[1] HCA Dam operations staff can access the damsite within 10 to 15 minutes under emergency conditions (Hatch, 2007).

logs should be immediately reinstalled if there is any evidence of increased turbidity and sediment transport at the dam. If such an event occurs, remedial measures to remove the source of the sediment (e.g., channel dredging or shoreline stabilization) will need to be implemented prior to removal of additional stop logs.

6.2.4 Sediment Management

As discussed in Section 4.2.10, an estimated 5000 m^3 of unconsolidated fine sediments exist in the Spencer Creek channel that would form following dam removal (Figure 6.1). These sediments are somewhat chemically degraded with elevated levels of arsenic, cadmium, lead, copper, mercury, nickel, zinc, total phosphorus, and total Kjeldahl nitrogen.

As concluded by the Reservoir Sediment Study (Hatch Acres, 2006), given the quantity and quality of the sediment, and its susceptibility to transport following dam removal, sediment management (i.e., removal and disposal) will be necessary as part of the dam removal process to prevent adverse environmental impacts. Accordingly, as stipulated by the Minister of the Environment (refer to Section 2.6), preparation of a Sediment Management Plan is required to confirm the specific sediment removal method, disposal options, monitoring, timing and costs, and to facilitate the preparation of contractor tender specifications to carry out the work.

Subject to the findings of the Sediment Management Plan, based on a preliminary review of the quantity, quality and composition of the sediments, the following identifies possible options for the removal and disposal of the sediment in the Spencer Creek low flow channel.

Sediment Removal

Three options are considered possible for carrying out the sediment removal under either 'wet' or 'dry' conditions:

- Mechanical dredging using an open bucket or clam-shell type bucket and casting directly on shore for dewatering. Once dewatered, the solids would remain on-site (i.e., spreading on floodplain) or be removed for appropriate off-site disposal.
- Hydraulic dredging using a suction dredge (i.e., mechanized auger-cutting heads and a pumping bucket) to remove the sediments in the form of a slurry. The slurry would be pumped to a temporary settling pond or another type of dewatering process to remove suspended material from the water/sediment slurry. Once dewatered, the solids would remain on-site or removed for off-site disposal. Given the largely silt, clay and organic sediments in the reservoir, hydraulic dredging is considered advantageous to minimize potential sediment resuspension and transport of fine materials downstream.
- Mechanical removal using excavators and bulldozers to remove the dewatered sediments and placement on shore for additional dewatering if required. Such an approach would use the existing dam for sediment and water control as the reservoir is drawn down so that the sediments are allowed to dry out and stabilize prior to removal. The sediment would then either remain on-site (i.e., spreading on floodplain) or be removed for appropriate off-site disposal. If carried out during the winter, this approach could provide advantages since low water and frozen ground conditions would enable better access of heavy equipment, whilst minimizing potential for erosion and sediment transport.

Sediment Disposal

Several options are possible for the disposal of the removed reservoir sediments and include the following:

- on-site use (i.e., spreading on floodplain)
- off-site removal to other HCA properties
- off-site removal to private property (e.g., agricultural fields)
- off-site removal to an appropriate landfill.

The final selection of the preferred disposal option will largely depend on the classification of the material i.e. hazardous vs. non-hazardous in accordance to Regulation 347 (as amended by Regulation 558). Currently, it is suggested that on-site placement of the material on the exposed floodplain would be the favoured approach since it is expected to be least costly option versus hauling and off-site disposal.

On-site disposal would be contingent on the sediment being classified as a non-hazardous waste in accordance to Regulation 347 and a determination that the sediment quality meets the specific land use criteria defined by MOE's "Soil Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act". In particular, it would need to be confirmed that the zinc concentration in the sediment material would be acceptable for use as a soil since the zinc concentration in two samples slightly exceeded the MOE Standard of 800 μg/g for parkland use.

If the sediment is found to be non-hazardous and chemically suitable for this use, it would be placed onto the floodplain (shown conceptually in Figure 6.1). If necessary, the sediment would be placed in a containment cell(s), constructed by shallow excavation of the existing floodplain with the excavated material used to create a low level containment berm. Alternatively, stone-filled gabion retaining walls or similar containment structures (possibly using inert concrete from the demolished dam) could be used to construct the perimeter of the containment cell.

Following placement of the dredged sediment, the entire containment area would be naturalized by final grading and contouring (possibly involving capping and/or placement of topsoil), along with seeding and plantings to prevent erosion and improve the aesthetics and habitat conditions of the area.

6.2.5 Site Restoration

Shoreline Stabilization and Restoration

The area subject to shoreline stabilization and restoration is shown conceptually in Figure 6.1. Possible shoreline stabilization mitigation and restoration works recommended for consideration as part of detailed design are described as follows:

- Exposed banks on outer bends of the creek and other areas identified as highly susceptible to erosion should be stabilized with soil bioengineering techniques (e.g. timber cribs, brush bundles, fascines, live staking and live brush layers) at the completion of the reservoir drawdown.
- Depending upon the observed formation and stability of the low flow channel, exposed shoreline sediments in a strip 10 m wide on either side of the low flow channel should be

stabilized with a combination of plantings of plugs (grasses, herbs and shrubs) and seeding with a fast-growing plant seed mix which incorporates seed components.

- Specific areas within the 10 m wide strip that do not warrant a bioengineering approach, but are considered to be potentially susceptible to erosion should be treated with a seed impregnated biodegradable erosion control blanket (i.e., straw, jute or coconut fibre) or equivalent.

Floodplain Stabilization and Restoration

The area subject to floodplain stabilization and restoration is shown in Figure 6.1. This area is characterized by a large depositional feature which has been annually inundated from the operating practice of installing stop logs in the summer. Observations conducted of this area following the normal fall drawdown indicate that this area exhibits natural regeneration of vegetation.

Possible floodplain stabilization mitigation and restoration works for consideration as part of detailed design are described as follows:

- Allow natural regeneration of exposed floodplain sediments to the extent possible noting that the primary floodplain area has been identified as a candidate area for sediment disposal (see Section 6.2.3) in which case, it is anticipated that seeding and planting will be required on top of the disposed sediments following their dredging and placement in this area.
- For floodplain areas that will not be used for disposal of dredged material and that do not exhibit natural regeneration, seed all areas with a fast-growing seed mix incorporating native species.
- Seedling establishment and growth should be closely monitored during this period to assess whether the proposed application rate results in the desired coverage, and to assess whether additional stabilization measures may be appropriate for specific areas.

Fish Habitat Restoration and Enhancement

Fish habitat restoration activities in the restored Spencer Creek low flow channel should be timed to coincide with the shoreline stabilization and restoration activities described above.

The location and extent of fish habitat restoration and enhancement works have not been established at this stage but may include planting of riparian vegetation along the restored creek channel and placement of shoreline and in-stream structures (e.g., root wads, boulder-log clusters, sweeper trees) to create aquatic habitat for the life history of the species that will occupy the restored channel. A long-term environmental monitoring program should also be prepared to assess the adequacy of the restoration/enhancement measures.

It is recommended that preparation of the fish habitat restoration and enhancement plan be prepared by HCA with advice from DFO and MNR. Possible additional partners could include the Royal Botanical Gardens and Trout Unlimited who have already expressed a willingness to participate in this endeavour. Once established, the conceptual elements would be incorporated into the detailed design and constructed in a phased manner during and following the dam removal process.

6.2.6 *Structural Demolition and Disposal*

The demolition of the dam structure is anticipated to occur coinciding with lower creek flows. This will minimize the potential for in-stream erosion at the damsite as well as minimize the extent of measures required for sediment and water control.

The anticipated works associated with dam removal and recommended mitigation measures are as follows:

- Install and maintain temporary sediment and water control measures such as pea-gravel bagging, silt curtains, temporary pumping or siphoning of water to divert inflows around or over the work area.
- Remove and salvage all scrap metal components (railing, decking, winches, guides, brackets, concrete reinforcing steel, etc.) and dispose at appropriate recycling depot.
- Utilize a hydraulic excavator and hoe ram (possibly combined with controlled blasting if required to crack large sections of the dam) to demolish the dam's concrete piers, sluiceways, wingwalls and base. Concrete demolition and removal may require the construction of an access ramp (likely of rock rubble) in the dewatered area on the upstream side of the dam (and/or possibly on the downstream side) to access the lower portions of the dam structure and its base. The access ramp will be removed following completion of the work.
- Remove all waste concrete and dispose at appropriate recycling depot. Alternatively, inert concrete rubble could be disposed on-site as embankment or shoreline fill material and buried, or possibly used as shoreline stabilization material or in the construction of the sediment disposal containment cell (see Section 6.2.3).
- Finally, all disturbed areas would be restored, including regrading, seeding and planting of native vegetation.

6.2.7 Environmental Monitoring and Follow-up

An environmental monitoring framework is proposed which consists of two components being the **construction phase** (i.e., monitoring sediment movement during the drawdown period, monitoring the sediment dredging and disposal activities, monitoring the dam removal activities, and monitoring the site restoration activities), and the post-construction, **operational phase** to evaluate the longer term performance and adequacy of the constructed shoreline stabilization and fish habitat enhancement works.

Construction Monitoring

Construction should be undertaken in accordance with current provincial guidelines for construction activities impacting on water resources (MOE, 1995; MNR, 1991) and current industry best site management practices. Monitoring of the construction process to verify compliance with contract specifications should be undertaken by the site engineer or his designate as part of the supervision/ monitoring of the project, and should include all aspects of project implementation including site preparation, access and construction staging, demolition and removal of the dam, dredging and on-site disposal of reservoir sediment, and the installation of floodplain/shoreline stabilization and fish habitat restoration/enhancement works.

Recommended monitoring activities during construction should include (but not be limited to) the following:

- Monitoring downstream water quality conditions during the sediment removal process (i.e., dredging) for visual signs of increased turbidity.

- Sampling and chemical analysis of dredged material for compliance to MOE standards and criteria.
- Monitoring the dredged disposal area and its' decant water prior to release.
- Post-dredging, in-stream sediment sampling and chemical analysis to confirm contract clean-up criteria.
- Monitor downstream water quality conditions during the installation of bank stabilization and fish habitat enhancement works for visual signs of increased turbidity.
- Monitoring downstream water quality conditions during the demolition and removal of the dam and the remedial and restoration works at that location for visual signs of increased turbidity.

Operational Monitoring

The goal of the operational monitoring program is to assess the success of the site restoration activities, and identify any unanticipated effects such that corrective measures can be undertaken.

Recommended monitoring activities following construction should include (but not limited to) the following:

- Conduct general inspections of the entire river channel shoreline and floodplain within the former reservoir following the spring freshet (years 1, 2 and 5) to identify erosion areas and assess the need for remedial works. Map any changes to channel form and structure, and the location and extent of any areas requiring remedial work.
- Inspect and monitor shoreline stabilization (bioengineering) works in the spring of the year following construction (year 1), and thereafter at years 2 and 5 to assess their retention, their state of development and identify the need for remedial repairs (if required). Record results of observations and remedial actions in project file.
- Inspect and monitor fish habitat enhancement works in conjunction with bioengineering works (years 1, 2 and 5) to assess their retention and the need for remedial repairs. Record results of observations and remedial actions in project file.
- Conduct fish community sampling at years 1, 2 and 5 after construction to assess response to habitat enhancement works. Establish fixed sampling points at upstream and downstream controls and 2 or 3 locations within the former reservoir and utilize standardized sampling protocol (i.e., Ontario Stream Assessment Protocol methodologies) for duration of study.
- Monitor natural regeneration and planted vegetation on the floodplain to document successional changes in community structure and composition. Initiate and maintain photographic record of succession, document and record changes at years 1, 2 and 5.

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