AGENDA FOR CONSERVATION ADVISORY BOARD MEETING

THURSDAY, NOVEMBER 13, 2014

Hamilton Conservation Authority

Vision

HCA works to ensure healthy streams and healthy communities in which human needs are met in balance with the needs of the natural environment, now and in the future.

Mission

To lead in the conservation and sustainable management of our watershed's natural environment.

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

Grindstone Falls

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

NOTICE OF MEETING

CONSERVATION ADVISORY BOARD

Thursday, November 13, 2014

7:00 p.m.

Woodend

AGENDA

1. **CHAIRMAN'S REMARKS** ~ Topalovic

2. **DECLARATION OF CONFLICT OF INTEREST**

3. **APPROVAL OF AGENDA**

4. **DELEGATIONS**

5. **MEMBER BRIEFING**

   5.1 HCA's Role in the Hamilton Harbour RAP ~ Peck

6. **CHAIRMAN'S REPORT ON BOARD OF DIRECTORS ACTIONS** ~ Topalovic

   CA1428 Maplewood Naturalization Plan

7. **APPROVAL OF MINUTES OF PREVIOUS MEETING**

   7.1 Minutes – Conservation Advisory Board (September 11, 2014) ~ Topalovic

8. **BUSINESS ARISING FROM THE MINUTES**

   8.1 E-Bikes – Update ~ Bell

9. **NEW BUSINESS**

   9.1 Waterfalls and Cascades of Hamilton Research and Inventory Report, 3rd Edition ~ Tellier

10. **OTHER NEW BUSINESS**

11. **NEXT MEETING – Thursday, December 11, 2014 at 7:00 p.m.**

12. **ADJOURNMENT**

HAMILTON CONSERVATION AUTHORITY

Conservation Advisory Board

MINUTES

September 11, 2014

Minutes of the Conservation Advisory Board meeting held on Thursday, September 11, 2014 at the HCA's Woodend Administration Building commencing at 7:00 p.m.

PRESENT:	**Maria Topalovic**	**John Barkovic**
	Rob Booth	**Sean Botham**
	Kristen Brittain	**Lydia Cartlidge**
	Frank Cucullo	**James Howlett**
	Donna Kydd	**Cheryl Larocque**
	Duke O'Sullivan	**Morgan Pirie**
	Marie Robbins	**John Shaw**
	Mary Tice	

REGRETS: **Dan Bowman, Chris Michels, and Robert Pasuta**

OTHERS PRESENT: **Sandy Bell, Hazel Breton, Grace Correia, Chris Firth-Eagland, Darren Kenny, Judy Love, Scott Peck, Chris Polap, John Williams, and Rick Woodworth - HCA Staff**

OTHERS: **Richard Leitner – Media**

1. CHAIR'S REMARKS

Maria Topalovic welcomed all to the meeting and passed on regrets from those members not able to attend.

2. DECLARATION OF CONFLICT OF INTEREST

There were none.

3. APPROVAL OF THE AGENDA

CA1426 **MOVED BY:** **Duke O'Sullivan**
SECONDED BY: **Mary Tice**

THAT the September 11, 2014 Conservation Areas Advisory Board agenda be approved.

CARRIED

4. DELEGATIONS

There were none.

5. MEMBER BRIEFING

5.1 Monitoring Program (City and HCA Partnership)

Chris Polap provided a presentation on the monitoring program.

The monitoring program is undertaken for:

- Evaluation of the health of a river, stream, wetland, pond or lake
- Flood forecasting and control
- Low water response
- Determine sources of inputs
- Determine available water resources
- To protect our landscape and the people that dwell therein
- Gathering and dissemination of data to partners

Stream flow and precipitation monitoring is completed through:

- 8 stream flow/level recording stations
- 11 precipitation gauges
- 4 snow survey courses
- Used for:
    - Assessment of water resource conditions
    - Detection of flooding and drought events
    - Hydrologic modeling/analysis

Water quality monitoring is currently being done through the following projects:

- Provincial Water Quality Monitoring Network (PWQMN)
- City of Hamilton Water Quality Monitoring

- Red Hill Creek Subwatershed Study
- Crooks Hollow Post Construction Monitoring
- Cootes Paradise/Hamilton Harbour Remedial Action Plan
- Greensville Surface Water Monitoring

Routine monitoring projects being conducted in the watershed include:

- PWQMN
  - 6 locations across watershed at existing hydrometric gauging stations
  - Program began in 2002 and is sampled monthly for a wide variety of parameters
  - Compared to Provincial Water Quality Objectives (PWQO) for safe recreational use

- PGMN
  - 9 wells monitored for quantity and quality

- City of Hamilton Water Quality Monitoring
  - 7 locations sampled monthly for nutrients, metals and e.coli

Benefits of the partnership:

- Supports core mandate of flood, drought and erosion protection
- Support for scientifically based studies (subwatershed studies)
- Input to watershed report card
- Support for planning reviews
- Meaningful monitoring network expansion
- Ability to apply for more funding due to increased in-house capacity for monitoring

6. CHAIRMAN'S REPORT OF BOARD OF DIRECTOR'S ACTIONS

There were none.

7. APPROVAL OF THE MINUTES FROM THE PREVIOUS MEETING

7.1 Minutes – Conservation Advisory Board (June 12, 2014)

CA1427 **MOVED BY:** **Cheryl Larocque**
SECONDED BY: **Lydia Cartlidge**

THAT the minutes of the June 12, 2014 Conservation Areas Advisory Board meeting be accepted.

CARRIED

8. BUSINESS ARISING FROM THE MINUTES

8.1 Maplewood Naturalization Plan

Sandy reviewed his staff report and added that the HCA has budgeted $20,000 per year for the next 4 years to complete the vegetation restoration. Morgan asked what funds were available for 2015. Grace stated that $154,000 in donations have been received to date with more forthcoming. Sandy stated that expenses to date total $85,000. Sandy added that the site will be hydro-seeded next week. Worst-case scenario costs for all road work are estimated at $205, 000.

Duke expressed concern about invasive plant species becoming established on-site prior to all work being completed. Sandy felt that this was not a significant concern and that maintenance costs had been built into the restoration budget.

CA1428 **MOVED BY: Morgan Pirie**
SECONDED BY: Frank Cucullo

THAT the Conservation Advisory Board recommends to the HCA Board of Directors that the Maplewood Naturalization Plan be approved and that the phased implementation of the Plan commence in 2015.

CARRIED

8.2 CAB Tracking Report

Darren briefly reviewed the report and noted that this report and future reports will attempt to track on-going projects that have already received Board of Directors approval.

CA 1429 **MOVED BY: John Shaw**
SECONDED BY: Sean Botham

THAT the September, 2014 Conservation Areas Advisory Board Tracking Report be received as presented.

CARRIED

9. NEW BUSINESS

9.1 Large-Scale Fill Placement

Scott reviewed his staff report and asked for CAB endorsement of the report recommendation. Scott noted that this report will go to the HCA Board of Directors and the issue will be coming back to CAB sometime in the fall of 2014.

CA1430 **MOVED BY: Frank Cucullo**
SECONDED BY: Duke O'Sullivan

THAT HCA staff recommends to the Conservation Advisory Board:

THAT the report be forwarded to the Board of Directors and be received as information.

CARRIED

9.2 HCA Level II Agreement – Department of Fisheries and Oceans – Fisheries Act

Scott reviewed his report concerning the recent changes to the Federal Fisheries Act and the termination of the Level Agreements with Conservation Authorities.

CA1431 **MOVED BY: John Shaw**
SECONDED BY: John Barkovic

THAT HCA staff recommends to the Conservation Advisory Board:

THAT the report be forwarded to the Board of Directors and be received as information.

CARRIED

9.3 East Mountain Wetland Restoration Project – Update

Chris Firth-Eagland provided some background on the project for the member's information.

In early 2014, the Heritage Green Community Trust asked if the HCA would suggest a "legacy" project for potential funding consideration on the East Hamilton Mountain. The concept of acquiring lands for a new conservation area was discussed and received with considerable enthusiasm. Subsequently, the HCA Board of Directors at its meeting of April 3, 2014 authorized the CAO to

pursue a joint funding relationship with the Trust. Presentations to the Heritage Green Community Trust and staff discussions have furthered the concept and support for a joint funding relationship. A grant request for $2 million was made. Councilor Brad Clark, as a member of the Trust's Board has fully endorsed the funding request and as a member of City Council, forwarded a notice of motion requesting the City of Hamilton to match the Trust's commitment. The total funding under the notice of motion format would equal $2 million dollars from each of these two partners. Contributions of $500 k from the HCA land acquisition fund and $250 k from the Hamilton Conservation Foundation were suggested at the April 3, 2014 HCA Board meeting.

Chris stated that the $2 million contribution from the City was approved at City Council the previous evening. The funds will go toward acquisition of land from willing sellers and may take the form of one large conservation area, or a complex of land parcels. Within the new conservation lands, the focus of the HCA will be environmental enhancements, surface water management and wetland creation. Chris added that the project meets all 5 strategic directions of the HCA 5 Year Strategic Plan. Documents are to be signed with Heritage Green in October, 2014.

10. OTHER NEW BUSINESS

10.1 Webster's Falls Staircase

Chris informed the members that there is still a desire amongst the community for a staircase to the lower falls and for a trail connection from Greensville to Dundas as was requested in the Webster's Falls/Spencer Gorge Master Plan. The issue of concern is that there is currently no pedestrian linkage to Dundas through the CN overpass on Highway 8. The HCA is ready to replace the staircase, but has been is awaiting the results of the Highway 8 Improvements Environmental Assessment being completed by the City of Hamilton prior to making a final decision on the matter.

10.2 Hermitage Ruins

Chris informed the members that last week the HCA Board of Directors rescinded the previously-approved approach for the ruin restoration and adopted a new proposal to work with a team of local citizens and Councilor Lloyd Ferguson. The proposal put forward was for a new construction process that would see a dismantling of the entire building, a new foundation constructed and the existing structure re-built to its current state. The structure would be self-supporting. The HCA will provide funding of the $200,000 already budgeted, the City will provide $200,000, and the remainder will come from public donations. To date, $75,000 had already been raised. The proposal will go to General Issues Committee at the City of Hamilton on September 17, 2014.

10.3 E-Bikes

Duke asked about the issue of e-bikes that had been raised at a previous meeting. This item was deferred until the October meeting.

10.4 Deer Harvest for 2014 - 2015

Duke also asked if the plans for the deer harvest for 2014/2015 were coming to CAB in the near future. Chris stated that the plan will go directly to the Board of Directors in November. The plans for 2014/2015 include few changes from last year other than possible minor date and/or harvest number changes.

11. NEXT MEETING

The next meeting of the CAB is scheduled for Thursday, October 9, 2014 at 7:00 p.m.

12. ADJOURNMENT

On motion, the meeting was adjourned.

Hamilton Conservation Authority

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Memorandum

TO:	**Conservation Advisory Board**
FROM:	**Chris Firth-Eagland, Chief Administrative Officer (CAO)**
RECOMMENDED BY:	**Tony Horvat, Director of Land Management**
PREPARED BY:	**Sandy Bell, Manager of Design & Development**
DATE:	**October 30, 2014**
RE:	**E-bike Policy on HCA Lands Update**

BACKGROUND

At the September Board of Directors meeting, staff were requested to bring back an update on e-bike use on HCA lands.

The HCA adopted an interim policy in 2008 for e-bike use on HCA lands when e-bikes started to become more popular in use. Staff brought forward a further report in 2010 after the Ministry of Transportation completed their three-year e-bike pilot project in 2009 and approved regulations for e-bike use in Ontario.

An e-bike is a power-assisted bicycle equipped with an electric motor whose power output does not exceed 500 watts and is incapable of providing further assistance once it attains a speed of 32 kilometres per hour. It must have functional pedals that power the bike without the assistance of the motor and riders must be at least sixteen years of age and wear a helmet. No license or insurance is required.

Although there is one set of criteria for e-bikes under provincial and federal regulations, there are essentially two types of e-bikes on the market in Canada. The one looks similar to a conventional bicycle (e-bike) while the other looks like a scooter or motorcycle (e-scooter). In Ontario, they operate as a bicycle under the Highway Traffic Act.

The policy HCA has been operating since 2008 is that the conventional style e-bikes are permitted on the multi-use trails in our parks. The e-scooters are not permitted on our multi-use trails due to the fact their greater size and weight is a safety concern. There is also a low level of acceptance of the e-scooters by the other trail users potentially

leading to confrontations. This approach is consistent with many municipalities and agencies that have significant trail resources.

STAFF COMMENT

While we all see greater use of e-bikes on the urban roads, the HCA park superintendents have not seen a great deal of increased usage or problems on our multi-use trails. It appears much of the increased e-bike use is related to a transportation focus rather than as a recreational use. Only the occasional e-scooter needs to be informed of the HCA's policy. While speed of bicycles is a constant issue on our busiest multi-use trails, almost all of that is with human powered bicycles.

The City of Hamilton is wrestling with concerns and complaints over e-bikes and e-scooters as is the City of Burlington, City of Toronto and others. Many of the issues relate to their use on City roads, bike lanes on the street, dedicated bikeways, sidewalks as well as multi-use trails. Existing traffic and park by-laws do not adequately cover these emerging forms of transportation. Conflicting feedback from the public make the development of city-wide strategies for e-bikes contentious but the need is recognized by the municipalities.

The HCA certainly encourages the use of alternate forms of transportation and devices that improve accessibility to our green spaces. This policy on e-bikes does not apply to mobility scooters and motorized wheelchairs which are permitted on any of our accessible trails and facilities.

While the HCA recognized the need for an interim policy on e-bikes on its lands and trails, it was viewed that we should wait for the City of Hamilton to establish guidelines for the overall use of e-bikes in the community. There are a number of multi-use trails that operate in a seamless manner connecting City and HCA park lands. Staff are of the opinion that the interim policy works from our current management perspective and that is should remain in place until more specific regulations or bylaws are established by the City.

STRATEGIC PLAN LINKAGE

The initiative refers directly to the HCA Strategic Plan 2014-2018:

- **Strategic Goal #3 – Conservation Area Experience**

  The HCA provides customers high quality, diverse conservation area to promote outdoor recreation, health and well-being, strengthening public awareness of the benefits of being in or near our conservation areas.

- Strategic Objective – Maintain and conservation area infrastructure and natural heritage features within the context of approved master plans.

AGENCY COMMENTS

Not applicable.

LEGAL/FINANCIAL IMPLICATIONS

Not applicable.

CONCLUSIONS

Continuation of the interim e-bike policy on the HCA lands and trails is recommended until further rules and regulations are established by the City of Hamilton.

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

Report

TO:	**Conservation Advisory Board**
FROM:	**Chris Firth-Eagland, Chief Administrative Officer**
RECOMMENDED BY:	**Scott Peck, Director, Watershed Planning & Engineering**
PREPARED BY:	**Jaime Tellier, Conservation Planner**
DATE:	**October 31, 2014**
RE:	**Waterfalls & Cascades of Hamilton Research & Inventory Report, 3rd Edition**

STAFF RECOMMENDATION

THAT HCA staff recommends to the Conservation Advisory Board:

THAT the Conservation Advisory Board receive and recommend to the Board of Directors the approval of the *Waterfalls & Cascades of Hamilton: Research and Inventory Report, (3rd edition),* and further

THAT once approved, a limited number of reports be printed for free distribution among project partners, educational institutions and libraries, and be archived as a reference document on HCA, partner and City of Hamilton websites.

BACKGROUND

In 2004, Joe Hollick, Waterfalls Enthusiast and Joan Bell, former Manager of Grants and Special Projects decided that a scientific method was needed to establish a consistent and accurate inventory of waterfalls if the City intended to market waterfalls as a visitor attraction or claim to be “The City of Waterfalls”.

HCA agreed and a proposal was written for a research study, with the goals to establish a set of criteria for identifying and examining Hamilton waterfalls, to inventory each waterfall, and to evaluate and rank these falls from a visitor attraction perspective.

A Waterfalls Project Advisory Team (WPAT) was assembled with waterfall enthusiasts and key agencies represented for the purpose of guiding the research and implementing its recommendations. Agencies included were the Hamilton Conservation Authority (HCA), the Corporation of the City of Hamilton, the Bruce Trail Conservancy and local Iroquoia Club, the Hamilton Naturalists' Club and Tourism Hamilton.

The project team met four times a year to review and approve newly identified waterfalls, discuss new projects and receive progress updates. The HCA hosted and supported the WPAT, with assistance provided by the Planning, Marketing, and Land Management Departments; it was chaired by Joan Bell. The first study was written by Nadeem Paracha, Waterfalls Project Planner, and published in May, 2005.

When the *Waterfalls and Cascades of Hamilton: Research & Inventory Report* was completed in 2005, sixty-five (65) waterfalls were recognized in the City of Hamilton as meeting the criteria of a waterfall, as defined for the purpose of the report. It defined, classified, described and ranked sixty-five (65) Hamilton waterfalls and two (2) Burlington waterfalls, and identified key issues and recommendations for action by the team members and their parent agencies. The study was subsequently presented and approved by the HCA Board of Directors, City Council, Tourism Hamilton Board, Iroquoia Bruce Trail Club Board and Hamilton Naturalists' Club.

Between 2005 and 2007, an additional thirty-one (31) new waterfalls were identified within the City of Hamilton's limits. In order to maintain up-to-date information on Hamilton's waterfalls for the Waterfalls Project Advisory Team, it was decided that an update to the 2005 edition of this report was needed.

In 2007, a second edition of the report was completed by Elizabeth Berestecki, HCA Planning staff. In addition to thirty-one (31) new waterfalls within the City of Hamilton, two (2) additional waterfalls were found on the outskirts of the City, within the City of Burlington. This brought the total waterfalls within the Hamilton area to one-hundred (100).

The 2005 report provided the methodologies to define, locate, and rank Hamilton's waterfalls, in addition to providing recommendations to the Waterfalls Project Advisory Team regarding Hamilton's waterfalls, including the Hamilton Waterfalls, Escarpment Open Space and Trails Access Enhancements – Multi-Year Plan by the City, HCA and Iroquoia Bruce Trail Club. The three partners met bi-annually to plan for and report on progress for the plan to upgrade access to select waterfalls on public land and the Bruce Trail.

In the 2007 edition, a ranking method was developed to rank each waterfall. The report determined a standardized ranking score for each waterfall as it related to visitor access, waterfall magnitude and overall potential visitor attraction. This allowed for comparisons of each waterfall to one another as well as classifying the waterfall as having Excellent, Good or Satisfactory potential for attracting visitors.

Reference copies of the second edition were supplied to Hamilton Public Libraries, one in each community, and McMaster and Mohawk College libraries. All project team members were provided a copy of each report and an electronic copy of the Access database for use by the team representative and the GIS staff at the Bruce Trail Conservancy and City of Hamilton.

A website and electronic database were also developed to complement the second edition of the report. The website was developed, and is to be maintained, jointly by City IT and HCA Marketing and Communications staff. Other websites have included content developed through the research and inventory report, including the Hamilton Naturalists' Club, Giant's Rib Discovery Centre and the Hamilton City of Waterfalls websites.

The City, HCA and Iroquoia Bruce Trail Club continued to meet bi-annually to update the Hamilton Waterfalls, Escarpment Open Space and Trails Access Enhancements Plan and to plan for and report on progress toward upgrading access to select waterfalls on public land and the Bruce Trail.

In the years following the second edition of the report, an additional forty-nine (49) new waterfalls were located within the City of Hamilton's limit and one (1) additional waterfall was found just outside the City, within the City of Burlington. It was decided that a third edition of the waterfalls report would be produced to include the newly identified waterfalls.

In September, 2014 the third edition Research & Inventory Study was completed by Jaime Tellier, HCA planning staff; it included data and analysis for 145 Hamilton waterfalls and 5 Burlington waterfalls. The above-mentioned content and statistical methods, developed for the first and second editions, were retained for the third edition of the report and applied to the new waterfalls. The total number of waterfalls within the Hamilton area is now one-hundred and fifty (150).

STAFF COMMENT

This is the final version of the Waterfalls and Cascades of Hamilton Research and Inventory Report. It has been reviewed by the members of the Waterfall Project Advisory Team. The Team has achieved a number of the goals originally set out for the initiative. Ten years have passed since the Project Team began to work together. It is appropriate to review the team's accomplishments and the actions recommended in the Waterfalls Report in order to finalize the work of the Waterfalls Project Team and plan for future commitments.

HCA is committed to maintaining our existing waterfalls-related promotional materials in web-based format, specifically the hiking and cycling guides. Moving forward, effort will be put toward developing online mapping and maintaining the website rather than continuing to develop and/or update print materials.

HCA staff continues to work with the project partners to implement recommendations put forward in the *Waterfalls & Cascades of Hamilton: Research and Inventory Report (3rd Edition)* related to site access and enhancements, with a focus on the most prominent, publically accessible waterfalls.

Reference copies of the third edition will be supplied to Hamilton Public Libraries, one in each community, and the McMaster University and Mohawk College libraries. All project team members will be provided a copy of the report. An electronic version of the Research and Inventory Report will only be available to City Public Works, GIS and IT staff; BTC GIS staff, and HCA Planning, Land Management & GIS staff for their non-commercial use.

An electronic Hamilton Waterfalls Access Database, which contains 150 waterfall datasheets (145 Hamilton, 5 Burlington), is housed in the HCA Planning department and will be treated similarly to the Nature Counts: Natural Areas Inventory database, which means it is available for research purposes in our main office. To research in-house is free of charge. A planning fee will apply for printed copies i.e., for planning consultants, university researchers, book authors, etc. An electronic copy of the Access database is also housed at the City of Hamilton to populate the website with waterfalls information.

STRATEGIC PLAN LINKAGE

The initiative refers directly to the HCA Strategic Plan 2014-2018:

- **Strategic Goal #2– Natural Heritage Conservation**
    - Strategic Objective – Maintain and enhance a natural heritage inventory
    - Strategic Objective – Promote the value of natural heritage lands on private and public property.
    - Strategic Objective – Maintain and enhance the natural heritage features of HCA lands and manage these lands on an environmentally sustainable basis.

- **Strategic Goal #3 – Conservation Area Experience**
    - Strategic Objective – Maintain and enhance conservation area infrastructure and natural heritage features within the context of approved master plans.

- **Strategic Goal #4 – Education and Environmental Awareness**
    - Strategic Objective – Maintain and enhance the education programs and infrastructure relating to natural and cultural heritage.
    - Strategic Objective – Collaborate with agencies and organizations to promote the importance and value of the watershed environment.

AGENCY COMMENTS

The Bruce Trail Conservancy, City of Hamilton, HCA and Royal Botanical Gardens are identified as having a continued role in the implementation of recommendations, related to site access and enhancements, put forward in the *Waterfalls & Cascades of Hamilton: Research and Inventory Report (3rd Edition)*.

Marketing and Communications staff from City of Hamilton (Information Services, Tourism & Culture Department), Giant's Rib Discovery Centre, Hamilton Naturalists Club, HCA, and Royal Botanical Gardens will coordinate messaging, on an as needed basis, related to the promotion of waterfalls.

LEGAL/FINANCIAL IMPLICATIONS

The financial implications of this recommendation include the costs for printing copies of the report. $3000.00 has been included in the 2014 budget for this cost. There are no future costs forecast for this project.

CONCLUSIONS

Enclosed is a copy of the *Waterfalls & Cascades of Hamilton: Research and Inventory Report (3rd Edition), 2014.* Much analysis and field research was conducted in order to complete the community mapping, ranking, and datasheets for the 150 waterfalls. Appendices are available separately.

Staff recommend that the report be received and recommend to the Board of Directors for approval of the *Waterfalls & Cascades of Hamilton: Research and Inventory Report, (3rd edition),* and that a limited number of reports be printed for free distribution among project partners, educational institutions and libraries, and be archived as a reference document on HCA, partner and City of Hamilton websites.

Hamilton Waterfalls

Hamilton Waterfalls and Cascades

Research & Inventory Report

Third Edition

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

WATERFALLS & CASCADE OF HAMILTON

Research & Inventory Report, 3rd Edition
FINAL
August 2014

Revised Text and Mapping by

Jaime Tellier

Original Text & Mapping by

Elizabeth Berestecki

Edited by

Joan Bell

Cover Design by

Tricia Leong

Hamilton Conservation Authority

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ACKNOWLEDGEMENTS

The Hamilton Conservation Authority (HCA) wishes to thank the following individuals and organizations for their contribution to this report.

Nadeem Paracha, HCA staff, who carried out the field research and composed the 1st edition of this report (May 2005), establishing the benchmark of 65 waterfalls within an urban municipality of Hamilton's size.

Elizabeth Berestecki, HCA staff, who carried out the field research and composed the 2nd edition of this report (November 2007), establishing the benchmark of 100 waterfalls within and immediately adjacent to the City of Hamilton.

Doug Mallory and Rick Woodworth, HCA staff, who maintain up-to-date HCA data; these individuals also completed the GIS mapping for the 1st edition of this report. The City of Hamilton and the Ontario Ministry of Natural Resources are recognized for providing the base data utilized in the mapping for this report.

A special thanks is given to the Waterfalls Project Advisory Team (2004-2012), outlined on the following page, who provided valuable support, feedback, and guidance to the development of this report.

Joseph Hollick, Phil Armishaw, Bill Crawford, Scott Ensminger, Stephen Head, Robert Nixon, and David Wooton are acknowledged for their enthusiasm for Hamilton's waterfalls and their lifelong hobby of discovering and photographing many of the waterfalls in this report.

The Bruce Trail Conservancy and the Iroquoia Bruce Trail Club are recognized for maintaining a second-to-none trail network from which residents and visitors can view Hamilton's Escarpment parks, vistas, waterfalls and cascades.

The Hamilton Naturalists' Club, Farrell Boyce, and Brian McHattie for stressing the significance of 'geography' to Hamilton's tourism and for being the first to draw attention to Hamilton as the "City of Waterfalls".

Recognition is also given to Ben Vanderbrug, Hamilton Region Conservation Authority (HRCA) General Manager (1966-2002), the Ontario Heritage Foundation, and the City of Hamilton staff and councilors who worked hard to ensure Niagara Escarpment lands and waterfalls were purchased and protected in public ownership many decades ago.

WATERFALLS PROJECT ADVISORY TEAM (2004 – 2012)

2004 – 2012

Steven Barnhart	*City of Hamilton*
Joan Bell	*Hamilton Conservation Authority*
Sandy Bell	*Hamilton Conservation Authority*
Paul Beneteau	*Iroquoia Bruce Trail Club*
Joseph Hollick	*Waterfalls Photographer & Enthusiast & Giant's Rib Discovery Centre*
Carolyn Puddicombe	*Tourism Hamilton*
Klaus Truderung	*Iroquoia Bruce Trail Club*

2008 – 2012

Phil Armishaw	*Waterfalls Enthusiast*
Daryl Bender	*City of Hamilton*
Jordan Fysh	*Green Venture*
Ken Lawday	*Iroquoia Bruce Trail Club*
Meghan Stewart	*City of Hamilton*
David Wooton	*Waterfalls Enthusiast*

2004 – 2007

Betty Blashill	*Hamilton Naturalists' Club*
Bill Crawford	*Amateur Photographer*
Bob Deacoff	*Iroquoia Bruce Trail Club*
Stephen Head	*Waterfalls Enthusiast*
George Hough	*Iroquoia Bruce Trail Club*
Peter McLaren	*Iroquoia Bruce Trail Club*
Robert Nixon	*Waterfalls Enthusiast*
Robert Norman	*City of Hamilton*
Crystle Numan	*Hamilton Naturalists' Club*
Anne Parker	
Dagmar Rudzewitsch	*Hamilton Naturalists' Club*
Glenda Slessor	*Hamilton Naturalists' Club*
Alison Watt	*Bruce Trail Conservancy*

EXECUTIVE SUMMARY

The goals of this study were to establish a set of criteria for examining waterfalls in the City of Hamilton, to inventory each waterfall in Hamilton that met these criteria and to evaluate and rank these waterfalls from a visitors' perspective. This information would then be used to provide updated and consistent information, as well as coordination and guidance, for the Waterfalls Project Advisory Team and their parent organizations so that informed decisions can be made with regard to Hamilton's waterfall visitor potential. This report provides an international benchmark to which others can define or identify a waterfall, as well as, the scientific basis for the City of Hamilton as having 'the most waterfalls of any urban municipality of comparable size in Ontario, Canada, and perhaps the world'. This 3rd edition of this report maintains these goals and purposes while incorporating additional waterfalls found within the City of Hamilton since the publication of the 2nd edition in 2007. This edition reassesses the evaluations and ranks of all of the previously inventoried waterfalls taking into consideration the newly discovered waterfalls as well as evaluates and ranks the new waterfalls using the methodology previously developed for the 2nd edition.

The results of this study can be used as a framework for the Project Advisory Team to fundraise and allocate multi-year capital and operating funds to ensure that the visitor experience is safe and of high quality. This report is a tool which will contribute to Tourism Hamilton's Strategic Plan 2011-2014, as well as the Hamilton Conservation Authority's (HCA), the Bruce Trail Conservancy's, and the City of Hamilton's ongoing outdoor marketing efforts. This information can be used by the Hamilton Conservation Authority, the Corporation of the City of Hamilton, Tourism Hamilton, the Bruce Trail Conservancy, the Hamilton Naturalists' Club and other community and media partners to inform residents, educate children and draw visitors, not only to waterfalls found within the City of Hamilton, but to our Niagara Escarpment parks, the Ontario Greenbelt, the Bruce Trail, the Dundas Valley and Red Hill Valley, and Hamilton's extensive regional trails network.

To be identified as a 'Hamilton Waterfall' and included in this report, a waterfall had to meet the following criteria:

- The waterfall must be located within the boundaries of the City of Hamilton,
- The waterfall must have a minimum vertical descent of 3 metres (10 feet), two exceptions were made where the waterfalls did not meet this criterion but were included because of their aesthetic value and ease of accessibility;
- The waterfall's crest width must be a minimum of 1 metre (3 feet);
- Water flowing over the waterfall must originate from a defined channel, ravine, ditch, swale, creek, stream, river, rock fissure or storm sewer device;
- The waterfall must have some natural component and not be entirely man-made;
- Water must be flowing over the waterfall at least during peak storm events;
- The waterfall must be photographed with water flowing over the rock face;
- Where waterfalls are located on the same watercourse they are identified as separate waterfalls if they were not visible as one unit from a safe location; and
- Where two waterfalls are close to one another but coming from two different watercourses they are identified as separate waterfalls.

All results, interpretations, and conclusions within this report were assembled with the aid of a Project Advisory Team which helped guide HCA staff through the development of this report. This Project Team represented stakeholders from the Hamilton Conservation Authority, the City of Hamilton, Tourism Hamilton, the Bruce Trail Conservancy, the Iroquoia Bruce Trail Club, the Hamilton Naturalists' Club and local waterfall photographers and enthusiasts.

Since the publication of the 2nd edition, *Hamilton Waterfalls and Cascades Research and Inventory Report (2007)*, fifty (50) new waterfalls were documented within the City of Hamilton, bringing the total number of waterfalls within the City to one hundred and forty-five (145). Although one main goal of this study was to identify waterfalls within Hamilton's boundaries, five waterfalls located within the City of Burlington are also noted within this report. These five additional waterfalls are noted as they lie just on the outskirts of Hamilton's boundary, are part of the same creek systems and are within short distances of nearby Hamilton waterfalls thereby forming part of waterfall clusters identified in this study. These waterfalls are not included in the body of this report and they are not part of any statistical calculations completed for Hamilton's waterfalls; however data and photographs for these Burlington waterfalls do appear within the appendices of this report.

Waterfalls within the City of Hamilton were mainly found within the communities of Flamborough (47), Stoney Creek (31), Hamilton (41), and Ancaster (20). The City wards with the highest number of waterfalls within their boundaries were Ward 15 (27), Ward 14 (23), Ward 11 (21), and Ward 12 (19). One hundred and twenty-seven (127) waterfalls were found within the HCA watersheds, with the Spencer Creek watershed containing the most (43). The area with the highest density of waterfalls is the Chedoke Creek watershed, located near Hamilton's city centre, which contains twenty-two (22) waterfalls; eighteen (18) of these border the Chedoke Civic Golf Course & Winter Sports Park. The majority of the waterfalls outlined in this report are a result of the Niagara Escarpment's steep slopes as they flow over the Escarpment's bedrock or near the Escarpment face. Additionally, the majority of Hamilton's waterfalls are located within a 23 kilometre radius of the Highway 403 and Main Street intersection in Hamilton, with the exception of four waterfalls located in the Troy area. The most visible waterfall is Lower Princess Falls which can be viewed travelling on Highway 403 between the Aberdeen Avenue and Lincoln M. Alexander Parkway exits.

The waterfall field surveys gathered valuable information regarding the natural characteristics and visitor accessibility of Hamilton's waterfalls. However, visitor accessibility characteristics (property ownership and difficulty of site access) were found to be the main driving factor when drawing visitors to waterfall sites.

It was found that the average dimensions of Hamilton's waterfalls are 9 metres high by 4 metres wide. The highest and widest waterfalls are both found within the community of Flamborough and within walking distance of one another, Tew's Falls (41 m) and Webster's Falls (30 m), respectively. Although the best time to visit Hamilton's waterfalls is during the spring and fall months, it was found that thirty-seven (37) waterfalls have year-round flow.

Out of all one hundred and forty-five waterfalls reported, eighty-six (86) waterfalls are located on public lands Forty-one (41) of these are located on lands owned by the Corporation of the City of Hamilton. There are thirty-two (32) waterfalls situated on lands owned by the Hamilton Conservation Authority. Other property owners include: Royal Botanical Gardens, Ministry of Transportation, Canadian National Railway, industrial and commercial establishments, and private citizens. Seventy (70) waterfalls are found to be currently inaccessible, meaning they are either on private property in which the Bruce Trail does not traverse, or they are too dangerous to access. Of the seventy-five (75) waterfalls that are currently accessible, twenty (20) have a low degree of difficulty and are accessible by all age groups, including visitors with strollers and wheelchairs. Fifty-two (52) of these waterfalls are accessible by visitors aged 5 to 65 years, and three (3) have a high degree of difficulty and are only accessible by hikers with special arrangements. Additionally there are fifty-four (54) waterfalls that can be viewed from a trail, with twenty-seven (27) of these being visible from the Bruce Trail. On average it takes a visitor 9 minutes and 341 metres to access Hamilton's waterfalls from the roadway or parking area noted in this report.

All one hundred and fifty (150) waterfalls in the Hamilton-Burlington area were ranked on visual appeal of the waterfall and its surroundings (Aesthetics Rank), the awe-factor to the visitor (Magnitude Rank), and current visitor accessibility (Visitor Access Rank). Finally these three ranks were used to develop a standardized numerical ranking score that incorporated both natural waterfall characteristics and visitor accessibility, allowing visitors to compare one waterfall to another. Based on natural breaks in the ranking scores, waterfalls were then divided into three Overall ranks: excellent, good, or satisfactory. All waterfall ranks examine different waterfall characteristics and therefore can be used in isolation or in combination with one another. However, the Overall Ranks will help guide the Project Advisory Team in determining potential visitor attraction to Hamilton's waterfalls.

The Overall Ranking analysis identified eighteen (18) waterfalls within the City of Hamilton as having excellent potential for attracting visitors, forty-seven (47) waterfalls have good potential, and eighty (80) waterfalls have satisfactory potential. In order of Overall Ranking score, those eighteen waterfalls that resulted in excellent potential visitor attraction were: Tew's Falls, Webster's Falls, Devil's Punchbowl Falls, Albion Falls, Felker's Falls, Tiffany Falls, Chedoke Falls, Darnley Cascade, Sherman Falls, Borer's Falls, Lower Princess Falls, Cliffview Falls, Great Falls, Progreston Falls, Lower Chedoke Falls, Westcliffe Falls, Buttermilk Falls, and Scenic Falls.

Overall, this report recommends that HCA, the Corporation of the City of Hamilton, the Bruce Trail Conservancy and the remaining members of the Project Advisory Team work together to improve waterfall access, information and education for those waterfalls that exhibit the most potential for attracting residents and visitors. It is also recommended that this group work to promote and strengthen the image of Hamilton as "A City of Waterfalls". It is undeniable that when the scenic waterfalls are combined with the natural beauty and amenities of Hamilton's waterfront, the Niagara Escarpment, Royal Botanical Gardens, the Dundas Valley, parklands, and regional trails, Hamilton has great potential as an active outdoor and nature-based tourism destination.

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1 INTRODUCTION

This section provides the reader with background information regarding the City of Hamilton, the Niagara and Eramosa Escarpments, waterfall formation and classification, Hamilton's waterfalls, previous editions of this report, the definition of a waterfall, and the purpose of this study.

1. 1 City of Hamilton

The City of Hamilton is a rare marriage of topography and human settlement. Hamilton is only one of a handful of urban centers in North America that is geographically tiered as well as situated on a bay large enough to serve as an international port. These unique natural characteristics have contributed greatly to the development of Hamilton's distinct regional character and heritage. The City of Hamilton has a wealth of parks, long distance trails, historic sites, waterfront landscapes and scenic city-wide views.

The area in which the City of Hamilton is now situated was first surveyed in 1788 and was then named The Head-of-the-Lake, for its location at the western end of Lake Ontario (City of Hamilton, 2006). The first plan of the town was set out around 1820 by a man named George Hamilton (1788-1836), and in 1833 the area was aptly called the Town of Hamilton, until thirteen years later when Hamilton became a city (City of Hamilton, 2006). In 2001 the *new* City of Hamilton was formed and incorporated the old City of Hamilton, as well as the constituent municipalities of the former Regional Municipality of Hamilton-Wentworth. The amalgamated City of Hamilton consists of six former cities, towns and townships: the Town of Dundas, the Town of Ancaster, the Township of Flamborough, the Township of Glanbrook, the City of Hamilton, and the City of Stoney Creek. These former municipalities are referred to in this report as Hamilton's 'communities'.

Hamilton Harbour has been used as a major port of entry to the western end of Lake Ontario for over two hundred years and is located at the north end of the City. Cootes Paradise is connected to Hamilton Harbour as a coastal wetland and is designated by the Ministry of Natural Resources as a provincially significant wetland. This wetland is home to the largest fish spawning habitat for all of western Lake Ontario and is managed by the Royal Botanical Gardens.

Designated by the United Nations as a World Biosphere Reserve, the Niagara Escarpment divides the City. In addition to providing refuge to wildlife habitat, natural heritage sites, clear coldwater streams, wetlands, rolling hills, and caves, the Niagara Escarpment is also home to agricultural lands, recreational areas, and historic sites. On the tablelands of the Niagara Escarpment, in the southern area of Hamilton there is a smaller escarpment, called the Eramosa Escarpment. This Escarpment also provides for a unique landscape. For example, the Eramosa Karst, a provincially designated Area of Natural and Scientific Interest, is a feature of the Eramosa Escarpment in which a wide variety of karst features have been identified, including sinking streams, dolines, springs and caves. As a result of Hamilton's diverse landscape, the City has attracted outdoor enthusiasts; these enthusiasts provide a good base for an ever-growing outdoor and eco-tourism market. Hamilton's outdoor activities include birding, cycling, hiking, camping, fishing, boating, skiing, and environmental education for all ages.

1. 2 Niagara and Eramosa Escarpments

The Niagara Escarpment is a fascinating landform that serves as one of the key ecological linkages within the City of Hamilton and provides shelter to some of the rarest species in all of Ontario. As a result, in 1990 the United Nations declared this natural feature a World Biosphere Reserve. Many inter-relationships have created this unique environment; two of the most significant, the geology and ecology, are described in the following sub-sections. The Eramosa Escarpment, also a significant geologic formation, runs parallel to, and about 1 km south, of the brow of the Niagara Escarpment. It is morphologically similar to the Niagara Escarpment however, it is much smaller in height (no more than 10 metres) and its crest is only occasionally defined by cliffs, which are no higher than 3 metres (Ontario Ministry of Energy and Infrastructure, 2008). The significance of the ecology and geology of this feature are also described in the subsections below.

1. 2. 1 Geology

The Bruce Trail Conservancy (2006) describes the geological history of the Niagara Escarpment as dating back to over 450 million years ago when a collision in the plates of the Earth's crust formed the Appalachian Mountains on the east coast of North America. Over time fast-flowing rivers from the east deposited eroded sediment into a shallow sea centred in what is now known as Michigan State. This sea was situated in a low lying depression known as the Michigan Basin. As these sediments were deposited they gradually hardened to form the red shale and sandstone which today forms the base of the Escarpment. Approximately 25 million years later the sea rose and flooded to form a warm, clear ocean where coral reefs flourished. As these marine organisms died their calcium-rich remains sank to the bottom of the ocean and were compressed into layers of limestone. 415 million years ago, the Earth's crust again repositioned causing the Michigan Basin to rise which in turn reduced the ocean to a shallow sea with high concentrations of salt and magnesium. When the limestone at the bottom of the sea absorbed the magnesium-rich water a chemical reaction occurred forming a harder, erosion-resistant rock known as dolostone. This dolostone today forms the cap-layer of the Niagara Escarpment. Over the next 100 million years this shallow sea receded uncovering a flat plain, vulnerable to erosional processes. As time passed, the formation of large rivers eroded the weaker shale underlying the stronger dolostone causing large blocks of dolostone to break off creating a vertical rock face (pp. 11-1 to 11-2). This erosional process is known as sapping (Figure 1).

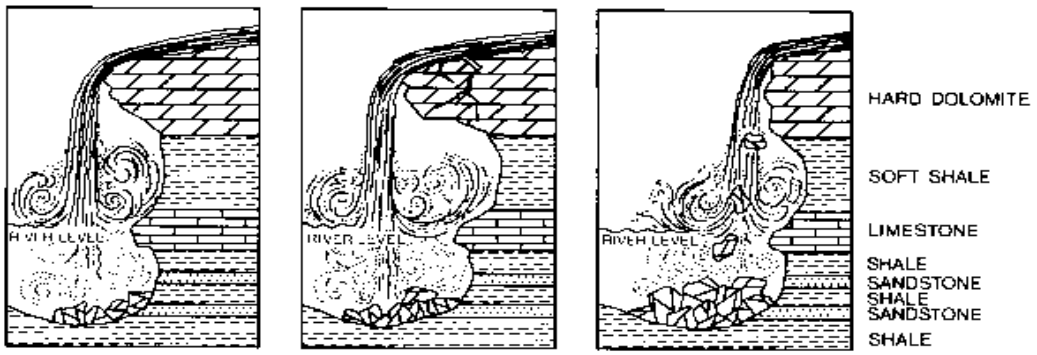

Figure 1: Process of sapping
Source: Tovell (1992)

Within the past 2 million years the Escarpment has been buried four times under 2 to 3 kilometres of ice during glaciation periods, and it was only 12 000 years ago that the last ice age unveiled the Niagara Escarpment (Bruce Trail Conservancy, 2006). Within the Hamilton area the best example of glacier

erosion can be seen in the Dundas Valley. In this region, the glacier slowed as it collided with the Escarpment. Then as the glacier retreated hummocky moraine was deposited and the Dundas Valley was formed (Benn & Evans 1998). Hall (2006) describes this type of moraine as exhibiting steep slopes, deep enclosed depressions, and meltwater channels. These are all characteristics that are today apparent within the Dundas Valley.

The Eramosa Escarpment also consists of sand and mud made of calcium carbonate that was converted into dolostone and uncovered by glaciation (Middleton, Eyles, Chapple and Watson, 2009). It is a small erosional escarpment developed in a distinct geologic unit identified as the Eramosa Member. This Member is the uppermost component of the Lockport Formation, the great sequence of resistant dolostones that form the Niagara Escarpment. The Eramosa Member around Stoney Creek was eroded back from the main Escarpment by glacier ice flow from the north and now forms a low, subsidiary scarp situated up to 2 kilometres south of it. Typically, it has a relief of 10 metres or less. A wide variety of karst features have been identified in the Eramosa Karst, including sinking streams, dolines, springs and caves (Buck, Worthington and Ford, 2003).

Since glaciation, Hamilton's Escarpments have since been shaped by erosional processes such as wind, ice, surface water, sapping, and human activities. Evidence of these more recent changes can be seen in the irregularities of the Niagara Escarpment's steep rock face, sheer road cuts to form new transportation links across the City, and karst formations on the Stoney Creek Mountain.

1. 2. 2 Ecology

After the retreat of the glaciers, Hamilton's escarpments, creeks, and watersheds became habitat for a diverse variety of plants and animals. The Niagara Escarpment is one of the most ecologically diverse parts of Ontario due to its many different elevations and exposures to the sun, wind and rain (Pim et al., 1998). The Hamilton Escarpment not only houses those species found along the length of the Niagara Escarpment but also exhibits ecological characteristics of the Carolinian Forest Zone. Most of Hamilton's waterfalls are located within the forested strip of land found along the edge of the Niagara Escarpment. Such areas form either large natural core areas whose extensive forests allow larger species to survive, or are part of an ecological corridor along which species can move.

Within the southwestern part of the Niagara Escarpment small, slow-growing eastern white cedar trees, which cling to the cliffs, have been noted by the Cliff Ecology Research Group at the University of Guelph. Many of these trees are over 1000 years old, with the oldest being 1650 years (Pim et al., 1998). This forest ecosystem along the edge and face of the Escarpment is thought to be the oldest, most intact and least disturbed ecosystem in eastern North America (Bruce Trail Conservancy, 2006). Hamilton's Escarpment is home to part of this old growth forest, with many trees being over 500 years. Some of Hamilton waterfalls are situated very close to these ancient trees. Another rare plant community in Ontario, known as the chinquapin oak-big bluestem rim forest, grows on very dry sites close to some waterfall locations.

Many nationally, provincially and locally rare species of plants and animals are found near waterfalls along Hamilton's Escarpment. Some of the most significant species are: Red mulberry (endangered); American chestnut (threatened); American columbo (species of concern); Louisiana waterthrush (species of concern); Cerulean warbler (species of concern); Acadian flycatcher (endangered); Jefferson salamander (threatened); and Eastern milk snake (species of concern).

In addition to the terrestrial ecology of the Escarpment, the waters tumbling over the rock face forces air into the creek below, which is very important in supporting aquatic ecosystems. This form of oxygenation is also found in karstic features along the Niagara Escarpment.

The Eramosa Karst, a feature attributed to the Eramosa and Niagara Escarpments is situated on the Stoney Creek Mountain in the eastern end of the City of Hamilton. Although the ecology of the Eramosa Karst has yet to be studied, many karstic features, such as underground caves and conduits, have been known to support very rare and primitive invertebrate species (Parks and Wildlife Service Tasmania, 2007).

1. 3 Waterfalls

Waterfalls are generally formed where a watercourse must flow over a sudden drop in elevation to reach a larger waterbody. This sudden drop can occur if there has been recent crustal activity, if fluvial erosion has caused a change in elevation, or if glaciers have created a change to the natural landscape.

Strahler & Strahler (1992) explain the life of a waterfall in four phases: 1) a steep gradient portion of a watercourse forming a waterfall; 2) the waterfall is cut back into the bedrock due to increased erosion; 3) in time waterfalls are transformed into rapids; 4) erosion of rapids reduces the gradient to one that is similar to the overall stream system. Depending on the type of bedrock on which the watercourse flows and the seasonality of the waterflow, the stream will eventually change in elevation to produce a graded stream. A graded stream is one that gradually changes in elevation, and at the very least contains meanders and a floodplain; ultimately, a stream that has achieved equilibrium within its surroundings.

Tovell (1992) describes the stream networks of the Niagara Escarpment watersheds flowing through three major zones. These three zones are described below:

Headwater Zone	This zone extends well upstream from the transfer zone and is the source of water downstream. This water is slowly released to form stream systems.
Transfer Zone	This zone begins at the top of a steep gradient and ceases where the gradient decreases as the stream approaches the valley floor. Where water flows over the transfer zone, picturesque waterfalls are formed. This essentially is the Escarpment brow.
Zone of Deposition	This zone begins where the transfer zone ceases and consists of the low gradient area at the bottom of the waterfall and in turn creates a floodplain. This is the area below the Escarpment brow.

1. 3. 1 Formation of Hamilton's Waterfalls

There are two laws of nature which establish the basis of waterfall formation in Hamilton. The first law is that water will always find the path of least resistance. The second law is that water will always travel towards a larger waterbody (i.e. larger stream system, lake, or ocean).

Hamilton's waterfall headwater zone extends well upstream of the Escarpment and into the Escarpment upland. In this zone, water from precipitation is retained in swamps and ponds and in porous sediments and soils as groundwater. The water is released from these natural reservoirs as small trickles and springs that gather into small channels which then combine to form larger creeks and streams. The channel gradient in this zone is low. The transfer zone begins at the edge of the Niagara Escarpment or where there is another steep gradient such as the Eramosa Escarpment. This gradient is reduced abruptly as the

stream approaches the valley floor. The zone of deposition for Hamilton's waterfalls remains at the base of the waterfall. This may be the base of the Niagara Escarpment or it may be the base of another natural or man-made landform.

As a result of Hamilton's unique geographical location, the majority of Hamilton's waterfalls are a function of the Niagara Escarpment. The City of Hamilton lies on the shores of Lake Ontario with the Niagara Escarpment running parallel to the shoreline. The streams and surface runoff take the least resistant path and flow down the Escarpment towards Lake Ontario. In Section 1. 2. 1 the formation of the Niagara Escarpment was discussed and the process of sapping was explained (Figure 1). The sapping process works to create slope stability in the Niagara Escarpment and in turn creates steep cliffs. Another common characteristic of the Niagara Escarpment is talus slopes. Talus is rock that has fallen from the rock face and lies at the bottom of the cliff. Where the talus is abundant the steep rock face could be veiled by the talus slope and as a result cause a gradual sloping surface rather than a steep rock face.

Other waterfalls within Hamilton are either a result of anthropogenic practices or due to local geomorphology. For example, some waterfalls are formed as streams flow over the Eramosa Escarpment, some of which flow toward the Grand River and Lake Erie and others toward the Niagara Escarpment and Lake Ontario. A waterfall may also be formed due to the release of water at a man-made dam which was created to reduce flooding downstream. Alternatively a waterfall could be formed as a result of erosion. For instance, where a stream channel has eroded a valley and steep valley walls are present then there is potential for any other stream flowing into valley to form a waterfall.

1. 3. 2 Definition of a Waterfall

Much research was done to determine if a standardized definition for a waterfall existed. However, it soon became apparent that there was no single international standard, definition, or criterion used to identify a waterfall. All waterfall sources however have mentioned the height of a waterfall as one of the most important factors, but unfortunately there is no agreement on a specific height that differentiates a waterfall from a rapid.

For the purpose of this report the following general criteria have been used to define and identify a waterfall within the City of Hamilton. This set of criteria was the result of the cooperative effort between HCA staff and the Project Advisory Team:

- The waterfall must be located within the boundaries of the City of Hamilton,
- The waterfall must have a minimum vertical descent of 3 metres (10 feet), two exceptions were made where the waterfalls did not meet this criterion but were included because of their aesthetic value and ease of accessibility, these were classified as 'Other';
- The waterfall's crest width must be a minimum of 1 metre (3 feet);
- Water flowing over the waterfall must originate from a defined channel, ravine, ditch, swale, creek, stream, river, rock fissure or storm sewer device;
- The waterfall must have some natural component and not be entirely man-made;
- Water must be flowing over the waterfall at least during peak storm events;
- The waterfall must be photographed with water flowing over the rock face;
- Where waterfalls are located on the same watercourse they are identified as separate waterfalls if they were not visible as one unit from a safe location; and
- Where two waterfalls are close to one another but coming from two different watercourses they are identified as separate waterfalls.

1. 3. 3 Classification of Waterfalls

Erosional processes, in conjunction with local geology, create different waterfall characteristics in which one can determine specific waterfall classifications. If you consider the process of sapping (Figure 1), this process can result in an 'overhang' waterfall since the erosion-resistant rocks create an overhang in which the waterfall has no contact with the bedrock surface. However, once this erosion-resistant bedrock weakens and tumbles below, the waterfall shape may change to create a 'plunge' or 'horsetail' waterfall.

For the purpose of this report each waterfall was put into three classes depending on its 'type', 'dimension', and 'form'. Since many waterfalls exhibit characteristics of more than one classification type, only the most dominant characteristic is noted in this report. The following definitions were used to classify each waterfall into the three above-noted classes, and have been drawn from waterfall glossaries of both Scott A. Ensminger (2007) and World Waterfalls (2007).

TYPE

Waterfall Any sudden descent of a stream over a very steep slope or precipice in its stream bed. Characterized by the stream dropping vertically, or very nearly so.

Cascade The sudden descent of a stream primarily over a very steep slope in its stream bed. Characterized by the stream rushing down the slope somewhat smoothly or in a series of small individual drops, or any combination of these. The steepness of the descent is greater than that of rapids, but less than vertical.

DIMENSION

Classical A waterfall whose height is roughly equal to its crest width. Both of the following must be true: (1) the height divided by 2 is smaller than the crest width; and, (2) the height times 1.5 is equal to or is larger than the crest width.

Curtain A waterfall whose height is notably smaller than its crest width. The following must be true: the height divided by 2 is smaller than the crest width.

Ribbon A waterfall whose height is notably greater than its crest width. The following must be true: the height divided by 2 is equal to or greater than its crest width.

FORM

Complex A single waterfall comprised of several different segments (e.g. overhanging, horsetail, terraced, cascading, etc.). The stream may divide into segments during its descent of the rock face, or the segments may occur side by side along the crest of a waterfall.

Fan A waterfall whose crest width is one third or less of its base width.

Funnel A waterfall whose crest width is over three (3) times its base width.

Horseshoe A waterfall with a crest that is curved or U shaped in an upstream direction.

Horsetail A falls that descends a very nearly vertical rock face, maintaining some contact with it. Horsetail falls cannot be a cascade.

Overhang A waterfall with a distinctly projecting or undercut crest, that creates an air space behind the falling water.

Plunge A single vertical, or very near vertical, fall of water.

Talus Water flowing over a chaotic mix of rock debris on a slope usually found at the base of a cliff or steep incline. Scree is usually the rocks that are smaller than a softball and talus is larger than a softball.

Terraced A waterfall comprised of two or more distinct drops. Each drop is connected with the preceding drop by continuous whitewater, to form a single waterfall. Generally, all of the drops can be seen from a single vantage point.

Twin Two waterfalls found side by side whose crests are separated by an island. The waterfalls can be from the same stream or different streams.

Washboard A waterfall with many small and rather evenly spaced drops.

1. 4 Previous Editions

1.4.1 1st Edition

The *Waterfalls & Cascades of Hamilton: Research & Inventory Report (May 2005)* was the 1st edition of this report. The goal of the 2005 edition was to create an inventory of waterfalls within the City of Hamilton, to provide a summary of research findings, to rank these waterfalls, and to offer recommendations about future initiatives in order to provide coordination and guidance to the Project Advisory Team and their parent organizations. Information was based on research, field surveys, discussion with waterfall enthusiasts, and input from the Project Advisory Team.

This 1st edition built on Joseph Hollick's inventory and photography of Hamilton waterfalls. Prior to the 2005 edition Mr. Hollick identified forty-four (44) waterfalls within the City of Hamilton. These forty-four documented waterfalls were visited by HCA staff in early summer of 2004 to record the waterfall location, height, and width, as well as amenities near the waterfall site. At the completion of this 1st edition, twenty-one additional waterfalls were located and recorded, bringing the number of waterfalls in Hamilton to sixty-five (65).

The ranking scheme in the 2005 edition differed from the later editions of this report. On-site and nearby facilities were factored into the 2005 ranking, however were removed from the 2007 and current analyses due to the subjective nature of these characteristics. It was recommended that the facilities in and around a waterfall site should not determine how magnificent a waterfall is deemed considering these amenities can be suited to the waterfall during the waterfall site development. Additionally the 2005 edition used characters to rank the waterfall, however to strengthen the validity of the analysis, the 2007 and current editions used a numerical ranking scheme and then transformed these rankings into character data to be consistent with the 1st edition.

The researcher used geo-spatial techniques to determine locations of waterfalls not yet discovered; including ortho-rectified digital aerial photography, in conjunction with digital topographical contour intervals. All mapping produced for the 1st edition was generated using Manifold System 6.00 GIS software with the exception of the site maps in the datasheets, which were produced using Autodesk's AutoCAD Map 5.

Additionally the 1st edition of this report provided recommendations on waterfall project planning, sustainable tourism potential, capital improvements and site enhancements, and marketing and promotion. This information has been used by the Project Advisory Team and as result a 5-year Site Planning Schedule, including cost estimates, has been developed. These recommendations have not been included in the body of this report but can be found within Appendix A.

1.4.2 2nd Edition

The *Hamilton Waterfalls and Cascades: Research & Inventory Report (November 2007)* was the 2nd edition of this report. The goals of the 2007 edition were to establish a set of criteria for examining waterfalls in the City of Hamilton, to inventory each waterfall in Hamilton that met these criteria and to evaluate and rank these waterfalls from a visitors' perspective. This information would provide updated and consistent information, as well as coordination and guidance, for the Waterfalls Project Advisory Team and their parent organizations so that informed decisions can be made with regard to Hamilton's waterfall visitor potential. The intent is that the Project Advisory Team members will work together to improve waterfall access, information and education for those waterfalls that exhibit the most potential for attracting residents and visitors.

The 2nd edition of this report built on the 1st edition, *Waterfalls & Cascades of Hamilton: Research & Inventory Report (May 2005)*. At the completion of the 1st edition, sixty-five (65) waterfalls were located within the City of Hamilton and recorded in the waterfalls inventory. In 2006 and 2007 an additional thirty-one (31) waterfalls were submitted to HCA to be inventoried by HCA staff and included in the subsequent edition of the Report. The 2nd edition of the report, published in 2007, lists a total of ninety-six (96) waterfalls within the City of Hamilton.

Data analysis in the 2005 edition of this report differed slightly from the 2007 edition of this report. Similar methods were utilized in the 1st edition of the report, with the main difference being those used to determine waterfall ranks. Where detailed methods are not noted in this section the same procedures were utilized for all editions of the report (see Section 2. 3). Data analysis methods used in the 2nd edition were also replicated for this most recent edition of the report.

For the 2nd edition, ESRI's ArcExplorer 2.0 GIS viewing software and TatukGIS 2.0 viewing software were utilized to view the geographical information system (GIS) data. Top-of-bank property ownership for proposed waterfall sites was determined using the above-noted GIS viewing software. After the field data was collected and transferred to a Microsoft Office Excel 2003 spreadsheet, the accuracy was then verified again using the above-noted GIS viewing software programs. All mapping produced for the 2nd edition was generated using Manifold System 6.00 GIS software.

1. 5 Research Question

While the names and photography of Hamilton's waterfalls date back more than a century, research and documentation on how many waterfalls are within the City's limits was not found and the tourism potential of Hamilton's waterfalls was yet to be studied. This study utilizes methodologies that incorporate geo-spatial techniques and geographical field methods to broaden the knowledge of the number of waterfalls within Hamilton and focus on explaining where and how local residents as well as visitors to the City of Hamilton can enjoy these natural features.

The purpose of this report is to provide updated and consistent information, as well as coordination and guidance, for the Project Advisory Team and their parent organizations so that educated decisions can be

made in regards to Hamilton's waterfall visitor potential. The goal of this project is to provide project partners with a waterfall inventory, mapping and ranking, of all known waterfalls within the City of Hamilton. This 3rdnd edition of the report will not only include both the 96 waterfalls identified within the *Hamilton Waterfalls & Cascades: Research & Inventory Report (November, 2007)* but also any new waterfalls found since this second publication. This current report will outline the methodologies used during this 2012 update and describe the results and conclusions of this current report which is meant to be utilized by the Hamilton Conservation Authority (HCA), the Corporation of the City of Hamilton, the Bruce Trail Conservancy, the Iroquoia Bruce Trail Club, Tourism Hamilton, the Hamilton Naturalists' club, and their partners, and treated as an update to the 2nd edition.

This study is divided into two phases: waterfall inventory and waterfall tourism potential. The first phase of this study uses spatial analysis and field research to explore potential locations of undiscovered waterfalls, examines each potential site individually, and records physical waterfall data and site characteristics where waterfalls are observed. It is assumed that the majority of waterfalls found within the limits of the City of Hamilton will be located along the Escarpment brow due to the gradient of this natural feature. The second phase of this study explores the tourism potential for each waterfall using standardized waterfall ranking schemes.

2 APPROACH & METHODOLOGY

A variety of research methods and approaches were used to achieve the objectives of this study. They are described here in detail, along with a description of the data and study area.

2. 1 Approach

The approach used for this study, and which guided the methods following, was one based on the existing reference material, current geographical techniques utilized in field exercises, geo-spatial and cartographic techniques, as well as looking at the project from a visitor perspective. A main component to this study was the fact that stakeholder input was obtained through regular meetings to ensure that well-balanced, unbiased results and conclusions were attained.

The research for this study began with a literature review of information on waterfalls in general and within the Hamilton area. At the forefront of this study, there was scattered information about local waterfalls available in the form of books, websites, maps, photos, and waterfall lists. The resources that proved most valuable and in turn were reviewed in order to provide a framework to this study are listed below in no specific order:

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- Hollick, J. Master list and photographs, 44 waterfalls. Unpublished, 2004.
- Bell, J. et al. "Cascades & Waterfalls of Hamilton." Map brochure. Hamilton: Hamilton Conservation Authority, 2003.

Field work, ortho-rectified digital aerial photography, and mapping techniques were used to accurately locate existing waterfalls, as well as previously undiscovered falls, within the boundaries of the City of Hamilton. Once the location of a proposed waterfall site was determined the ownership of the property was examined to determine site enhancement potential. Where waterfalls were located on private property, permission was sought in order to access the waterfall site to conduct a detailed waterfall survey.

2. 2 Study Area

This study took place within the boundaries of the City of Hamilton, Ontario, Canada. The City of Hamilton is located in Southern Ontario at the western tip of Lake Ontario, strategically located between Toronto and Niagara Falls. Although this study pursued all possible waterfall locations within the City's boundaries, specific attention was paid to the areas along and within close vicinity to the Niagara Escarpment. It was assumed that waterfall discovery through this study would occur along the Escarpment brow due to the gradient of this landform, and due to the fact that the majority of Hamilton's previously identified waterfalls were located along this natural feature. For the 3rd edition, the study area

was broadened to focus on areas along the Eramosa Escarpment, as research confirmed that newly discovered waterfalls were attributed to this landform (Figure 2).

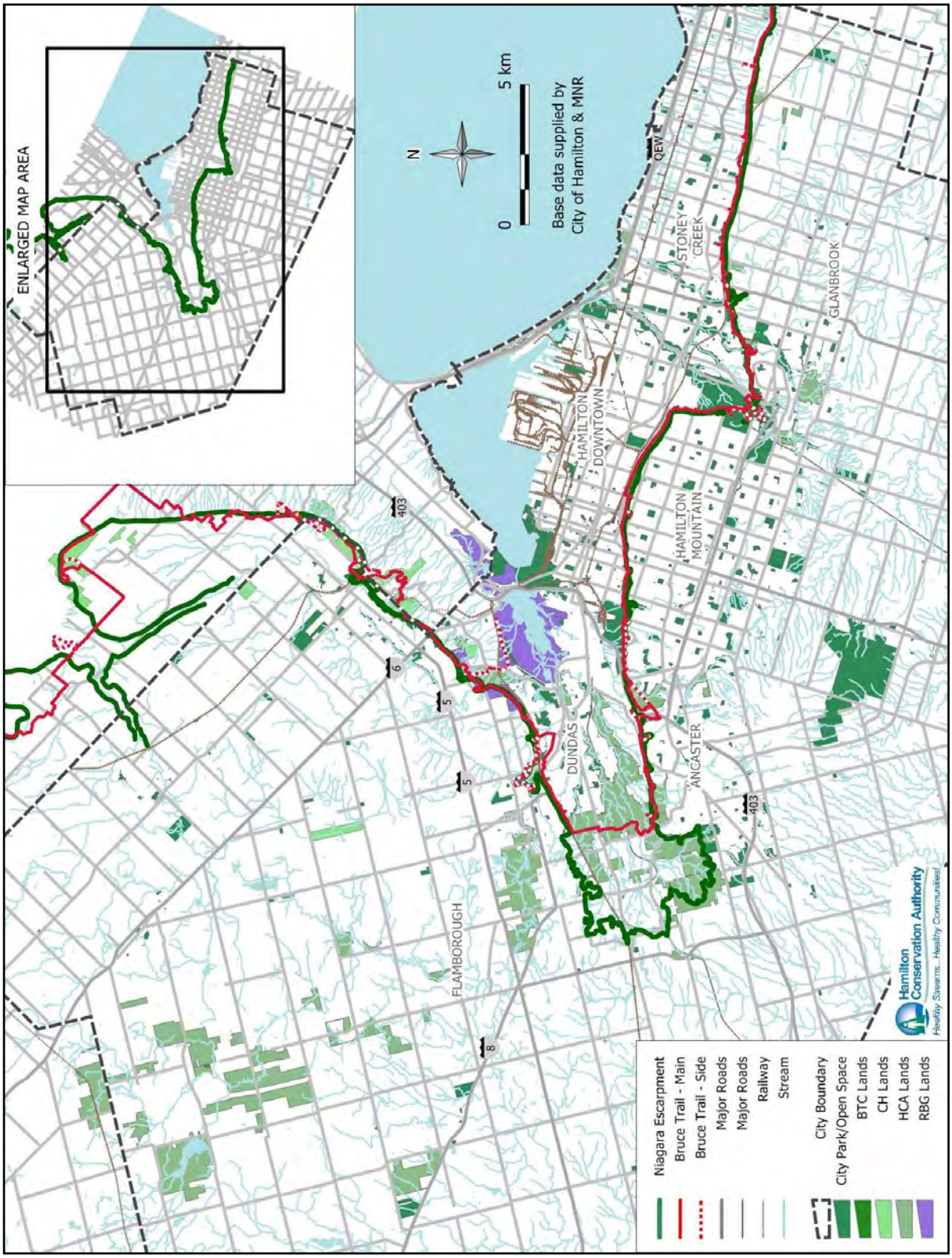

Figure 2: Study Area & the Niagara Escarpment

The study area boundaries reflect the boundaries of the amalgamated City of Hamilton. The City is situated on Hamilton Harbour and Lake Ontario. The City of Burlington borders Hamilton to the north-east, the County of Wellington is to the north-west, the Regional Municipality of Haldimand-Norfolk is located to the south-west, and the Regional Municipality of Niagara is located to the south-east of the study area. The Niagara Escarpment parallels the shoreline of Lake Ontario and at the westerly tip of the lake it travels further inland encompassing the Dundas Valley. There are two major highways that traverse the City. These highways are the Queen Elizabeth Way (QEW) which connects Niagara Falls and the U.S.A. border to Toronto, and Highway 403 which connects the western suburbs of Toronto with Highway 401 just outside of Woodstock to the west.

In 2001, the municipalities within the Regional Municipality of Hamilton-Wentworth amalgamated to form the *new* City of Hamilton. These municipalities included the former City of Hamilton and the City of Stoney Creek, the Towns of Dundas and Ancaster, and the Townships of Glanbrook and Flamborough. This report divides the City of Hamilton into these former municipalities and refers to them as communities, with the former City of Hamilton being known as the community of Hamilton.

The population for the City of Hamilton is 504 559 persons (Statistics Canada, 2006). The following facts are extracted from the 2006 census performed by Statistics Canada as cited within City of Hamilton (2011). These facts were reported here to provide guidance to the project partners when determining the tourism draw within the City and the needs of the local population.

- Population:
  - The City of Hamilton is the eighth largest city in Canada;
  - The City of Hamilton is the fourth largest city in Ontario, preceded by Toronto, Ottawa, and Mississauga;
  - The City experienced a population increase of 2.91% between 2001 to 2006; and
  - The population density of the City of Hamilton is approximately 452 persons per square kilometre.
- Ethnicity:
  - Over 6% of the City's population speaks Italian; Polish, Portuguese and Spanish are the next highest non-official languages spoken in Hamilton; and
  - 25% of Hamilton's population are immigrants, slightly higher than the 24.7% in 2001; and
  - 13.6% of the population are visible minorities an increase of 15,410 from 2001 to 2006.
- Employment:
  - The City's employed labour force increased by 5.6%, while the unemployed labour force increased 6.7% between 2001 and 2006 compared to the previous census cycle when the employed labour force increased by 10%, while the unemployed labour force decreased by 24% between 1996 and 2001.
- Community Statistics:
  - *Population*: The community of Hamilton has the highest population with over 329 820 people living in this area, Stoney Creek has the second highest population, and Flamborough the third highest;
  - Both the communities of Glanbrook and Ancaster showed a significant percentage population change for a combined increase in total population of some 8,895 individuals. Generally, all communities contributed to the growth of the City with the exception of the community of Hamilton showing a slight decline in its overall population but remaining consistent at 329,820.
  - *Densities*: The community of Hamilton has the highest population density with 2 692 persons per square kilometre, Dundas has the second highest population density, and Stoney Creek the third highest.

2. 3 Methods & Data

Three geographical research methods were utilized for this study in order to locate additional waterfalls that would meet this study's waterfall criteria. These methods include spatial analysis using a geographical information system (GIS), field research, and external consultation with local waterfall enthusiasts. Data analyses were conducted in order to gain a better understanding of the data. These analyses included producing a ranking scheme in which all waterfalls can be compared to one another, and performing descriptive statistics on the data. All waterfall data used for the purpose of this study has been stored within a database using Microsoft Office Access 2003 software.

2. 3. 1 Waterfall Discovery

In addition to reviewing the literature and speaking with local waterfall enthusiasts, the researcher utilized geo-spatial techniques to identify possible waterfall locations. Ortho-rectified digital aerial photography (City of Hamilton, 2010), in conjunction with 1 metre digital topographical contour intervals modeled from a Digital Elevation Model (Ministry of Natural Resources, 2002 and 2010 and City of Hamilton 2005 and 2007), were used in order to determine locations of waterfalls not yet discovered. Additionally the most current HCA watercourse layer, Niagara Escarpment layer (City of Hamilton, 1990's), Manifold System 7x and 8x GIS and ESRI's ArcMap 9 software were used for this spatial analysis. Where contours decreased in elevation at a significant rate and a watercourse was present, this location was flagged for closer examination in the field. Furthermore, where streams traversed the Niagara Escarpment but a waterfall was yet to be recognized, again further field work was scheduled.

It was also necessary to hike the Niagara Escarpment to locate any waterfalls which were not yet inventoried, as well as to verify any proposed waterfall sites. The Bruce Trail was used during this field assessment. This trail was hiked from the boundary of the City of Hamilton and the City of Burlington to the boundary of Stoney Creek and the Town of Grimsby between 2005 and 2012. This field research was primarily conducted following a heavy rainfall, or thawing period, in order to locate waterfalls during prime viewing conditions.

For the purpose of the 2005 edition of this report, the same methods were utilized for waterfalls numbered 1 to 65; however different software was used for analysis. See Section 1. 4 for more information.

2. 3. 2 Review of Assessment Records

Once the location of the waterfall was predicted using the methods outlined in Section 2. 3. 1, the next step was to obtain the property ownership information. It was apparent using current public property layers which waterfalls were located on public property, however for private waterfall sites property ownership information was obtained using the following methods. For the purpose of this study waterfall ownership was positioned at the top of the waterfall. The property Roll Numbers were obtained through visualization of the proposed waterfall sites in relation to the Teranet Inc. property parcel layer, current as of 2012, using Manifold System 7x and 8x GIS software and ESRI's ArcMap 9 software. The data was then compared to the Niagara Escarpment layer and the ortho-rectified digital aerial photography noted in Section 2. 3. 1. This information was then sent to the Finance and Corporate Services Department at the City of Hamilton to gain ownership information. Where it was determined that proposed waterfall sites were located on private property, a letter, including a permission slip, was mailed to the landowner in order to gain permission to access the property to conduct a one-time waterfall survey. The landowner

was asked to mail the permission slip back to HCA indicating whether permission was granted to HCA staff. In some cases HCA staff were unable to make contact with the private landowner.

2. 3. 3 Global Positioning System

For each waterfall surveyed in the field, Garmin's eTrex handheld Global Positioning System (GPS) was used to record the geographic coordinates in the Universal Transverse Mercator Geographic Coordinate System (UTM) using North American Datum 1983 (NAD83). This device had a minimum spatial accuracy to 5 metres, which was dependant on the tree canopy or cloud cover at the site. The coordinates of nearby major structures and intersections were also taken to confirm the waterfall location. For those waterfalls in which a field survey was not possible see Section 2. 3. 4.

2. 3. 4 Waterfall Survey

Waterfalls located on public property, and those waterfalls in which private landowners granted permission to access their property, were visited to survey the height and width, the distance and time from the nearest access point, the ease of access to the waterfall site, the environ and waterfall aesthetics, and the facilities in and around the site. Additionally geographic coordinates were collected and photographs were taken. See Section 2. 3. 3 for the methods regarding the acquisition of geographic coordinates.

The height and width of the waterfall was measured with a measuring tape and metre stick, and wherever it was too dangerous to climb the waterfall, a sextant was used to measure the angle. Once the length of the base was known, trigonometric calculations were used to determine the height. Due to the irregular shape and location of some waterfalls, it was very difficult and dangerous to measure the exact height in the field. However, wherever it was possible, each and every waterfall was measured from the top-most bedrock layer at the waterfall's crest to the surface of the water at the base of the waterfall. The seasonality of the waterfall's waterflow was determined through consultation with local waterfall enthusiasts and through previous studies conducted by the Hamilton Conservation Authority and Conservation Halton. Seasonality was broken into three nominal classes: year-round, seasonal, and peak storm events. Where the source of the waterflow was not apparent on the most current HCA watercourse layer, the seasonality was classed as a peak storm event. Those waterfalls fed by watercourses shown on the current HCA watercourse layer were put into the seasonal or year-round seasonality classification. A waterfall was deemed seasonal if it dried up at sometime during the year.

Distance and time figures from the nearest access point (parking lot or roadway) to the waterfall site are approximate as they were recorded using estimated paces and a wristwatch on-site. The visitor's ease of access to the waterfall site was determined by the field researcher and each waterfall was put into one of three nominal classes. The ease of access was determined as follows: easy (accessible by all age groups, including visitors with strollers and wheelchairs); moderate (accessible by ages 5 to 65 years); and difficult (only accessible by hikers with special arrangements). It was also noted if a waterfall was inaccessible (i.e. the waterfall was either on private property in which the Bruce Trail does not traverse, or it was currently too dangerous to access). The means by which a person must access the waterfall site was also recorded. This included: trail access, road access, and off-trail hiking. The means of access was determined by the location of the waterfall's viewing point. If a waterfall could not be viewed from a trail or roadway then it was deemed that the visitor must hike off-trail either part or all of the way to see the waterfall from the access point.

A preliminary aesthetics rank was given to each waterfall during the waterfall survey and was based on the visual appeal of the waterfall's surrounding environment. This waterfall characteristic was determined

on an individual waterfall basis by the field researcher. Ultimately the researcher was looking for a unique or pleasing shape to the waterfall itself in addition to the waterfall's rock formation, landscape features, vistas and scenery around the waterfall. Each waterfall was placed in one of the following nominal classes: very scenic, scenic, or ordinary. These classifications were then confirmed by the Project Advisory Team prior to data analysis.

Site amenities within and nearby each waterfall site were scouted and recorded. Facilities within the waterfall site may be at the waterfall itself, within the park or conservation area that the waterfall resides, or may even include the nearest parking facility. Facilities nearby the site were included if they were within a short walk or drive from the site and these facilities could be used either going to or coming from the waterfall location.

Photographs of the waterfalls were taken from various lookouts using a digital camera. In addition to this, Joseph Hollick, Sandy Bell, Phil Armishaw, Dan Court, Bill Crawford, Ray Love, David Piano, Jeremy Shortt and David Wooton donated waterfall photographs to the Hamilton Conservation Authority for its photo library, website, and publications.

In those cases where waterfalls were located on private property and permission was not granted in order to conduct a detailed waterfall survey, waterfall data was collected using a GIS along with the data and software noted in Section 2. 3. 1. Waterfall location was estimated at a scale of 1:10 000 using the sane methods for waterfall discovery. Height and width measurements, the distance from the nearest access point, and ease of access classification were estimated at a scale of 1:500 with the aid of topographical contours intervals and visits to nearby waterfall sites. Waterfall seasonality was estimated using the methods and data noted in this section. Aesthetics was determined by the Project Advisory Team using donated photography. Information on site amenities / facilities was gathered using assumptions and visits to surrounding areas.

2. 3. 5 Mapping & Spatial Distribution

The field data collected through the Global Positioning System (GPS) went into Manifold System 7x and 8x GIS software where the data could be displayed. The accuracy of the waterfall locations was then verified, at a scale of 1:10 000 and using the same ortho-rectified digital aerial photography, GIS layers, and software noted in Section 2. 3. 1. Once the data was confirmed it was further displayed and analyzed. All mapping produced in this report was created using Manifold System 8x GIS software.

The City ward that the waterfall is located was determined by overlaying the City's ward layer (City of Hamilton, 2006) with the waterfall point layer using Manifold System 8x GIS software. Additionally, the community in which a waterfall is situated was determined by overlaying the former municipalities' layer (City of Hamilton, 1990's) with the waterfall layer. Information in this report pertaining to the watershed and subwatershed that a waterfall is located within, and the watercourse that feeds a waterfall was obtained through previous studies and/or analyses completed by the Hamilton Conservation Authority or Conservation Halton.

Two types of maps were produced in order to display the results of the waterfall discovery and associated analyses. Community maps display waterfalls by Hamilton's communities and are identified using the letter 'C' followed by an associated number. In addition to community maps, site maps were completed for waterfalls which are in close proximity. These site maps are at a larger scale than the community maps and will indicate formal parking areas and roadside parking, which should be used at the visitor's own risk. These maps are named using the letters 'SM' followed by an associated number. Both the community maps and site maps display the waterfall's Overall Ranking using the classification scheme

explained in Section 2. 3. 9. 1. 4. The first community map and site map encompass those waterfalls at the northern end of the Escarpment where the City of Hamilton and the City of Burlington meet. See Section 2. 2 for the delineation of community boundaries.

2. 3. 6 Waterfall Numbering

The 2005 edition of this report assigned site, or identification, numbers to the sixty-five waterfalls found within the City of Hamilton. The 2007 report retained those numbers, and continued that numbering system for the new 31 waterfalls, while also providing site numbers for the five Burlington waterfalls identified in the 2005 and 2007 reports. The Burlington waterfalls were given the same number as nearby waterfalls within Hamilton's limits but lower case letters were added to this number. For all new waterfalls noted in this report, waterfalls were numbered beginning with ninety-seven (97), maintaining consistency in the numbering scheme but without changing the identification numbers in the 2005 and 2007 editions of this report.

2. 3. 7 Natural Areas Inventory

In 1990 and 1991, the Hamilton Naturalists' Club (HNC) conducted a biological inventory of over 80 natural areas in the City of Hamilton. A team of professional biologists identified significant flora and fauna found in these areas. The Natural Areas Inventory (NAI) was updated by the HNC in the 2001 and 2002 field seasons and documented in a final report entitled *Nature Counts Project: Hamilton Natural Areas Inventory (2003).* In addition to describing the flora and fauna, geology and physiography was also outlined in this NAI report.

Appendix F identifies natural areas frequently noted within the datasheets of this report and provides the page numbers associated with the NAI report for ease of reference.

2. 3. 8 Waterfall Naming

It was difficult to determine an accurate name for some of the waterfalls within the Hamilton area as research proved that many of the waterfalls had no associated name or had acquired multiple names.

For the purpose of this report, the Project Advisory Team agreed to reference existing naming policies to develop criteria for naming the waterfalls. First, the advisory team considered the Principles and Procedures for Geographical Naming (2004) as defined by the Ontario Geographic Names Board Act (2000), Ministry of Natural Resources. Secondly the Hamilton Conservation Authority's naming policies were referred to in order to provide consistency between historic and current corporate documents. Finally, naming policies utilized by the City of Hamilton, adjacent Conservation Authorities, and the Royal Botanical Gardens were consulted in order to finalize the proposed naming policy.

It was determined that a waterfall name must meet the following criteria:

- A name that has been locally or commonly used for 10 or more years, where local refers to the area immediately associated with the waterfall and common refers to the area beyond the area immediately associated with the waterfall. First consideration will be given to a name that is well established in current local usage. In the absence of a name that is well established in current local usage, consideration will be given to a name that is well established in current common usage.

- Where no name is known to exist for a waterfall, consideration will be given to:

(a) a name that restores a name established in the historical or traditional record; and,
(b) the adoption of a name which:
   a. identifies the location or a noteworthy physical, environmental or scenic quality;
   b. recognizes an historical connection to the land or nearby community;
   c. recognizes an individual, family or object with a historical connection to the site; or,
   d. recognizes an organization or individual that has made a significant contribution to the community, province or nation, under the following conditions:
      i. The reputation and contribution of the honouree must be well documented and broadly acknowledged.
      ii. A direct relationship must exist between the individual and the waterfall being considered for name recognition.
      iii. A person must be deceased at least 2 years prior to the proposed naming (the naming policy does not permit the commemorative naming of a living person).

In an attempt to determine the most historical or commonly used name for a waterfall, and to collect some local history regarding the waterfall site, historical atlases, books, librarians, curators, and local historians were consulted. See Appendix B for a cultural history of some of Hamilton's well-known waterfalls.
Where a historical or common name was not available, or where multiple waterfall names appeared, the Project Advisory Team recommended a preferred name for these waterfalls based on the above-mentioned criteria. An application will be made to the Ontario Geographic Names Board to formalize the chosen names of these waterfalls.

2. 3. 9 Data Analysis

The detailed methodologies of the waterfall ranking schemes for aesthetics, magnitude, visitor access, and overall waterfall ranking are described in the following sub-sections. In addition to the ranking analysis, descriptive statistics were used to better understand the data. These descriptive statistics included measures of central tendency and variability. Specifically the mean, median, and standard deviation of the dataset were explored. The mean is the average of all values in a dataset, while the median is the middle value from a set of observations that has been ranked. The standard deviation of a dataset measures variability. If the standard deviation is small then this indicates that the values are clustered around the mean, but if there is a large standard deviation then the values are far from the mean. If all the values are equal, then the standard deviation is zero. It is noted that the mean and standard deviation were rounded to the nearest whole number.

2. 3. 9. 1 Waterfall Ranking Schemes

The purpose of ranking the waterfalls was to determine Hamilton's best waterfalls, to define tourism potential, and also to provide guidance to the Project Advisory Team in determining waterfall site development and funding priorities. This ranking scheme differs from the 2005 edition of this report but remains consistent with the ranking scheme from the 2nd edition. For more information of the 2005 edition's ranking scheme see Section 1. 4. As with the 2nd edition of this report, it was determined by the Project Advisory Team that the dimensions of the waterfall, the seasonality of waterflow, the ease of accessibility and the current and future trail conditions to the waterfall site, the ownership of the waterfall site, and the overall judgment of the waterfall aesthetics was of importance in waterfall ranking. Ranks for waterfall aesthetics and magnitude are thought to remain constant as they are ranks based on the

waterfall's natural characteristics. However, visitor access and overall ranks are thought to be dynamic since variables that contribute to these ranks can change over time as site enhancements are completed. Therefore waterfall ranks are broken into constant ranks, based on natural waterfall characteristics, and dynamic ranks, based on visitor attraction characteristics. Equations 1 through 4 demonstrate how standardized numerical scores were determined for each ranking scheme, while the following sub-sections outline the ranking scheme processes in detail.

Using the Visitor Access Ranks the Project Advisory Team can verify which waterfalls currently provide the best visitor accessibility within Hamilton, while the Magnitude Ranks will indicate which waterfalls provide the best awe-factor to the visitor. The Aesthetics Ranks take into consideration overall visual appeal of the waterfall and its surroundings. Therefore all waterfall ranks examine different waterfall characteristics and can be used in isolation or in combination with one another. However, the Overall Ranks will help guide the Project Advisory Team in determining potential visitor attraction to Hamilton's waterfalls, since it takes into account the Aesthetics, Magnitude, and Visitor Access Ranks.

CONSTANT RANKS: Based on Natural Waterfall Characteristics

Equation 1: Aesthetics Rank (AR)* - *Numerical Ranking Score*

AR = [Project Advisory Team Determination: very scenic (3), scenic (2), ordinary (1)]

Equation 2: Magnitude Rank (MR)* - *Numerical Ranking Score*

$$\mathbf{MR} = \left(\frac{\text{(waterfall height + waterfall width + Seasonality Score)}}{\text{highest value}} \right) * 100$$

DYNAMIC RANKS: Based on Visitor Attraction Characteristics

Equation 3: Visitor Access Rank (VAR)* - *Numerical Ranking Score*

$$\mathbf{VAR} = \left(\frac{\text{(Accessibility Score + Trail Score + Ownership Score)}}{\text{highest value}} \right) * 100$$

Equation 4: Overall Rank (OR)* - *Numerical Ranking Score*

$$\mathbf{MRVAR} = (\mathbf{MR} * 0.75) + (\mathbf{VAR} * 0.25)$$

$$\mathbf{OR} = \left(\frac{\mathbf{(MRVAR * AR)}}{\text{highest value}} \right) * 100$$

***NOTE:** *each standardized numerical ranking score was converted to a character rank (A, B, or C) based on natural breaks in the resulting data.*

2. 3. 9. 1. 1 Aesthetics Rank

It was determined that the overall aesthetics of the waterfall would be of primary importance in determining an Overall Rank for each waterfall. It is noted that this a subjective rank and therefore the class in which each waterfall was placed was determined by the Project Advisory Team. The waterfalls were placed in one of three classes based on whether the waterfall surroundings were unique or very scenic, and if the waterfall viewing enjoyment would be elevated as compared to the other waterfalls reported in this study (i.e. shape of waterfall, rock formation, landscape features, and the scenery around the waterfall).

The nominal aesthetics classes, noted in Section 2. 3. 4, were assessed by the Project Advisory Team and in turn converted to an ordinal scale. Therefore each class was given an associated numerical ranking score: very scenic (3); scenic (2); or ordinary (1). These numerical scores were used to bias the Overall

Ranking in favour of waterfall aesthetics. Each numerical score can be converted to a character rank, where Rank A encompasses all waterfalls given a score of 3, Rank B contained all waterfalls with a score of 2, and Rank C included those waterfalls with a score of 1.

2. 3. 9. 1. 2 Magnitude Rank

Waterfall dimensions and seasonality would be of secondary importance in determining an Overall Rank for each waterfall as it would provide an awe-factor to the onlooker.

For the purpose of this report, the dimensions of the waterfall (height and width in metres) and the Seasonality Score (Section 2. 3. 9. 1. 3. 1) were summed. These summed values were then standardized on a ratio scale of 1 to 100 to determine a numerical ranking score for each waterfall (Equation 2). Each numerical score was converted to a character rank: excellent (Rank A), good (Rank B), and satisfactory (Rank C). Rank conversion was accomplished by determining natural breaks in the data using Manifold System 8x GIS software.

2. 3. 9. 1. 3. 1 Seasonality Score

The Seasonality Score utilized the nominal classes recorded during the waterfall survey (Section 2. 3. 4). These three classes were then given an associated numerical score: year-round (3); seasonal (2); and peak storm event (1).

2. 3. 9. 1. 3 Visitor Access Rank

The waterfall's accessibility and ownership would be of least importance in determining an Overall Rank for each waterfall as these characteristics could be altered to suit the waterfall site in the future. For example, permission could be given to enhance a waterfall site on private property or the access trail to the site could be improved in order to increase the accessibility by additional age groups.

Once the Accessibility, Trail, and Ownership Scores were determined (Section 2. 3. 9. 1. 3. 1, Section 2. 3. 9. 1. 3. 3, and Section 2. 3. 9. 1. 3. 3), they were summed. These summed values were then standardized using a ratio scale of 1 to 100 to determine a numerical ranking score for each waterfall (Equation 3). Each numerical score was converted to a character rank: excellent (Rank A), good (Rank B), satisfactory (Rank C). Rank conversion was accomplished by determining natural breaks in the data using Manifold System 8x GIS software.

2. 3. 9. 1. 3. 1 Accessibility Score

The Accessibility Score utilized the nominal classes recorded during the waterfall survey (Section 2. 3. 4), in addition to one class being created for waterfalls on private property with no permission to access the waterfall site and those where currently it is too dangerous to access the waterfall site. These four classes were then given an associated numerical score: easy access (4); moderate access (3); difficult access (2); and no permission to access / currently too dangerous to access (1).

2. 3. 9. 1. 3. 2 Trail Score

Each waterfall was put into one of four classes based on the current trail conditions leading to the waterfall site (Bruce Trail or regional trail), if any, as well as future improvements and the potential for new trails. These four classes were then given an associated numerical score: trail is currently in place with no plans for improvements (4); potential for a new trail, or trail extension (3); improvements to existing trails are planned (2); no trail currently in place and no potential for new trail / extension.

2. 3. 9. 1. 3. 3 Ownership Score

Each waterfall was put into one of five classes based on current property ownership in which the waterfall is situated. These five classes were then given an associated numerical score: public park or conservation area (5); public open space or conservation area where no amenities are available (4); public right-of-way, including road and railway right-of-ways, and restaurant premises (3); private property with permission to access the waterfall site (2); and private property without permission to access the waterfall site (1).

Property ownership was determined to be public if the waterfall was within lands owned by the City of Hamilton (park or open space), Conservation Authorities, or the Royal Botanical Gardens (RBG). If the Bruce Trail provided access across private property to view the waterfall then the waterfall was put into the 'private property with permission to access the waterfall site' class. It was assumed that if the waterfall was located in a public park or conservation area then it would have more amenities than other waterfall sites, and it was assumed that waterfalls located on private property without permission to access the waterfall site would have few or little amenities for the visitor. Amenities were deemed to be parking facilities, trail access, interpretive signs, picnic tables, washrooms, recreational facilities, meeting facilities, and eating facilities.

2. 3. 9. 1. 4 Overall Rank

Once numerical scores were determined for Magnitude Rank and Visitor Access Rank, an Overall Rank was developed to take into consideration both of these ranking schemes in addition to the Aesthetics Rank. It was determined by the Project Advisory Team that the Magnitude Rank was three times more important in determining an Overall Rank than the Visitor Access Rank, for the reasons noted in previous sections.

Therefore, the Overall Rank was established by applying a 75% weight to the numerical score for Magnitude Rank and a 25% weight to the numerical score for Visitor Access Rank and then summing these values. This new value was then multiplied by the numerical score for Aesthetics Rank. The resulting values were then standardized using a ratio scale of 1 to 100 to determine an overall numerical ranking score for each waterfall (Equation 4). Each numerical score was converted to a character rank: excellent (Rank A), good (Rank B), satisfactory (Rank C). Rank conversion was accomplished by determining natural breaks in the data using Manifold System 8x GIS software.

3 RESULTS & DISCUSSION

The results of this study have been broken down by waterfall discovery and waterfall ranking. Data collected and analyzed for those waterfalls on the outskirts of the City of Hamilton's boundaries were not included in the following sections, however this information can be found in the appropriate appendices.

3. 1 Waterfall Discovery

Using geo-spatial techniques and field research, this study built on the number of waterfalls within the City of Hamilton. Before this study began, forty-four waterfalls were known within the City of Hamilton. The 2005 edition of this report inventoried sixty-five waterfalls within the City's limits. The 2007 edition inventoried an additional 31 waterfalls within the City's limits, and now one hundred and forty-five (145) waterfalls are documented (Figure 3). The highest and widest waterfalls are both found within the community of Flamborough and within walking distance of one another. These are Tew's Falls, with a height of 41 metres, and Webster's Falls, with a width of 30 metres. The most visible waterfall within Hamilton is Lower Princess Falls which can be viewed travelling on Highway 403 between the Aberdeen Avenue and Lincoln M. Alexander Parkway exits.

The majority of the new waterfalls were discovered using field research methods, with only a fraction of the new waterfalls found using the geo-spatial methods described in Section 2. 3. 1. This can be attributed to the data utilized for this analysis. The watercourse data used for this analysis only contained drainage that met a certain flow volume, therefore where drainage did not meet this threshold, the drainage did not appear within the GIS layer. Therefore locations where swales and ditches, that are only apparent during peak storm events, flow over the Escarpment were not flagged for further field research. Also, the researcher only flagged areas where steep contours were apparent and not those of a lesser slope; hence if there was not a sudden drop in elevation along the Escarpment than this area was not visited using this discovery method. Additionally, on-site investigations of certain waterfalls lead to the discovery of neighbouring waterfalls. A complete inventory of waterfalls is found in Appendix C. This inventory contains spatial data, descriptive characteristics, water source information, and access information for each waterfall noted within this report. Individual datasheets were also completed for each waterfall, and can be found in Appendix E.

3. 1. 1 Spatial Distribution

It was assumed that the majority of the waterfalls would be found near the edge of the Niagara Escarpment due to the steep drop that this landform presents as well as its associated erosional processes. Although correlation analysis was beyond the scope of this study, it seems as though the majority of the one hundred and forty-five (145) waterfalls reported are a function of the Escarpment's steep slopes as they flow over the Escarpment's bedrock at or near the Escarpment face. Therefore, the results point towards this assumption holding true. There are 5 waterfalls that are found to be substantially distanced from the Niagara Escarpment's steep sloping face; they are found in the settlement areas of Carlisle, Troy and Stoney Creek and can be attributed to the Eramosa Escarpment. It was also found that the majority of the waterfalls were located within a 23 kilometre radius of the Highway 403 and Main Street intersection in Hamilton.

All nine community maps are found within Appendix D. These maps display the Overall Rank, therefore taking into consideration both the natural characteristics and current visitor accessibility characteristics for each waterfall. For more information on the results of the Overall Ranking scheme see Section 3. 2. 4.

The Flamborough community has forty-seven (47) waterfalls within its limits. Hamilton has forty-one (41) waterfalls and Stoney Creek has thirty-one (31). Ancaster and Dundas have an additional twenty (20) and six (6) waterfalls within their limits, respectively. Glanbrook has no waterfalls within its limits. Table 1 illustrates how Hamilton's waterfalls are divided among the City's communities.

Community Name	No. of Waterfalls
Flamborough	47
Stoney Creek	31
Hamilton	41
Ancaster	20
Dundas	6
Glanbrook	0
TOTAL	145

Table 1: Waterfalls by community

There is an absence of waterfalls along the Escarpment brow in the community of Hamilton which can be attributed to altered surface drainage in this area due to intense urban development. Therefore it can be hypothesized that at one time the community of Hamilton may have had many more waterfalls within its limits.

Waterfalls were also summarized by City of Hamilton wards. There are fifteen wards within the City and eleven of these have waterfalls within their boundaries. Table 2 displays these results.

Ward No.	No. of Waterfalls	Ward No.	No. of Waterfalls	Ward No.	No. of Waterfalls
1	14	9	7	13	5
5	13	10	6	14	23
6	5	11	21	15	27
8	5	12	19	***TOTAL***	145

Table 2: Waterfalls by City ward

Wards 15 (East Flamborough) and 14 (West Flamborough) have the most waterfalls within their boundaries, twenty-seven (27) and twenty-three (23), respectively. Wards 11 (Stoney Creek) and 12 (East-Central Ancaster) also have a considerable number of waterfalls with their boundaries, twenty-one (21) and nineteen (19).

Ward 7, which is situated on the Escarpment but within an area noted to have high urban development, has an absence of waterfalls. Wards 2, 3, and 4, which are at the north end of the City adjacent to Hamilton Harbour, do not have any waterfalls within their limits. This is to be expected considering the Escarpment does not pass through these wards and there are no steep slopes found here.

In addition to summarizing waterfall counts by municipal boundaries, waterfalls within watershed and subwatershed boundaries were also investigated. There are four Conservation Authorities (CAs) that work within the boundaries of the City of Hamilton. This is due to the fact that the jurisdiction of a Conservation Authority is dependent on the watershed that they manage. All one hundred and forty-five

(145) waterfalls fall within three (3) of the four Conservation Authorities' jurisdictions: the Hamilton Conservation Authority (HCA), Conservation Halton (CH) and Grand River Conservation Authority (GRCA). The Hamilton Conservation Authority jurisdiction includes a significant portion of the Niagara Escarpment as it passes through the City of Hamilton, and therefore it is not unexpected that one hundred and twenty-seven (127) of the waterfalls are within the HCA watershed area.

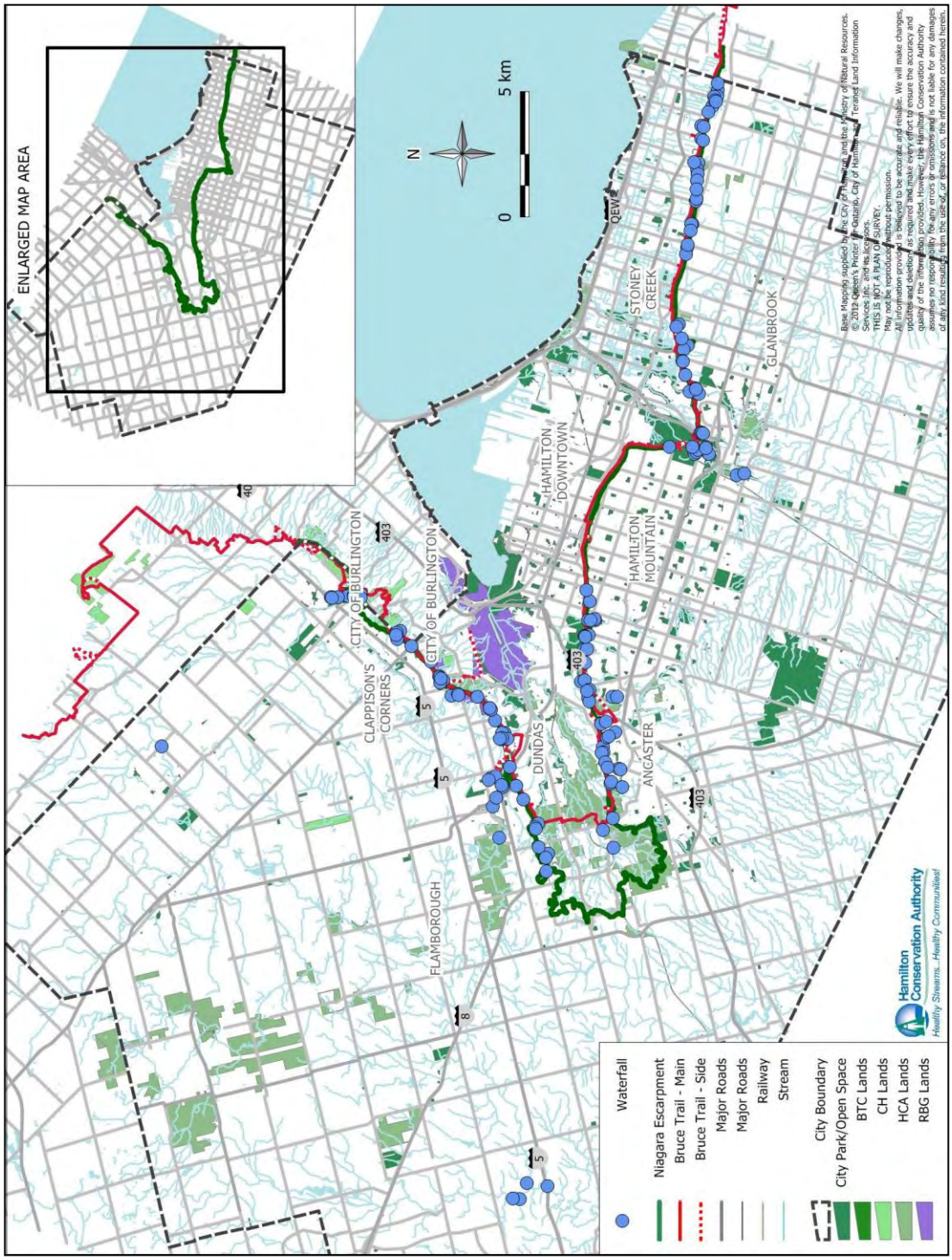

Figure 3: Waterfall Locations

Table 3 summarizes the number of waterfalls within each watershed and subwatershed within the HCA's and CH's jurisdiction. Where no waterfalls were located within a watershed, or its associated subwatershed, those watersheds and subwatersheds were not listed.

Conservation Authority	Watershed	Subwatershed	Number of Waterfalls
CH			**14**
	Bronte Creek		**1**
		Upper Main Branch	1
	Grindstone Creek		**10**
		220	4
		222	3
		228	3
	North Cootes Paradise		**3**
		232	3
GRCA			**4**
	Grand River		**4**
		Fairchild Creek	4
HCA			**127**
	Borer's Creek		**10**
	Chedoke Creek		**22**
	Red Hill Creek		**21**
		Hannon Creek	2
		Lower Davis Creek	4
		Montgomery Creek	3
		Red Hill Valley	9
		Upper Davis Creek	3
	Spencer Creek		**43**
		Ancaster Creek	8
		Logie's Creek	3
		Lower Spencer Creek	1
		Middle Spencer Creek	11
		Spring Creek	4
		Sulphur Creek	6
		Sydenham Creek	6
		Tiffany Creek	4
	Stoney/Battlefield Creek		**5**
		Battlefield Creek	3
		Stoney Creek	2
	Stoney Creek #'d Watercourses		**26**
		WC-2	1
		WC-4	2
		WC-5	5
		WC-7	6
		WC-9	4
		Fifty Creek/WC-12	8
TOTAL			***145***

Table 3: Waterfalls by CA, watershed & subwatershed

Within the HCA jurisdiction there are waterfalls located within six watersheds: Borer's Creek, Chedoke Creek, Red Hill Creek, Spencer Creek, Stoney/Battlefield Creek and Stoney Creek Numbered Watercourses, including Fifty Creek. Spencer Creek watershed is the largest of the watersheds and in turn contains the most waterfalls within the HCA watershed area (43). Chedoke Creek is a small watershed; however twenty (22) waterfalls are within its boundaries.

The spatial distribution of Hamilton's waterfalls shows an obvious gap in waterfall occurrences. This absence may be attributed to altered surface drainage in this area due to intense urban development. Therefore it is hypothesized that at one time there may have been waterfalls located along the Escarpment brow between the West Hamilton Mountain and the East Hamilton Mountain.

Although statistical point pattern analyses were not within the scope of this study, it seems evident that there are obvious clusters of waterfalls along certain watercourses. All of these clusters appear along the slopes associated with the Niagara and Eramosa Escarpments, whereas waterfalls found away from the edge of the Escarpment appear to be independent occurrences. Twenty-two (22) waterfall clusters were identified through this study and in turn twenty-two (22) waterfall site maps were created and recognize these localized waterfall clusters. To alleviate overlap in waterfall mapping some clusters were divided. All site maps can be found in the datasheets in Appendix E by waterfall name, while the twenty-two (22) site planning clusters are noted within Appendix H.

3. 1. 2 Ownership & Accessibility

The results for waterfall ownership and accessibility for Hamilton's waterfalls are outlined in this section. This data was obtained using the methods outlined in Section 2. 3 and is of benefit to the project partners in developing site enhancement strategies.

Table 4 identifies how many waterfalls are owned publicly and privately, in addition to the property on which the publicly-owned waterfalls are located. For the purposes of this document, public ownership includes all lands that are accessible by the public, rather than the literal definition of lands owned and /or managed by a government body. For example, Royal Botanical Gardens is a charitable organization of which some of its land is accessible to the public.

Out of all one hundred and forty-five (145) waterfalls found within the City of Hamilton, 59% were located on public land. More waterfalls are located on land owned by the City of Hamilton than any other agency (41). The City of Hamilton's Escarpment Open Space refers to four different properties. One property is located at the top of the Escarpment on the east side of Mount Albion; Glendale Falls is located here. Little Davis Falls is found in the property below the Escarpment at Quigley Road. Another is the property between the railway and the Escarpment brow on the west side of Centennial Parkway; Glover's and East Glover's Falls' are located here. Finally, there are eighteen (18) waterfalls found on the property adjacent to the Chedoke Civic Golf Course & Winter Sports Park.

Ownership	Agency	Property Type	Property Name	Number of Waterfalls
Publicly Accessible				**86**
	City of Hamilton			**41**
		Road Right of Way		12
			Rymal Road East	1
			Queen Street South	2
			Centennial Pky.	2
			Dewitt Rd.	1
			Fifty Rd.	1
			Mill Street South	1
			Sulphur Springs Rd.	1
			Sydenham Rd.	1
			Wilson St. E	2
		Parks / Open Space		29
			City Open Space	3
			Escarpment Open Space	15
			Greenhill Ave Rail Trail	1
			King's Forest Park	4
			Oak Knoll Park	4
			Smokey Hollow Resource Management Area	2
	Hamilton Conservation Authority			**32**
		Conservation Area		30
			Borer's Falls CA	4
			Christie Lake CA	1
			Crook's Hollow CA	1
			Devil's Punchbowl CA	2
			Dundas Valley CA	4
			Felker's Falls CA	3
			Iroquoia Heights CA	2
			Mount Albion CA	1
			Spencer Gorge/Webster's Falls CA	5
			Tiffany Falls CA	3
			Vinemount CA	4
		Open Space		2
			n/a	2
	Ministry of Transportation			**5**
		Road Right of Way		5
			Hwy 403	4
			Hwy 6	1
	Royal Botanical Gardens			**8**
		Nature Reserve		8
			Patterson Road	3
			Rock Chapel Sanctuary	4
			Valley Road	1
Ownership	**Agency**	**Property Type**	**Property Name**	**Number of Waterfalls**
Private				**59**
	CN	Road Right of Way	n/a	11
	Hydro One	Road Right of Way	n/a	1
	Old Mill Restaurant		n/a	2
	Private Landowners		n/a	45
TOTAL				***145***

Table 4: Waterfall ownership

Table 5 summarizes the number of waterfalls within each visitor ease of access class (see Section 2. 3. 4). This table also identifies how many waterfalls within each class are inaccessible (i.e. the waterfall was either on private property in which the Bruce Trail does not traverse, or it was currently too dangerous to access). Most of the twenty-one (21) waterfalls with easy visitor ease of access can either be viewed from the roadway without having to exit the vehicle or there are accessible facilities on-site. These waterfalls are: Albion Falls, Billy Green Falls, Centennial Falls, Devil's Punchbowl Falls, Dewitt Falls, East Iroquoia Falls, Felker's Falls, Hermitage Cascade, Lower Princess Falls, Princess Falls, Tew's Falls, Weirs Falls, and West Iroquoia Falls. The majority of waterfalls within the City of Hamilton have a moderate ease of access (88) with 41% of them being inaccessible. There are thirty (30) waterfalls that are within the difficult ease of access class, 90% (27) of these are inaccessible. Overall, 48% of all waterfalls within the City of Hamilton are inaccessible; twenty-seven of these waterfalls are located on public land.

Ease of Access	# of Waterfalls	# of Inaccessible Waterfalls	# of Accessible Waterfalls
Easy	27	7	20
Moderate	88	36	52
Difficult	30	27	3
TOTAL	145	70	75

Table 5: Waterfall ease of access

The number of waterfalls that are accessible by roadway, trail, or off-trail hiking are shown in Table 6. Of all one hundred and forty-five waterfalls, fifty-four (54) can be viewed from a trail; while twenty-seven (27) can be viewed from a roadway. The Bruce Trail currently provides direct viewing access to twenty-seven (27) of all waterfalls in the City of Hamilton. Waterfalls that currently require off-trail hiking account for sixty-four (64) of all waterfalls. All inaccessible (i.e. the waterfall was either on private property in which the Bruce Trail does not traverse, or it was currently too dangerous to access) waterfalls are found within this group.

Means of Access	# of Waterfalls
Bruce Trail	27
Other Trail	27
Road	27
Off Trail Hiking	64
TOTAL	145

Table 6: Means of waterfall site access

Table 7 displays the results of the statistics performed on the time it would take a visitor to arrive at the waterfall site from the roadway or parking area noted in the datasheets in Appendix E; waterfalls which would require permission from the private landowner or are currently too dangerous to access are not included in this analysis. The waterfall access times range from 1 minute to 45 minutes. The average time it would take to arrive at a waterfall site would be approximately 9 minutes, whereas the median indicates that 50% of all waterfalls have an access time of 5 minutes or less.

Statistic	Result (mins)
Low Value	1
High Value	45
Mean	9
Median	5
Standard Deviation	8

Table 7: Waterfall access time statistics

Figure 4 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of values fall between 0 and 17 minutes, or within 8 minutes of the mean in either direction. The peak indicates that it is probable that a waterfall will have an access time similar to the median. This distribution is positively skewed as a result of there being more waterfalls with short access times and one extreme value above 40 minutes [Denlow Falls (45 mins)]. This also indicates that deviations from the mean will be in a positive direction. Out of the one hundred and forty-five waterfalls inventoried, seven (7) waterfalls had an access time of 0 minutes due to the fact they can be viewed roadside from a vehicle. These waterfalls are: Billy Green Falls, Centennial Falls, Dewitt Falls, East Iroquoia Falls, Lower Princess Falls, Weirs Falls, and West Iroquoia Falls.

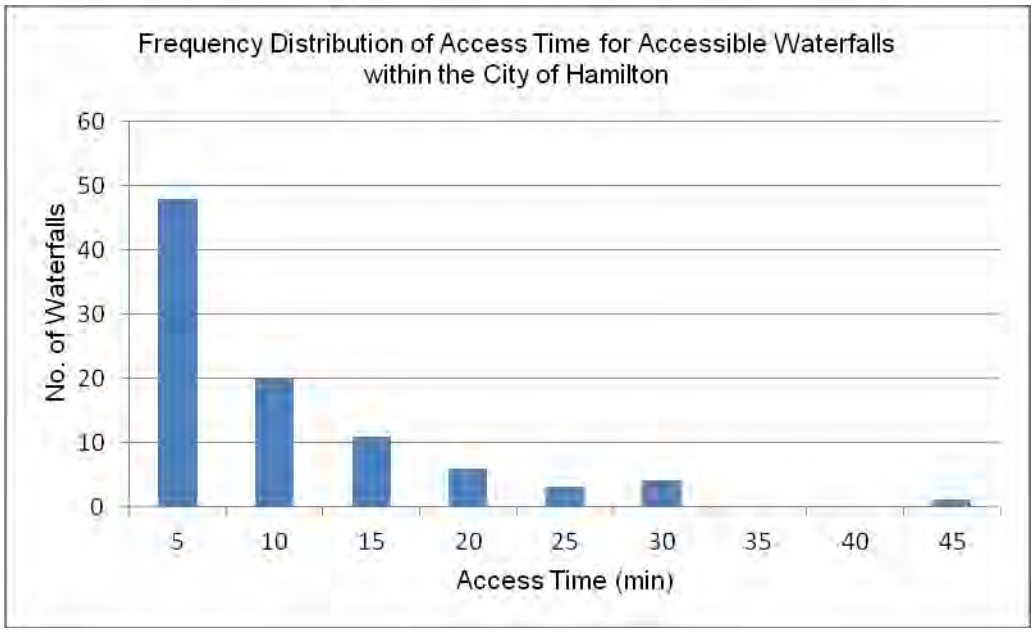

Figure 4: Frequency distribution of waterfall access times

Table 8 displays the results of the statistics performed on the distance it would take a visitor to arrive at the waterfall site from the roadway or parking area noted in the datasheets in Appendix E; waterfalls which would require permission from the private landowner or are currently too dangerous to access are not included in this analysis. The waterfall access distances range from 0 metres to 1700 metres. The average distance it would take to arrive at a waterfall site would be 341 metres, whereas the median indicates that 50% of all waterfalls have an access distance of 208 metres or less.

Statistic	Result (m)
Low Value	1
High Value	1700
Mean	341
Median	208
Standard Deviation	348

Table 8: Waterfall access distance statistics

Figure 5 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of values fall between 0 and 689 metres, or within 348 metres of the mean in either direction. The peak indicates that it is possible that a waterfall will have an access distance similar to the median. This distribution has a large range of values and is positively skewed as a result of there being more waterfalls with short access distances and four extreme values above 1 kilometre [Lower Tew's Falls (1200 m), Heritage Falls (1300 m), Denlow Falls (1500 m), and Jones Rd. Falls (1700 m)]. This also indicates that deviations from the mean will be in a positive direction. Out of the one hundred and forty-five waterfalls inventoried, seven (7) waterfalls had an access distance of 0 minutes due to the fact they can be viewed roadside from a vehicle. These waterfalls are: Billy Green Falls, Centennial Falls, Dewitt Falls, East Iroquoia Falls, Lower Princess Falls, Weirs Falls, and West Iroquoia Falls.

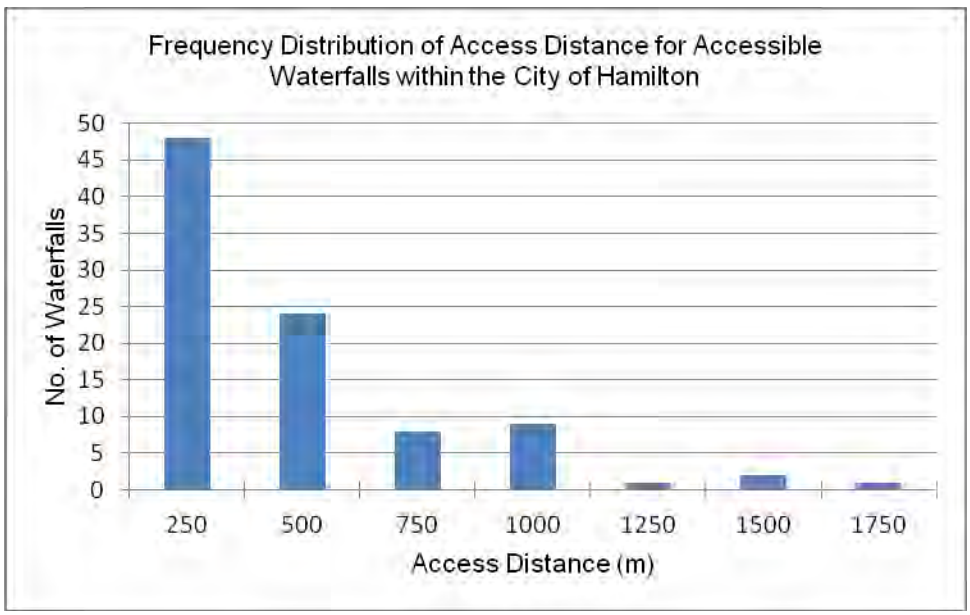

Figure 5: Frequency distribution of waterfall access distances

3. 1. 3 Physical Attributes

For the purpose of this study three physical waterfall attributes were collected. These attributes were: waterfall dimensions, source of waterflow, and seasonality of waterflow. In the following sub-sections the results of the analyses performed on these datasets are described.

3. 1. 3. 1 Waterfall Dimensions

The width and height of each waterfall is reported in Appendix C as well as within the appropriate datasheet in Appendix E. Both the height and width were analyzed using descriptive statistics and the results of these analyses follow.

2. 3. 9. 1. 1 Height

Table 9 displays the results of the statistics performed on the waterfall heights. The waterfall heights range from 1 metre to 41 metres. The average waterfall height for waterfalls within the City of Hamilton is 9 metres, whereas the median indicates that 50% of all waterfalls have a height of 7 metres or less.

Statistic	Result (m)
Low Value	1.2
High Value	41
Mean	9
Median	7
Standard Deviation	7

Table 9: Waterfall height statistics

Figure 6 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of values fall between 2 and 16 metres, or within 7 metres of the mean in either direction. The peak indicates that it is probable that a waterfall will have a height similar to the mean. This distribution is positively skewed as a result of there being more waterfalls with lower height values and two extreme values above 33 metres [Devil's Punchbowl Falls (37 m) and Tew's Falls (41 m)]. This also indicates that deviations from the mean will be in a positive direction. Out of the one hundred and forty-five inventoried, sixteen (16) waterfalls had the minimum required height to be defined as a waterfall. An additional two (2) waterfalls that are less than the minimum required height were included in the report because of their immense width, aesthetic value and access characteristics.

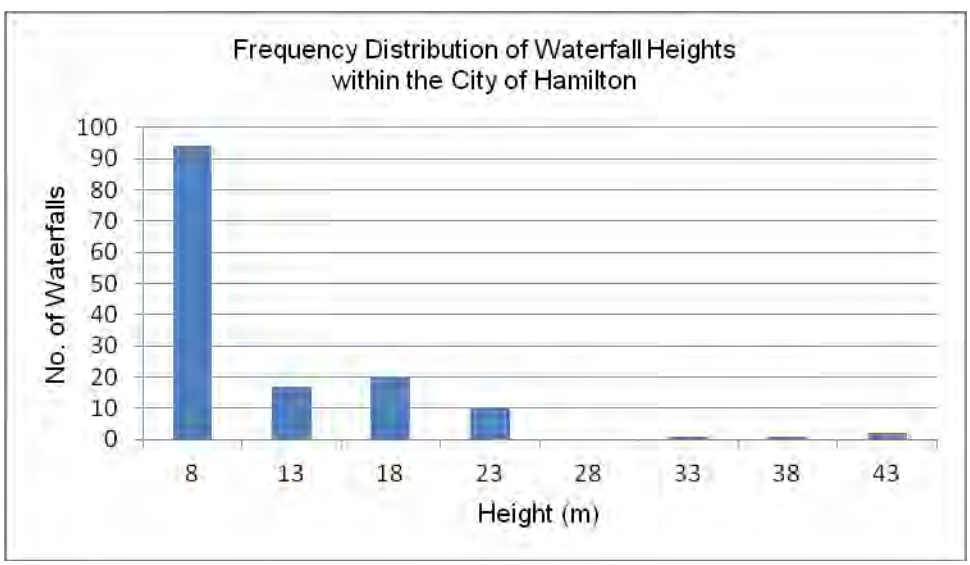

Figure 6: Frequency distribution of waterfall heights

2. 3. 9. 1. 2 Width

Table 10 displays the results of the statistics performed on the waterfall widths. The waterfall widths range from 1 metre to 30 metres. The average waterfall width for waterfalls within the City of Hamilton is 4 metres, whereas the median indicates that 50% of all waterfalls have a width of 3 metres or less.

Statistic	Result (m)
Low Value	1
High Value	30
Mean	4
Median	3
Standard Deviation	4.5

Table 10: Waterfall width statistics

Figure 7 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of values fall between 0 and 8.5 metres, or within 4.5 metres of the mean in either direction. The very large peak indicates that it is highly probable that a waterfall will have a width similar to the mean. This distribution is positively skewed as a result of there being more waterfalls with lower width values and six extreme values above 15 metres [Troy Cascade (15m), Progreston Falls (16.5 m), Albion Falls (18 m), Darnley Cascade (22 m), Beverly Cascade (27m) and Webster's Falls (30 m)]. This also indicates that deviations from the mean will be in a positive direction. Out of the one hundred and forty-five waterfalls inventoried, eighteen (18) waterfalls had the minimum required width to be defined as a waterfall.

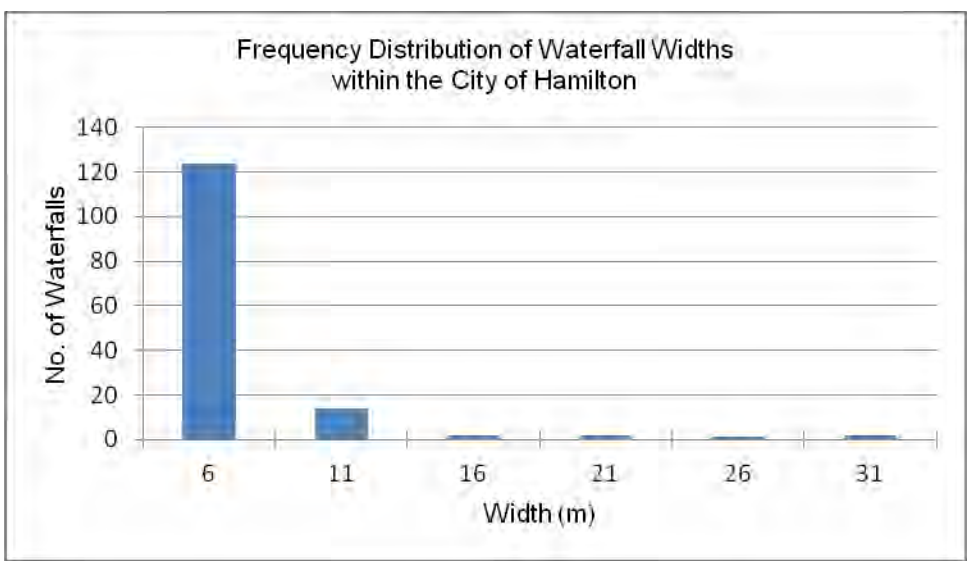

Figure 7: Frequency distribution of waterfall widths

3. 1. 3. 2 Source & Seasonality of Waterflow

Each waterfall within the City of Hamilton falls into one of two water source categories: stream-fed or surface drainage resulting from peak storm events. One hundred and four (104) of the waterfalls inventoried were fed by stream systems while the others were fed by surface drainage resulting from peak storm events. Out of the one hundred and forty-five waterfalls, thirty-seven (37) are fed by year-round waterflow, sixty-seven (67) are seasonal, and forty-one (41) are fed by surface drainage resulting from

peak storm events. Table 11 summarizes the number of waterfalls that flow year-round, during the spring and fall seasons, and which are only apparent during the peak storm events or after a snow-melt.

Seasonality of Waterflow	No. of Waterfalls
Year-round	37
Seasonal	67
Peak Storm	41
TOTAL	*145*

Table 11: Waterfall seasonality

3. 2 Waterfall Ranking

Following are the results from the Waterfall Ranking analysis using the methods outlined in Section 2. 3. 9. 1. For a detailed account showing the calculations of each waterfall rank see Appendix G. All tables list waterfalls from the best to the worst ranked. Where waterfalls share the same numerical ranking score they are listed alphabetically.

3. 2. 1 Aesthetics Rank

The Project Advisory Team determined the Aesthetics Rank for the City of Hamilton's waterfalls. Overall it was deemed that seventeen (17) waterfalls within the City of Hamilton were very scenic (Rank A), thirty-four (34) waterfalls were scenic (Rank B), and ninety-four (94) were ordinary (Rank C). The results from this analysis of waterfall aesthetics are found in Table 12.

Site No.	Waterfall Name	Numerical Ranking Score	Aesthetics Rank
48	Albion Falls	3	A
6	Borer's Falls	3	A
45	Chedoke Falls	3	A
42	Cliffview Falls	3	A
15	Darnley Cascade	3	A
55	Devil's Punchbowl Falls	3	A
50	Felker's Falls	3	A
3	Great Falls	3	A
43	Lower Chedoke Falls	3	A
22	Lower Mill Falls	3	A
21	Mill Falls	3	A
1	Progreston Falls	3	A
26	Sherman Falls	3	A
11	Tew's Falls	3	A
28	Tiffany Falls	3	A
13	Webster's Falls	3	A
41	Westcliffe Falls	3	A
14	Baby Webster's Falls	2	B
76	Betzner Falls	2	B
53	Billy Green Falls	2	B
47	Buttermilk Falls	2	B
23	Canterbury Falls	2	B

Rank A = 17

Rank B = 34

Site No.	Waterfall Name	Numerical Ranking Score	Aesthetics Rank
44	Denlow Falls	2	B
16	Dundas Falls	2	B
71	Dyment Falls	2	B
4	Grindstone Cascade	2	B
19	Hermitage Cascade	2	B
119	Hunter Falls	2	B
72	Lafarge Falls	2	B
49	Little Davis Falls	2	B
7	Lower Borer's Falls	2	B
40	Lower Cliffview Falls	2	B
108	Lower Glendale Falls	2	B
34	Lower Princess Falls	2	B
54	Lower Punchbowl Falls	2	B
10	Lower Sydenham Falls	2	B
12	Lower Tew's Falls	2	B
39	Lower Westcliffe Falls	2	B
9	Middle Sydenham Falls	2	B
18	Mineral Springs Falls	2	B
38	Mountview Falls	2	B
35	Princess Falls	2	B
33	Scenic Falls	2	B
31	Shaver Falls	2	B
77	Sisters of Mary Falls	2	B
32	Stephanie Falls	2	B
17	Steven's Falls	2	B
8	Sydenham Falls	2	B
114	Troy Cascade	2	B
2	Upper Grindstone Falls	2	B
29	Washboard Falls	2	B
79	Ancaster Heights Falls	1	C
113	Auchmar Falls	1	C
130	Baby Albion Falls	1	C
99	Beckett Falls	1	C
117	Beverly Cascade	1	C
118	Beverly Falls	1	C
126	Billy Monkley Cascade	1	C
140	Blue Falls	1	C
122	Broman Falls	1	C
105	Brown's Falls	1	C
125	Cave Falls	1	C
83	Centennial Falls	1	C
100	Clappison Falls	1	C
57	Dewitt Falls	1	C
104	Duchess Falls	1	C
51	East Glover's Falls	1	C
74	East Greensville Falls	1	C
81	East Iroquoia Falls	1	C

Rank C = 94

Site No.	Waterfall Name	Numerical Ranking Score	Aesthetics Rank
95	East of Fifty Falls	1	C
56	Erland Falls	1	C
101	Ferguson Falls	1	C
94	Fifty Rd. Cascade	1	C
60	Fruitland Falls	1	C
52	Glover's Falls	1	C
91	Grand Cascade	1	C
137	Great Western Cascade	1	C
115	Hannon Cascade	1	C
89	Harvey Falls	1	C
20	Heritage Falls	1	C
103	Heritage Green Falls	1	C
102	Hidden Grindstone Falls	1	C
65	Jones Rd. Falls	1	C
88	Lewis Rd. East Falls	1	C
87	Lewis Rd. West Falls	1	C
128	Limeridge Falls	1	C
24	Little Canterbury Falls	1	C
27	Little Falls	1	C
139	Logie's Falls	1	C
120	Lottridge Cascade	1	C
61	Lower Fruitland Falls	1	C
69	Lower Hopkins Cascade	1	C
78	Lower Little Falls	1	C
129	Lower Maple Cascade	1	C
133	Lower Mohawk Falls	1	C
37	Lower Sanatorium Cascade	1	C
141	Lower Scenic Cascade	1	C
135	Maple East Falls	1	C
131	Maple Falls	1	C
132	Maple West Falls	1	C
86	McNeilly Falls	1	C
85	McNeilly West Falls	1	C
109	Middle Glendale Falls	1	C
136	Moss Falls	1	C
110	Mountain Spring Falls	1	C
116	Oak Knoll Falls	1	C
25	Old Dundas Rd. Falls	1	C
97	Optimist Cascade	1	C
112	Patterson East Cascade	1	C
111	Patterson West Cascade	1	C
121	Pettit Cascade	1	C
127	Pond Falls	1	C
123	Pritchard Falls	1	C
90	Promontory Falls	1	C
96	Puddicombe Falls	1	C
67	Quarry Falls	1	C

Site No.	Waterfall Name	Numerical Ranking Score	Aesthetics Rank
106	Read Baker's Falls	1	C
58	Ridge Falls	1	C
70	Rock Chapel Falls	1	C
142	Romar Cascade	1	C
98	Samuel Cascade	1	C
143	Smith Cascade	1	C
73	Springhill Falls	1	C
138	Sugar Shack Falls	1	C
64	Tallman East Falls	1	C
84	Tallman West Falls	1	C
46	Upper Glendale Falls	1	C
68	Upper Hopkins Cascade	1	C
134	Upper Mohawk Cascade	1	C
66	Upper Quarry Cascade	1	C
36	Upper Sanatorium Falls	1	C
30	Upper Shaver Falls	1	C
107	Valley Falls	1	C
82	Veevers Falls	1	C
63	Vinemount East Falls	1	C
62	Vinemount West Falls	1	C
59	Wall Falls	1	C
124	Walnut Grove Falls	1	C
75	Weirs Falls	1	C
144	Wesley Cascade	1	C
145	West Brown's Cascade	1	C
80	West Iroquoia Falls	1	C
146	West Moss Cascade	1	C
92	West of Fifty Lower Falls	1	C
93	West of Fifty Upper Cascade	1	C

Table 12: Aesthetics Ranks

3. 2. 2 Magnitude Rank

When the dimension and seasonality of each waterfall was analyzed, using the methods in Section 2. 3. 9. 1. 2, the following ranks resulted (see Table 13). Magnitude Ranks were a function of waterfall width and height, in combination with seasonality of waterflow. Therefore the tallest waterfalls, the widest waterfalls, the waterfalls with a good combination of both dimensions, as well as those waterfalls with higher numerical scores for seasonality, produced higher numerical ranking scores. The Magnitude Ranking scores were then broken into three classes; excellent (Rank A – score: 100 to 42), good (Rank B – score: 41 to 21), satisfactory (Rank C – score: 20 to 0) using natural breaks classification. As a result of this analysis twenty (20) waterfalls within the City of Hamilton have excellent natural characteristics, seventy (70) waterfalls have good natural characteristics, and fifty-five (55) waterfalls have satisfactory natural characteristics. Since these results are displayed in ratio scale we can compare the results of one waterfall to another. For example, Buttermilk Falls has a Magnitude Ranking score of 60 and McNeilly West Falls has a Magnitude Ranking score of 30, therefore we can say that Buttermilk Falls is twice as grand as McNeilly West Falls.

Site No.	Name	Numerical Ranking Score	Magnitude Rank
13	Webster's Falls	100	A
11	Tew's Falls	96	A
34	Lower Princess Falls	81	A
55	Devil's Punchbowl Falls	76	A
48	Albion Falls	73	A
47	Buttermilk Falls	60	A
101	Ferguson Falls	60	A
117	Beverly Cascade	57	A
50	Felker's Falls	56	A
45	Chedoke Falls	55	A
28	Tiffany Falls	55	A
15	Darnley Cascade	53	A
44	Denlow Falls	53	A
33	Scenic Falls	51	A
26	Sherman Falls	51	A
1	Progreston Falls	48	A
53	Billy Green Falls	45	A
60	Fruitland Falls	45	A
81	East Iroquoia Falls	42	A
6	Borer's Falls	42	A
80	West Iroquoia Falls	41	B
77	Sisters of Mary Falls	41	B
71	Dyment Falls	39	B
8	Sydenham Falls	38	B
125	Cave Falls	38	B
42	Cliffview Falls	38	B
89	Harvey Falls	38	B
118	Beverly Falls	36	B
43	Lower Chedoke Falls	36	B
90	Promontory Falls	36	B
114	Troy Cascade	36	B
41	Westcliffe Falls	36	B
72	Lafarge Falls	35	B
110	Mountain Spring Falls	33	B
56	Erland Falls	33	B
3	Great Falls	33	B
39	Lower Westcliffe Falls	33	B
38	Mountview Falls	33	B
58	Ridge Falls	33	B
120	Lottridge Cascade	32	B
2	Upper Grindstone Falls	32	B
82	Veevers Falls	32	B
76	Betzner Falls	31	B
79	Ancaster Heights Falls	31	B
119	Hunter Falls	31	B
128	Limeridge Falls	31	B
32	Stephanie Falls	31	B

Rank A = 20

Rank B = 70

Site No.	Name	Numerical Ranking Score	Magnitude Rank
85	McNeilly West Falls	30	B
16	Dundas Falls	29	B
23	Canterbury Falls	29	B
83	Centennial Falls	29	B
103	Heritage Green Falls	29	B
86	McNeilly Falls	29	B
17	Steven's Falls	29	B
113	Auchmar Falls	26	B
14	Baby Webster's Falls	25	B
88	Lewis Rd. East Falls	25	B
49	Little Davis Falls	25	B
54	Lower Punchbowl Falls	25	B
21	Mill Falls	25	B
138	Sugar Shack Falls	25	B
36	Upper Sanatorium Falls	25	B
29	Washboard Falls	25	B
95	East of Fifty Falls	25	B
12	Lower Tew's Falls	24	B
52	Glover's Falls	24	B
87	Lewis Rd. West Falls	24	B
22	Lower Mill Falls	24	B
31	Shaver Falls	24	B
62	Vinemount West Falls	24	B
126	Billy Monkley Cascade	23	B
94	Fifty Rd. Cascade	22	B
19	Hermitage Cascade	22	B
27	Little Falls	22	B
78	Lower Little Falls	22	B
98	Samuel Cascade	22	B
133	Lower Mohawk Falls	21	B
9	Middle Sydenham Falls	21	B
121	Pettit Cascade	21	B
130	Baby Albion Falls	21	B
69	Lower Hopkins Cascade	21	B
70	Rock Chapel Falls	21	B
93	West of Fifty Upper Cascade	21	B
100	Clappison Falls	20	B
51	East Glover's Falls	20	B
4	Grindstone Cascade	20	B
139	Logie's Falls	20	B
7	Lower Borer's Falls	20	B
61	Lower Fruitland Falls	20	B
35	Princess Falls	20	B
102	Hidden Grindstone Falls	19	C
108	Lower Glendale Falls	19	C
116	Oak Knoll Falls	19	C
122	Broman Falls	18	C

Rank C = 55

Site No.	Name	Numerical Ranking Score	Magnitude Rank
92	West of Fifty Lower Falls	18	C
57	Dewitt Falls	18	C
115	Hannon Cascade	18	C
20	Heritage Falls	18	C
65	Jones Rd. Falls	18	C
40	Lower Cliffview Falls	18	C
10	Lower Sydenham Falls	18	C
96	Puddicombe Falls	18	C
63	Vinemount East Falls	18	C
129	Lower Maple Cascade	18	C
107	Valley Falls	17	C
109	Middle Glendale Falls	17	C
142	Romar Cascade	17	C
105	Brown's Falls	17	C
74	East Greensville Falls	16	C
24	Little Canterbury Falls	16	C
37	Lower Sanatorium Cascade	16	C
136	Moss Falls	16	C
25	Old Dundas Rd. Falls	16	C
143	Smith Cascade	16	C
97	Optimist Cascade	16	C
132	Maple West Falls	15	C
67	Quarry Falls	15	C
145	West Brown's Cascade	15	C
140	Blue Falls	15	C
18	Mineral Springs Falls	15	C
46	Upper Glendale Falls	15	C
30	Upper Shaver Falls	15	C
104	Duchess Falls	14	C
68	Upper Hopkins Cascade	14	C
134	Upper Mohawk Cascade	13	C
66	Upper Quarry Cascade	13	C
124	Walnut Grove Falls	13	C
112	Patterson East Cascade	13	C
91	Grand Cascade	13	C
73	Springhill Falls	13	C
84	Tallman West Falls	13	C
59	Wall Falls	13	C
131	Maple Falls	12	C
111	Patterson West Cascade	12	C
123	Pritchard Falls	12	C
75	Weirs Falls	12	C
141	Lower Scenic Cascade	11	C
106	Read Baker's Falls	11	C
127	Pond Falls	11	C
64	Tallman East Falls	11	C
144	Wesley Cascade	11	C

Site No.	Name	Numerical Ranking Score	Magnitude Rank
137	Great Western Cascade	10	C
99	Beckett Falls	9	C
135	Maple East Falls	9	C
146	West Moss Cascade	9	C

Table 13: Magnitude Ranks

Table 14 displays the results of the statistics performed on this dataset. The Magnitude Ranking scores range from 9 to 100. The average Magnitude Ranking score for waterfalls within the City of Hamilton is 27 (Rank B), whereas the median indicates that 50% of all waterfalls have a Magnitude Ranking score of 22 or less, or are within Rank B and C.

Statistic	Result (out of 100)
Low Value	9
High Value	100
Mean	27
Median	22
Standard Deviation	16

Table 14: Magnitude Ranking score statistics

Figure 8 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of waterfalls have a Magnitude Ranking score between 11 and 43, or within 16 points of the mean in either direction. The peak indicates that it is probable that a waterfall's Magnitude Ranking score will be similar to the mean. This distribution is positively skewed as a result of there being more waterfalls with lower Magnitude Ranking scores and two extreme scores above 90 [Tew's Falls (96) and Webster's Falls (100)]. This also indicates that deviations from the mean will be in a positive direction.

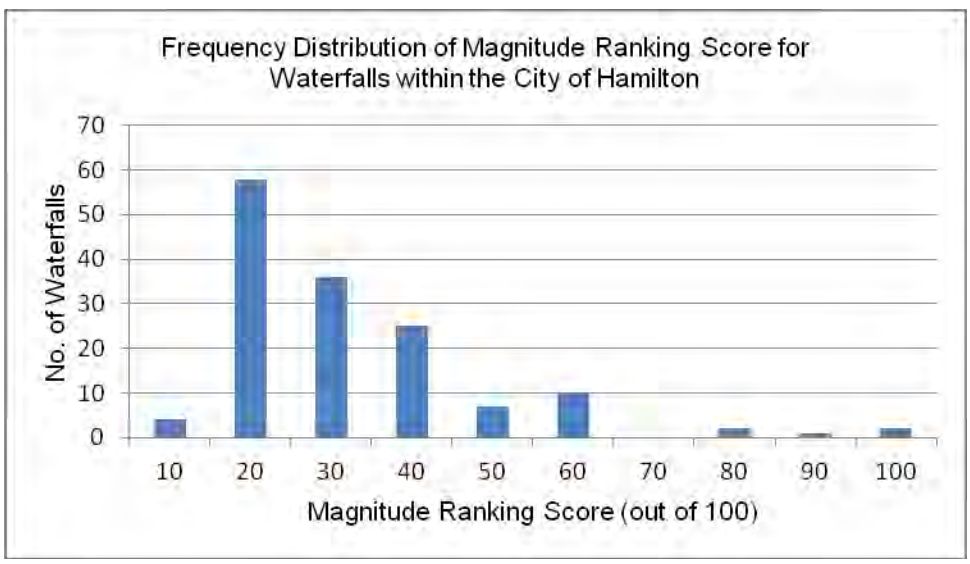

Figure 8: Frequency distribution of Magnitude Ranking scores

3. 2. 3 Visitor Access Rank

When the visitor accessibility characteristics were analyzed, using the methods in Section 2. 3. 9. 1. 3, the following ranks resulted (see Table 15). Since Visitor Access Ranks were a function of waterfall ownership and accessibility, the publicly owned and easily accessible waterfalls, produced higher numerical ranking scores. The Visitor Access Ranking scores were then broken into three classes using natural breaks classification: excellent (Rank A – score: 100 to 77), good (Rank B – score: 76 to 46), satisfactory (Rank C – score: 45 to 0). As a result of this analysis forty-five (45) waterfalls within the City of Hamilton have excellent visitor accessibility characteristics, fifty-six (56) waterfalls have good visitor accessibility characteristics, and forty-four (44) waterfalls have satisfactory visitor accessibility characteristics. Since these results are displayed in ratio scale we can compare the results of one waterfall to another. For example, Albion Falls has a Visitor Access Ranking score of 92 and Progreston Falls has a Visitor Access Ranking score of 46, therefore we can say that currently Albion Falls is twice as visitor-friendly as Progreston Falls.

Site #	Waterfall Name	Numerical Ranking Score	Visitor Access Rank
50	Felker's Falls	100	A
103	Heritage Green Falls	100	A
110	Mountain Spring Falls	100	A
123	Pritchard Falls	100	A
11	Tew's Falls	100	A
48	Albion Falls	92	A
122	Broman Falls	92	A
55	Devil's Punchbowl Falls	92	A
3	Great Falls	92	A
4	Grindstone Cascade	92	A
78	Lower Little Falls	92	A
109	Middle Glendale Falls	92	A
35	Princess Falls	92	A
96	Puddicombe Falls	92	A
138	Sugar Shack Falls	92	A
28	Tiffany Falls	92	A
107	Valley Falls	92	A
93	West of Fifty Upper Cascade	92	A
79	Ancaster Heights Falls	85	A
14	Baby Webster's Falls	85	A
6	Borer's Falls	85	A
47	Buttermilk Falls	85	A
23	Canterbury Falls	85	A
74	East Greensville Falls	85	A
94	Fifty Rd. Cascade	85	A
20	Heritage Falls	85	A
24	Little Canterbury Falls	85	A
69	Lower Hopkins Cascade	85	A
54	Lower Punchbowl Falls	85	A
70	Rock Chapel Falls	85	A

Rank A = 45

Site #	Waterfall Name	Numerical Ranking Score	Visitor Access Rank
13	Webster's Falls	85	A
53	Billy Green Falls	77	A
83	Centennial Falls	77	A
42	Cliffview Falls	77	A
57	Dewitt Falls	77	A
19	Hermitage Cascade	77	A
49	Little Davis Falls	77	A
40	Lower Cliffview Falls	77	A
39	Lower Westcliffe Falls	77	A
38	Mountview Falls	77	A
112	Patterson East Cascade	77	A
111	Patterson West Cascade	77	A
33	Scenic Falls	77	A
46	Upper Glendale Falls	77	A
36	Upper Sanatorium Falls	77	A
130	Baby Albion Falls	69	B
99	Beckett Falls	69	B
45	Chedoke Falls	69	B
15	Darnley Cascade	69	B
16	Dundas Falls	69	B
71	Dyment Falls	69	B
95	East of Fifty Falls	69	B
91	Grand Cascade	69	B
89	Harvey Falls	69	B
88	Lewis Rd. East Falls	69	B
87	Lewis Rd. West Falls	69	B
27	Little Falls	69	B
7	Lower Borer's Falls	69	B
43	Lower Chedoke Falls	69	B
22	Lower Mill Falls	69	B
37	Lower Sanatorium Cascade	69	B
21	Mill Falls	69	B
90	Promontory Falls	69	B
26	Sherman Falls	69	B
17	Steven's Falls	69	B
68	Upper Hopkins Cascade	69	B
66	Upper Quarry Cascade	69	B
29	Washboard Falls	69	B
41	Westcliffe Falls	69	B
126	Billy Monkley Cascade	62	B
51	East Glover's Falls	62	B
81	East Iroquoia Falls	62	B
52	Glover's Falls	62	B
65	Jones Rd. Falls	62	B

Rank B = 56

Site #	Waterfall Name	Numerical Ranking Score	Visitor Access Rank
34	Lower Princess Falls	62	B
10	Lower Sydenham Falls	62	B
86	McNeilly Falls	62	B
82	Veevers Falls	62	B
80	West Iroquoia Falls	62	B
113	Auchmar Falls	54	B
128	Limeridge Falls	54	B
12	Lower Tew's Falls	54	B
140	Blue Falls	46	B
125	Cave Falls	46	B
44	Denlow Falls	46	B
101	Ferguson Falls	46	B
115	Hannon Cascade	46	B
102	Hidden Grindstone Falls	46	B
108	Lower Glendale Falls	46	B
129	Lower Maple Cascade	46	B
133	Lower Mohawk Falls	46	B
141	Lower Scenic Cascade	46	B
18	Mineral Springs Falls	46	B
116	Oak Knoll Falls	46	B
1	Progreston Falls	46	B
142	Romar Cascade	46	B
143	Smith Cascade	46	B
134	Upper Mohawk Cascade	46	B
124	Walnut Grove Falls	46	B
144	Wesley Cascade	46	B
146	West Moss Cascade	46	B
100	Clappison Falls	38	C
104	Duchess Falls	38	C
72	Lafarge Falls	38	C
9	Middle Sydenham Falls	38	C
67	Quarry Falls	38	C
31	Shaver Falls	38	C
77	Sisters of Mary Falls	38	C
73	Springhill Falls	38	C
32	Stephanie Falls	38	C
8	Sydenham Falls	38	C
64	Tallman East Falls	38	C
2	Upper Grindstone Falls	38	C
75	Weirs Falls	38	C
92	West of Fifty Lower Falls	38	C
76	Betzner Falls	23	C
117	Beverly Cascade	23	C
118	Beverly Falls	23	C

Rank C = 44

Site #	Waterfall Name	Numerical Ranking Score	Visitor Access Rank
105	Brown's Falls	23	C
56	Erland Falls	23	C
60	Fruitland Falls	23	C
137	Great Western Cascade	23	C
119	Hunter Falls	23	C
139	Logie's Falls	23	C
120	Lottridge Cascade	23	C
61	Lower Fruitland Falls	23	C
135	Maple East Falls	23	C
131	Maple Falls	23	C
132	Maple West Falls	23	C
85	McNeilly West Falls	23	C
136	Moss Falls	23	C
25	Old Dundas Rd. Falls	23	C
97	Optimist Cascade	23	C
121	Pettit Cascade	23	C
127	Pond Falls	23	C
106	Read Baker's Falls	23	C
58	Ridge Falls	23	C
98	Samuel Cascade	23	C
84	Tallman West Falls	23	C
114	Troy Cascade	23	C
30	Upper Shaver Falls	23	C
63	Vinemount East Falls	23	C
62	Vinemount West Falls	23	C
59	Wall Falls	23	C
145	West Brown's Cascade	23	C

Table 15: Visitor Access Ranks

Table 16 displays the results of the statistics performed on this dataset. The Visitor Access Ranking scores range from 23 to 100. The average Visitor Access Ranking score for waterfalls within the City of Hamilton is 58 (Rank B), whereas the median indicates that 50% of all waterfalls have a Visitor Access Ranking score of 62 or less, or are within Rank B and C.

Statistic	Result (out of 100)
Low Value	23
High Value	100
Mean	58
Median	62
Standard Deviation	24

Table 16: Visitor Access Ranking score statistics

Figure 9 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of waterfalls have a Visitor Access Ranking score between 34 and 82, or within 24 points of the mean in either direction. This distribution is very similar to

a normal distribution meaning that nearly 50% of the time a waterfall's Visitor Access Ranking score would fall above the mean. However, this distribution is just slightly skewed in the negative direction due to there being a sub-set of waterfalls with Visitor Access Ranking scores between 20 and 58. This skewness also indicates that deviations from the mean will be slightly in the negative direction. There are five waterfalls with Visitor Access Ranking scores of 100 (Felker's Falls, Ferguson Falls, Hunter Falls, Lower Glendale Falls and Tew's Falls).

This distribution is interesting due to the sub-set of waterfalls that exhibit a decreasing trend leading up to the mean value. The results show that the waterfalls with Visitor Access Ranking scores between 20 and 69 include those waterfalls with limited visitor accessibility. Within this group of waterfalls, those with numerical ranking scores of 23 to 69 include inaccessible waterfalls where no trail is currently in place, while waterfalls with a numerical ranking score of 46 to 77 include are those on private property in which you can see from a roadway or those located on public property and are difficult to access. However, as site access enhancements are encouraged these Visitor Access Ranking scores may change.

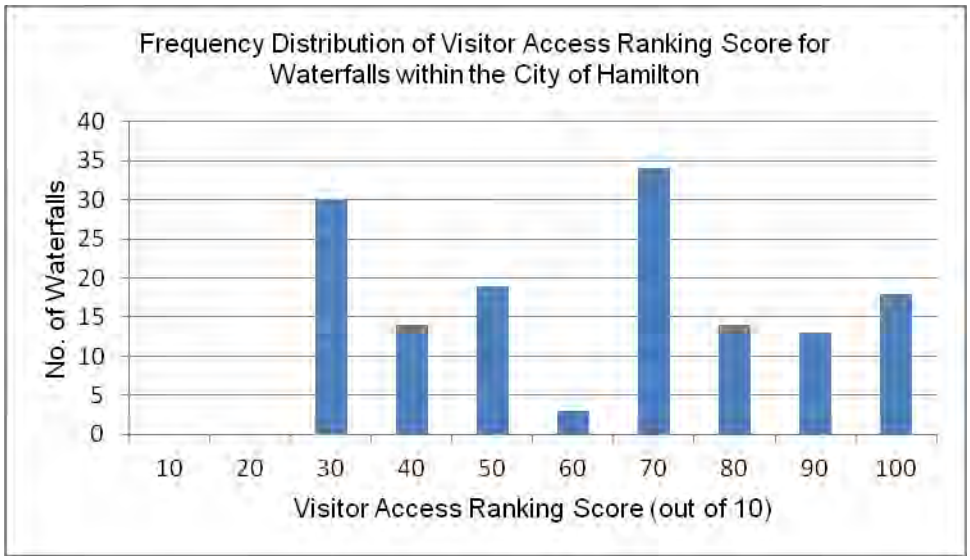

Figure 9: Frequency distribution of Visitor Access Ranking scores

3. 2. 4 Overall Rank

The Overall Ranking results are outlined in this section using the methods in Section 2. 3. 9. 1. 4 (see Table 17). Since the Overall Rank of a waterfall is a function of the high weighting of natural characteristics and the low weighting of visitor accessibility characteristics, a higher numerical ranking score resulted from a waterfall with appealing natural characteristics. The Overall Ranking scores were then broken into three classes using natural breaks classification: excellent (Rank A – score: 100 to 39), good (Rank B – score: 38 – 14), satisfactory (Rank C – score: 13 to 0). As a result of this analysis eighteen (18) waterfalls within the City of Hamilton are found to be excellent for potential visitor attraction, forty-seven (47) waterfalls are good for potential visitor attraction, and eighty (80) waterfalls are satisfactory for potential visitor attraction. Since these results are displayed in ratio scale we can compare the results of one waterfall to another. For example, Chedoke Falls has an Overall Ranking score of 60 and Lower Westcliffe Falls has an Overall Ranking score of 30, therefore we can say that Chedoke Falls is twice as likely to attract visitors as Lower Westcliffe Falls.

Site #	Waterfall Name	Numerical Ranking Score	Overall Rank
11	Tew's Falls	100	A
13	Webster's Falls	99	A
55	Devil's Punchbowl Falls	83	A
48	Albion Falls	80	A
50	Felker's Falls	69	A
28	Tiffany Falls	66	A
45	Chedoke Falls	60	A
15	Darnley Cascade	58	A
26	Sherman Falls	57	A
6	Borer's Falls	54	A
34	Lower Princess Falls	52	A
42	Cliffview Falls	49	A
3	Great Falls	49	A
1	Progreston Falls	49	A
43	Lower Chedoke Falls	46	A
41	Westcliffe Falls	46	A
47	Buttermilk Falls	45	A
33	Scenic Falls	39	A
21	Mill Falls	37	B
53	Billy Green Falls	37	B
22	Lower Mill Falls	36	B
44	Denlow Falls	35	B
71	Dyment Falls	32	B
39	Lower Westcliffe Falls	30	B
38	Mountview Falls	30	B
23	Canterbury Falls	29	B
77	Sisters of Mary Falls	28	B
14	Baby Webster's Falls	28	B
54	Lower Punchbowl Falls	28	B
16	Dundas Falls	27	B
17	Steven's Falls	27	B
8	Sydenham Falls	26	B
49	Little Davis Falls	26	B
4	Grindstone Cascade	26	B
35	Princess Falls	26	B
29	Washboard Falls	25	B
19	Hermitage Cascade	24	B
72	Lafarge Falls	24	B
2	Upper Grindstone Falls	23	B
114	Troy Cascade	23	B
40	Lower Cliffview Falls	23	B
32	Stephanie Falls	22	B
7	Lower Borer's Falls	22	B
12	Lower Tew's Falls	22	B
76	Betzner Falls	20	B
10	Lower Sydenham Falls	20	B
119	Hunter Falls	20	B

Rank A = 18

Rank B = 47

Site #	Waterfall Name	Numerical Ranking Score	Overall Rank
101	Ferguson Falls	19	B
31	Shaver Falls	19	B
108	Lower Glendale Falls	18	B
9	Middle Sydenham Falls	18	B
110	Mountain Spring Falls	17	B
117	Beverly Cascade	17	B
81	East Iroquoia Falls	16	B
103	Heritage Green Falls	16	B
80	West Iroquoia Falls	16	B
89	Harvey Falls	16	B
18	Mineral Springs Falls	15	B
79	Ancaster Heights Falls	15	B
90	Promontory Falls	15	B
138	Sugar Shack Falls	14	B
83	Centennial Falls	14	B
125	Cave Falls	14	B
60	Fruitland Falls	14	B
78	Lower Little Falls	14	B
82	Veevers Falls	13	C
93	West of Fifty Upper Cascade	13	C
36	Upper Sanatorium Falls	13	C
94	Fifty Rd. Cascade	13	C
86	McNeilly Falls	13	C
122	Broman Falls	13	C
69	Lower Hopkins Cascade	13	C
70	Rock Chapel Falls	13	C
96	Puddicombe Falls	13	C
128	Limeridge Falls	13	C
88	Lewis Rd. East Falls	12	C
107	Valley Falls	12	C
109	Middle Glendale Falls	12	C
95	East of Fifty Falls	12	C
87	Lewis Rd. West Falls	12	C
20	Heritage Falls	12	C
123	Pritchard Falls	12	C
27	Little Falls	12	C
74	East Greensville Falls	11	C
24	Little Canterbury Falls	11	C
113	Auchmar Falls	11	C
52	Glover's Falls	11	C
118	Beverly Falls	11	C
130	Baby Albion Falls	11	C
57	Dewitt Falls	11	C
126	Billy Monkley Cascade	11	C
51	East Glover's Falls	10	C
56	Erland Falls	10	C
58	Ridge Falls	10	C

Rank C = 80

Site #	Waterfall Name	Numerical Ranking Score	Overall Rank
46	Upper Glendale Falls	10	C
120	Lottridge Cascade	10	C
37	Lower Sanatorium Cascade	10	C
65	Jones Rd. Falls	10	C
112	Patterson East Cascade	10	C
85	McNeilly West Falls	10	C
111	Patterson West Cascade	10	C
68	Upper Hopkins Cascade	9	C
133	Lower Mohawk Falls	9	C
66	Upper Quarry Cascade	9	C
91	Grand Cascade	9	C
102	Hidden Grindstone Falls	9	C
116	Oak Knoll Falls	9	C
115	Hannon Cascade	9	C
129	Lower Maple Cascade	8	C
100	Clappison Falls	8	C
99	Beckett Falls	8	C
142	Romar Cascade	8	C
143	Smith Cascade	8	C
62	Vinemount West Falls	8	C
92	West of Fifty Lower Falls	8	C
140	Blue Falls	8	C
98	Samuel Cascade	8	C
121	Pettit Cascade	7	C
134	Upper Mohawk Cascade	7	C
124	Walnut Grove Falls	7	C
67	Quarry Falls	7	C
139	Logie's Falls	7	C
61	Lower Fruitland Falls	7	C
141	Lower Scenic Cascade	7	C
104	Duchess Falls	7	C
144	Wesley Cascade	7	C
63	Vinemount East Falls	7	C
73	Springhill Falls	7	C
146	West Moss Cascade	6	C
75	Weirs Falls	6	C
105	Brown's Falls	6	C
136	Moss Falls	6	C
25	Old Dundas Rd. Falls	6	C
64	Tallman East Falls	6	C
97	Optimist Cascade	6	C
132	Maple West Falls	6	C
145	West Brown's Cascade	6	C
30	Upper Shaver Falls	6	C
84	Tallman West Falls	5	C
59	Wall Falls	5	C
131	Maple Falls	5	C

Site #	Waterfall Name	Numerical Ranking Score	Overall Rank
106	Read Baker's Falls	5	C
127	Pond Falls	5	C
137	Great Western Cascade	5	C
135	Maple East Falls	4	C

Table 17: Overall Ranks

Table 18 displays the results of the statistics performed on this dataset. The Overall Ranking scores range from 4 to 100. The average Overall Ranking score for waterfalls within the City of Hamilton is 20 (Rank B), whereas the median indicates that 50% of all waterfalls have an Overall Ranking score of 13 or less, or are within Rank C.

Statistic	Result (out of 100)
Low Value	4
High Value	100
Mean	20
Median	13
Standard Deviation	18

Table 18: Overall Ranking score statistics

Figure 10 illustrates the frequency of the distribution and pictorially represents the above-noted statistics. The standard deviation demonstrates that the majority of waterfalls have an Overall Ranking score between 2 and 38, or within 18 points of the mean in either direction. The peak indicates that it is possible that a waterfall's Overall Ranking score will be similar to the mean. This distribution is positively skewed as a result of there being more waterfalls with lower Overall Ranking scores and few waterfalls with numerical ranking scores above 80 [Albion Falls (80), Devil's Punchbowl Falls (83), Webster's Falls (99), and Tew's Falls (100)]. These are the same waterfalls noted within the Magnitude Ranking analysis (see Section 3. 2. 2). This skewness also indicates that deviations from the mean will be in a positive direction.

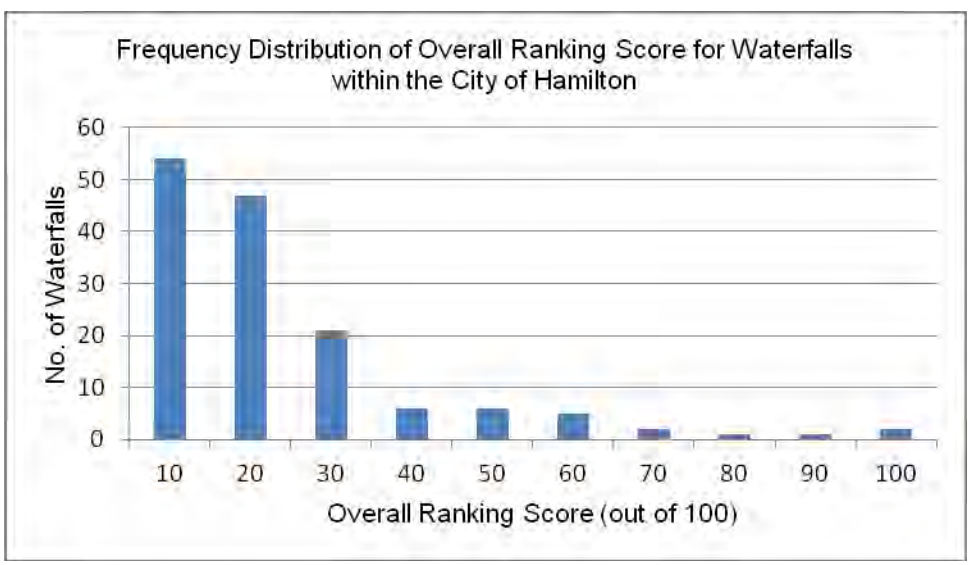

Figure 10: Frequency distribution of Overall Ranking scores

3. 3 Study Limitations

The limitations and constraints of this study are outlined in this section. These factors should be taken into consideration when interpreting the data and results found within this report.

3. 3. 1 Study Limitations

One of the main limitations to this study was that more than one person collected the data presented in this report due to time constraints. It would have been beneficial for one person to have visited all of the waterfall sites in order to conduct a thorough and consistent analysis of the waterfall variables. The benefit being that when an overall analysis is conducted there would be a baseline set by one individual in regards to each and every waterfall site. Since this standardized measurement of waterfall variables was not available, the author used the data supplied by the field researchers in addition to consulting with Hamilton waterfall experts.

It must be noted that ranking in such a manner that is presented in this report is only as accurate as the variables that are factored into the equation. Although every effort was taken to determine accurate property ownership at the top of the waterfall, most of the waterfall site locations were estimated using a GIS in addition to GPS readings, therefore due to technical inaccuracies some degree of error may be present. Therefore, ownership assignments should be reviewed in the field prior to finalizing conceptual site design and capital cost estimates for the site enhancements of the highest-ranked waterfall clusters.

The natural characteristics of a waterfall could have been better evaluated by taking waterfall volume and slope into consideration. Unfortunately these two variables were not within the scope of this study, and therefore an Aesthetics Rank was created to account for this oversight and as a result used to bias the Overall Ranking results. Although waterfall Aesthetics Ranks were well-discussed by the Project Advisory Team, this ranking is still subjective.

Additionally, numerical ranking scores, and therefore associated ranks, are based on the number of waterfalls under study. If more waterfalls are found within the City of Hamilton then these ranking scores may be slightly altered since the highest value in which each score is divided may change. Consequently natural breaks in the data may change and as a result waterfalls may shift up or down a rank depending on the results. Also dynamic ranks (Visitor Access and Overall Ranks), based on visitor attraction characteristics, will change depending on site access enhancements that are completed.

3. 4 Future Considerations for Access & Management

Future reports and analyses are dependent on a number of specific factors, such as property ownership, public safety, sustainability, environmental impact, budgeting and development approvals. This section outlines recommendations for project partners to consider when planning for future waterfall site access enhancements and visitor potential.

3. 4. 1 Property Ownership

Waterfall site access enhancement is dependent on property ownership. Even though one hundred and forty-five waterfalls were found within the City of Hamilton, not all are publicly accessible as a result of their ownership.

Private ownership is the main constraint to waterfall site access enhancement, since permission must be sought in order to access the waterfall site. Out of the sixty-three (63) waterfalls that are owned privately, four (4) are considered by the Project Advisory Team as having excellent aesthetics, fourteen (14) are considered to have good aesthetics, and forty-five (45) have satisfactory aesthetics. Some of these waterfalls are currently accessible through an agreement with the landowner and the Bruce Trail Conservancy (BTC) for the public to access the Bruce Trail for hiking purposes. Of those waterfalls that do not have Bruce Trail access, three (3) are considered as having excellent aesthetics, fourteen (14) are considered as having good aesthetics, while thirty-seven (37) are thought to have satisfactory aesthetics by the Project Advisory Team.

The Corporation of the City of Hamilton owns forty one (41) waterfalls. Of the forty one, many are ranked as some of the best waterfalls in the City. Without their commitment and cooperation, site access and enhancements would not be possible. It is important that the Corporation of the City of Hamilton ensures visitor accessibility is improved where environmentally possible and recreation potential realized. HCA will work with project partners to encourage detailed site concept designs and accurate cost estimates for waterfall clusters with high Overall Ranks.

3. 4. 2 Public Safety

In all cases, public safety, liability, due diligence, and risk management must be addressed. Project partners will determine appropriate signage and necessary steps to ensure public safety at all times.

No members of the public should attempt to access any waterfalls on private property. Permission to access waterfalls on private property has been requested by the researcher, and where permission has been granted, these waterfalls have been included in official publications and promotional materials associated with this report. Any attempt to visit a waterfall that is on private property but that is not listed as accessible through this inventory is done so as the person's own risk.

Also in the interest of public safety, waterfalls only accessible by walking along railways have been categorized as inaccessible. These waterfalls are also not included in official publications and promotional materials associated with this report. Railway lines are private property and accessing these waterfalls is trespassing. It is recommended that these waterfalls not be visited by members of the public; any person who does visit these waterfalls does so at their own risk.

3. 4. 3 Marketing and Promotion

The Hamilton Halton Brant Regional Tourism Association recently completed Regional Tourism Organization 3 (RTO3) The Heart of Ontario: A Three Year Regional Tourism Strategy Final Draft August 2011 and the Outdoor Adventure Product Assessment April 2012. Both documents contain strategic directions related to outdoor tourism marketing. The Outdoor Adventure Product Assessment identifies waterfalls as a key influencer in the region; one that forms the basis for many regional outdoor experiences.

Outdoor tourism products should focus on enhancing the quality of visitor experiences to natural areas while maintaining the conservation ethic and recognizing the need for ecologically sustainable tourism.

Products should focus on promoting waterfalls where trails and infrastructure are in place to ensure the ecological sensitivity of the waterfalls is not disturbed. The surrounding natural environment, communities and infrastructure must be able to support the demand for visitor access. It is recommended that outdoor tourism products primarily promote the eighteen (18) Category A waterfalls, taking into consideration that only waterfalls on public lands or on privately owned property, where permission to access has been obtained, are to be included in publications and promotional materials.

Promotional products should also be designed around non vehicular modes of transit for accessing waterfalls, including: public transit, carpooling, hiking and cycling. Alternative promotions to highlight other methods of access or other key attractions should be considered for waterfalls where significant numbers of visitors becomes a concern.

Bruce Trail Conservancy, City of Hamilton (Tourism Hamilton), City of Waterfalls, Dundas Valley 50 Year Vision Community Advisory Committee, Hamilton Conservation Authority and Royal Botanical Gardens should be consulted on outdoor tourism products to be developed subsequent to the Outdoor Adventure Product Assessment Report. These products should draw from the City of Hamilton / Hamilton Conservation Authority Waterfalls Survey Analysis 2007 (DeGroote School of Business, 2007).

Hamilton Conservation Authority will update the Waterfalls and Cascades of Hamilton brochure on an as needed basis. Tourism Hamilton will continue to oversee the printing and distribution of the brochure. The City of Hamilton and Hamilton Conservation Authority will continue to maintain and update on an as needed basis, the Cascades and Waterfalls of Hamilton website to ensure that the content continues to be operational and accurate. This includes the online versions of the self-guided waterfalls walks, cycling routes and website pages designed for mobile devices.

Citizen groups focused on visiting Hamilton's waterfalls have already formed and should be encouraged, and where applicable, be included in the marketing and promotion of the waterfalls. These groups have the potential to participate in the promotion of the sustainable use and stewardship of the waterfalls in Hamilton.

3. 4. 4 Environmental Impacts

Waterfalls are a natural phenomenon where without nature they would not occur. As noted earlier in this report, the geological and ecological importance of the Niagara and Eramosa Escarpments and Hamilton's waterfalls is significant. Recreational infrastructure should be designed and managed in accordance with appropriate uses as classified in the Niagara Escarpment Parks and Open Spaces System. Proper short- and long-term environmental impact analyses must be considered prior to any site concept designs for recreational planning and infrastructure being finalized. Consideration of the environmental sensitivity of waterfall sites must also be given when developing marketing and promotional campaigns and community events, such as litter cleanups. Conservation Authority and City of Hamilton staff can aid in these analyses and provide input and guidance in this regard. Additionally the impact of vandalism, littering, and loitering will be considered in design considerations and park operations.

3. 4. 5 Capital & Operational Funding

Considering the appeal of waterfalls to both residents and visitors alike, it is assumed that funding partners will also find this initiative attractive. Coupled with the extensive trail network, waterfront, and natural lands associated with the City of Hamilton, waterfalls could be a strong element in developing the

City of Hamilton's image as a healthy community with many outdoor recreation opportunities and a strong tourism sector.

Project partners will need to make challenging fundraising decisions if they are to commit to developing the waterfall recreation and tourism potential within the City of Hamilton. This fundraising is required in order to fully implement site access enhancements to these destinations and to meet recreation and tourism marketing initiatives. Site concept design is fundamental in providing the framework for the funding process as it will provide a clearer indication of the capital cost of improving waterfall access, viewing, and visitor facilities.

Due to the nature and expenses associated with capital improvements and operational considerations, it is suggested that all partners continue their commitment to the existing Waterfall Site Development Plan (2006-2010) to complete plans for improving access and recreational opportunities at select waterfall sites. It is recommended that resources be allocated to improvements at Category A and B waterfalls only. Historic records of Waterfall Site Development Plans can be found in Appendix A.

Below are descriptions of waterfall site developments planned for the ten year period (2014 to 2023). This summary should be reviewed and endorsed by the project partners. It should also be periodically reviewed and revised throughout the duration of the term in an attempt to maintain the coordination of timelines and budgets.

- Albion Falls / Buttermilk Falls – The City of Hamilton will develop safer access to Albion Falls. In this vicinity of Albion Falls, the Bruce Trail Conservancy would like to develop a Bruce Trail Side Trail to the base of Buttermilk Falls. The City of Hamilton will consider an enhanced viewing point for Buttermilk Falls at the top of the Niagara Escarpment.

- Billy Monkley Cascade – HCA will be updating the Mount Albion Conservation Area Master Plan, beginning in 2014. Components of the master plan will include trail improvements and the addition of an access trail to Billy Monkley Cascade.

- Borer's Falls – Royal Botanical Gardens will make improvements to the viewing area at Borer's Falls and access from the parking lot at Rock Chapel.

- Chedoke Falls / Scenic Falls – HCA will be updating the Iroquoia Heights Conservation Area Master Plan beginning in 2014. HCA will work with the City of Hamilton and Bruce Trail Conservancy to plan for improved access and viewing to Scenic and Princess Falls as part of the master planning process. Improvements will include strategic viewing points and additional parking at this node which provides access to several waterfalls. Heritage features, such as remnants of historic dam structures will be considered as part of the improvements.

- Darnley Cascade – An updated conditions report for the Darnley Mill is recommended as part of the recently approved Crooks Hollow Conservation Area Master Plan. HCA will use the findings of the report to plan for improvements to access and viewing points for Darnley Cascade from the Darnley Mill location.

- Devil's Punch Bowl Falls – HCA has undertaken works to refurbish the illuminated cross at the crest of the Niagara Escarpment in the Devil's Punch Bowl Conservation Area. Additional improvements include development of a walkway and landscaping. The City of Hamilton will be considering safety measures along Ridge Road due to the erosional nature of the main waterfall.

- Felker's Falls – HCA will be working with the City of Hamilton to improve safety and viewing opportunities of Felker's Falls at the Felker's Falls Conservation Area. A new bridge and multi-use trail will connect the East Mountain Trail Loop to the Heritage Green Sports Park and a protective railing will be installed on the east side of the gorge to provide for visitor safety.

- Shaver Falls – The Bruce Trail Conservancy will be realigning the Bruce Trail access closer to Shaver Falls for improved viewing and access.

- Sherman Falls – HCA plans to establish a parking lot on HCA lands in the vicinity of Sherman Falls to improve off available road parking facilities.

- Webster's Falls – A Master Plan for the Spencer Gorge / Webster's Falls Conservation Area has been completed. The master plan recommends continued plans for improving access to Webster's and Tew's Falls, including working towards the objective of re-routing the Bruce Trail Main Trail back through the gorge.

3. 4. 6 Development Controls and Approval

It is noted that any development approval required by law must be acquired prior to the commencement of any works related to waterfall site development. This includes but is not limited to: Niagara Escarpment Commission Development Permits, Conservation Authority permits for development, municipal building permits, and any other provincial or federal permits required. Adequate allowance for the development approval process should be included in planning for maintenance and capital improvements at waterfalls destinations.

4 CONCLUSION

Through geo-spatial techniques and field research methods one hundred and forty-five (145) waterfalls have been identified within the City of Hamilton. An additional five (5) waterfalls located just within the limits of the City of Burlington are reported in this document, since they are in close proximity and form waterfall clusters with Hamilton waterfalls; however these waterfalls found on Hamilton's outskirts are only documented in the appendices to this report.

Waterfalls within the City of Hamilton were mainly found within the communities of Flamborough (47), Stoney Creek (31), Hamilton (41), Ancaster (20), and Dundas (6). The City wards with the highest number of waterfalls within their boundaries were Ward 15 (27), Ward 14 (23), Ward 11 (21) and Ward 12 (19). The HCA jurisdictional boundaries include one hundred and twenty-seven (127) waterfalls found within the City of Hamilton's limits, with the Spencer Creek watershed containing the most waterfalls (43). The area with the highest density of waterfalls within its limits is the Chedoke Creek watershed which contains twenty-two (22) waterfalls; this area is located near Hamilton's city centre. Additionally, it was also found that majority of the waterfalls were located within a 23 kilometre radius of the Highway 403 and Main Street intersection in Hamilton.

Although rigorous statistical analyses were not within the scope of this study, three theories seem to become evident looking at the spatial distribution of the waterfalls reported in this document. It is apparent that there are clusters of waterfalls along certain watercourses. All of these clusters appear along the slopes associated with the Niagara Escarpment, whereas waterfalls found away from the edge of the Niagara Escarpment are associated with the Eramosa Escarpment or are independent occurrences. Therefore it seems as though the majority of the waterfalls reported in this document are a function of the Escarpment's steep slopes as they flow over the Escarpment's bedrock at or near the Escarpment face. Additionally, it is hypothesized that at one time Hamilton may have had many more waterfalls within its limits as there is an obvious absence of waterfalls along Hamilton's Escarpment brow and within an area that now is characteristic of intense urban development and altered surface drainage.

Although a waterfall must be visually appealing, visitor accessibility characteristics were found to be the main driving factor when drawing visitors to waterfall sites. The following conclusions were drawn from the data collected through this study.

It was found that the average dimensions of Hamilton's waterfalls are 9 metres high by 4 metres wide. The majority of waterfall heights range from 2 to 16 metres with 65% of all waterfalls within the City of Hamilton having a height of 8 metres or less. On the other hand, 86% of all waterfall widths are 6 metres or less, while the majority of Hamilton's waterfalls range between 0 and 8 metres in width. The highest and widest waterfalls are both found within the community of Flamborough and within walking distance of one another, Tew's Falls (41 m) and Webster's Falls (30 m), respectively.

The seasonality of Hamilton's waterfalls varies and is dependent on water volume. Although the best time to visit Hamilton's waterfalls is during the spring and fall months, it was found that thirty-seven (37) waterfalls have year-round flow. Sixty-seven (67) waterfalls dry up during the summer season, and forty-one (41) waterfalls are only visible after peak storm events and spring thaw.

Overall, there are eighty-six (86) waterfalls in Hamilton that are located on public lands. Forty-one (41) of these are situated on lands owned by the City of Hamilton, while thirty-two (32) are on HCA lands. Lands owned by the Ministry of Transportation accommodate five (5) of Hamilton's waterfalls, and eight (8) waterfalls are located on Royal Botanical Gardens lands. It is worth noting that the City of Hamilton

owns fourteen (14) waterfalls that are all adjacent to one another and border the Chedoke Civic Golf Course & Winter Sports Park.

Out of all one hundred and forty-five waterfalls, seventy (70) are found to be currently inaccessible, meaning they are either on private property in which the Bruce Trail does not traverse, or they are too dangerous to access. Twenty-seven (27) of these inaccessible waterfalls are located on public property; they are either off-trail or are too dangerous to access. Of the seventy-five (75) waterfalls that are currently accessible, twenty (20) have a low degree of difficulty and are accessible by all age groups, including visitors with strollers and wheelchairs. Fifty-two (52) of these waterfalls are accessible by visitors aged 5 to 65 years, and there are three (3) waterfalls that have a high degree of difficulty and are only accessible by hikers with special arrangements. Not including those waterfalls that are currently inaccessible, there are twenty (20) waterfalls that can be viewed from a roadway and two (2) that require off-trail hiking. Additionally there are fifty-four (54) waterfalls that can be viewed from a trail, with twenty-seven (27) of these being visible from the Bruce Trail. On average it takes a visitor 9 minutes and 341 metres to access Hamilton's waterfalls from the roadway or parking area noted in this report. From this access point, the majority of waterfalls can be accessed in 1 to 17 minutes with 47% of all waterfalls being accessible within 10 minutes or less. Additionally, the majority of Hamilton's waterfalls can be accessed in 0 to 500 metres with 33% of all waterfalls being within 250 metres of the access point noted in this report.

Using the Visitor Access Ranks the Project Advisory Team can verify which waterfalls currently provide the best visitor accessibility within Hamilton, while the Magnitude Ranks will indicate which waterfalls provide the best awe-factor to the visitor. The Aesthetics Ranks take into consideration overall visual appeal of the waterfall and its surroundings. Therefore all waterfall ranks examine different waterfall characteristics and can be used in isolation or in combination with one another. However, the Overall Ranks will help guide the Project Advisory Team in determining potential visitor attraction to Hamilton's waterfalls, since it takes into account the Aesthetics, Magnitude, and Visitor Access Ranks.

The Project Advisory Team set the Aesthetics Ranks for the waterfalls within the City of Hamilton and as a result seventeen (17) waterfalls within the City of Hamilton have excellent visual appeal, thirty-four (34) waterfalls have good visual appeal, and ninety-four (94) have ordinary visual appeal.

The Magnitude Ranking analysis identified twenty (20) waterfalls within the City of Hamilton as having excellent natural characteristics, seventy (70) waterfalls as having good natural characteristics, and fifty-five (55) waterfalls as having satisfactory natural characteristics. The average waterfall was found to have good natural characteristics; with 86% of all waterfalls having either good or satisfactory natural characteristics. The two waterfalls that resulted in having the greatest awe-factor were Tew's Falls and Webster's Falls.

The Visitor Access Ranking analysis identified forty-five (45) waterfalls within the City of Hamilton as having excellent visitor accessibility characteristics, fifty-six (56) waterfalls as having good visitor accessibility characteristics, and forty-four (44) waterfalls as having satisfactory visitor accessibility characteristics. The average waterfall was found to have good visitor accessibility characteristics with 70% of all waterfalls having either excellent or good visitor accessibility characteristics. The two waterfalls that resulted in currently having the best visitor accessibility characteristics were Felker's Falls Heritage Green Falls, Mountain Spring Falls, Pritchard Falls and Tew's Falls.

The Overall Ranking analysis identified eighteen (18) waterfalls within the City of Hamilton as having excellent potential for attracting visitors, forty-seven (47) waterfalls have good potential, and eighty (80) waterfalls have satisfactory potential. The average waterfall was found to have good potential for attracting visitors with 32% of all waterfalls having good potential for attracting visitors and 55% of

waterfalls having satisfactory potential for attracting visitors. Those waterfalls that resulted in the best potential visitor attraction are Tew's Falls, Webster's Falls, Devil's Punchbowl Falls and Albion Falls.

It is assumed that visitors will visit one waterfall individually, spend a half-day exploring a specific waterfall cluster, or enjoy a full-day tour of Hamilton's waterfalls. The premise of waterfall clustering in addition to waterfall ranking provides the framework for planning for destination enhancements and recreation opportunities. In total (22) site planning clusters were identified and it is encouraged that these site planning clusters are used in conjunction with the ranking results in this report in order to provide guidance to the Project Advisory Team in prioritizing waterfall site development. Site development should consider those waterfall clusters with excellent and good potential for visitor attraction as these waterfalls will draw visitors to Hamilton's waterfalls. As detailed site plans are developed on an annual basis, waterfall property ownership should be verified in the field.

The City of Hamilton's waterfalls attract thousands of waterfall lovers per year. With market research complete, route planning underway, and this most comprehensive waterfall research and inventory complete, the HCA and waterfall project partners are ready to develop appropriate marketing strategies and sustainable recreation destinations so that residents and visitors alike will have the benefit of enjoying the natural wonders of Hamilton's Escarpment.

GLOSSARY OF TERMS

Base The point at the bottom of a waterfall where the stream ends its descent.

Cascade The sudden descent of a stream primarily over a very steep slope in its stream bed. Characterized by the stream rushing down the slope somewhat smoothly or in a series of small individual drops, or any combination of these. The steepness of the descent is greater than that of rapids, but less than vertical.

Classical A waterfall whose height is roughly equal to its crest width. Both of the following must be true: (1) The height divided by 2 is smaller than the crest width; and, (2) The height times 1.5 is equal to or is larger than the crest width.

Complex A single waterfall comprised of several different segments (e.g. overhanging, horsetail, terraced, cascading, etc.). The stream may divide into segments during its descent of the rock face, or the segments may occur side by side along the crest of a waterfall.

Crest The point at the top of a waterfall where the stream first begins its descent.

Crest Width The distance from one stream bank to the other along the crest of a waterfall.

Curtain A waterfall whose height is notably smaller than its crest width. The following must be true: The height divided by 2 is smaller than the crest width.

Fan A waterfall whose crest width is one third or less of its base width.

Funnel A waterfall whose crest width is over three (3) times its base width.

Height The vertical distance from the base to the crest of a waterfall.

Historic Waterfall The site where a waterfall once existed. The falls no longer exists because the stream has stopped flowing.

Horseshoe A waterfall with a crest that is curved or U shaped in an upstream direction.

Horsetail A falls that descends a very nearly vertical rock face, maintaining some contact with it. Horsetail falls cannot be a cascade.

Overhang A waterfall with a distinctly projecting or undercut crest, that creates an air space behind the falling water.

Plunge A single vertical, or very near vertical, fall of water.

Precipice An overhanging, vertical, or nearly vertical rock face or cliff.

Rapid Any descent of a stream over a moderately steep slope in its stream bed. Characterized by swift moving water with violent choppy waves and whitewater. Also any vertical drop of less than three metres (5 feet) found along the course of a stream.

Ribbon A waterfall whose height is notably greater than its crest width. The following must be true: The height divided by 2 is equal to or greater than its crest width.

Talus Water flowing over a chaotic mix of rock debris on a slope usually found at the base of a cliff or steep incline. Scree is usually the rocks that are smaller than a softball and talus is larger than a softball.

Terraced A waterfall comprised of two or more distinct drops. Each drop is connected with the preceding drop by continuous whitewater, to form a single waterfall. Generally, all of the drops can be seen from a single vantage point.

Twin Two waterfalls found side by side whose crests are separated by an island. The waterfalls can be from the same stream or different streams.

Washboard A waterfall with many small and rather evenly spaced drops.

Waterfall Any sudden descent of a stream over a very steep slope or precipice in its stream bed. Characterized by the stream dropping vertically, or very nearly so.

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APPENDICES

Appendix A: 1st Edition Recommendations

Appendix B: Cultural History of Hamilton's Waterfalls

Appendix C: Waterfall Inventory

Appendix D: Community Maps

Appendix E: Waterfall Datasheets

Appendix F: NAI Selected References

Appendix G: Detailed Waterfall Ranks

Appendix H: Site Planning Clusters