

**WITNESS STATEMENT**

**Of**

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**In the Matter of:**

**Ontario Municipal Board, OMB Case No. PL100472/  
Files: PL100472-474; PL100807, 881, 882; PL1010302, 303, 314  
Sifton Properties and Grandview Ravines Inc.**

**June 15, 2012**

## **QUALIFICATIONS**

1. I am a certified professional geoscientist specializing in geomorphology and karst hydrogeology. I have two academic degrees (Bachelor and Masters), a career history approaching 40 years, extensive field experience, and numerous published papers. My detailed Curriculum Vitae is attached as Schedule A and a brief qualifications summary is provided below.

## **RELEVANT EXPERIENCE**

2. I have conducted field work, mapped, and otherwise studied karst, glacial and fluvial landforms and processes in Ontario, Yukon, Manitoba, Alberta, NWT, and NU. This work has been undertaken in support of environmental impact assessments, natural heritage inventories, ecosystem classification systems, protected areas studies, and process research studies. A part of this work has included designating over 50 earth science ANSIs in Ontario, including all of those north of Highway 401 in the Niagara Escarpment Planning Area (now part of the Niagara Escarpment Parks and Open Space System). I have also prepared earth science descriptions for more than 100 ANSIs, Conservation Reserves, Park Additions, and Signature Sites in the Province of Ontario. Municipal work has included designation, updating, and/or description of earth science ESAs for the Region of Halton, The Region of Hamilton-Wentworth, the Region of Ottawa-Carleton, and the City of Toronto.
3. Much of my work includes undertaking detailed peer reviews of development application technical documents associated with landform (e.g., ORMCP) and karst groundwater. This includes consulting work with the Town of Newmarket, the Town of Aurora, Richmond Hill, City of Hamilton, Niagara Escarpment Commission, the County of Bruce, Town of The Blue Mountains, the Region of Halton, the Halton and Region Conservation Authority, and the Township of Melancthon. I have also been involved in the preparation of technical documents and participation in review meetings for several development applications including for residential developments, quarry applications, and a sports park.
4. I am currently representing the City of Guelph in support of moraine landform policies in the City's OPA #42. My retainer includes providing advice on related policies, the negotiation of possible boundary adjustments with appellants, and the provision of expert evidence at a Hearing, as required.
5. I have previously participated in several Ontario Municipal Board and Consolidated Board Hearings relating to geoscience evidence. These have included specific technical input on karst geology and hydrogeology relating to quarry and residential development applications, glacial landform evidence pertaining to residential developments on the Oak Ridges Moraine and in the City of Toronto.

6. I am familiar with the landforms of the local area through site visits in conjunction with a study of tufa mounds and other deposits in the area south of Hardy Road. The work included site visits undertaken on October 19 and November 16, 2004. The results of the field work were presented in an MNR ANSI report (Document #1, in Schedule B) that was prepared for Mr. Ken Cornelisse of the MNR Guelph District. As part of this work, I also observed two other tufa deposits (not mounds) along the Grand River in the Brantford – Paris area.
7. I have undertaken mapping of the Grand River and its major tributaries within the Regional Municipality of Waterloo. This work included the preparation of a planning definition of “Significant Valleylands”, as well as the mapping of Significant Valleylands and specific fluvial landforms.

#### **BASIS OF RETAINER**

8. I was retained on behalf of the City on January 17, 2012. My evidence specifically addresses environmental and natural heritage matters, in regards to the geosciences including karst hydrogeology, karst geology, and fluvial and glacial geomorphology.

#### **LIST OF DOCUMENTS**

9. In addition to those included in the “Joint Document Brief”, I will specifically refer to some or all of the documents listed in Schedule B for the preparation of my evidence.

#### **EVIDENCE and OPINION**

##### **OVERVIEW**

10. There are a number of important fluvial, glacial and other depositional landform features in the Northwest Sector of Brantford which have been identified as key elements for protection and representation within the Waterfront Master Plan (WMP). The northwest portion of Brantford’s waterfront plan area is the least disturbed from development, other than localized agricultural and recreational activities, and provides excellent examples for representation of the geosciences.
11. Features represented included moraines (Moffat Moraine), a glaciofluvial meltwater channel, proto and modern fluvial features of the Grand River, marl and tufa deposits characteristic of karst processes, and several surface water features supported by a complex groundwater system. Grand River fluvial forms include a former river ox-bow and alluvial island, an existing ox-bow wetland, and four terrace embankments separating four individual floodplains at different levels. The current active floodplain represents the most recent of fluvial forms

- and serves as the base level for groundwater discharge which is particularly marked by the presence of several springs at the upper edge of the floodplain on the Sifton Property.
12. Karst processes relate to the solution and deposition of certain types of carbonate bedrock, principally limestone and dolostone. Gypsum bedrock is common in this part of Ontario and, although not a “carbonate” rock like limestone and dolostone, is significantly affected by solution leading to the formation of characteristic karst features. Common karst features include sinkholes, caves and springs. Sinkholes mark the location where surface waters are directed downward into the bedrock, usually into a cave conduit but include pre-existing fractures. The karst groundwater then flows through the bedrock to re-emerge on the surface as a karst spring. These typically occur in conjunction with a change in bedrock type (non solutional) and/or the local or regional base level such as a lake or major river (e.g., the Grand River).
  13. The presence of karst bedrock and features has been recognized in the PPS (1997 and 2005) as contributing to unstable bedrock and such areas are designated as “Hazardous Sites” under the PPS. Such sites are required to either be avoided by development or made non-hazardous by geotechnical means. Although the PPS identifies “karst topography” as principally a concern due to bedrock instability, it should be pointed out that this instability is also related to potential hazardous drainage conditions including the loss of surface waters to the subsurface, upstream flooding in the event the sinkhole/cave is blocked, and/or undermining by continuous or intermittent spring flows<sup>1</sup>. The latter is of most import to the features referred to as the “tufa mounds” located on the Sifton Property.
  14. The presence of tufa mounds is commonly associated by the presence of karst features and processes, particular the flow of groundwater through karst conduits; groundwater that contains high concentrations (large loadings) of carbonate minerals. A significant change in environment occurs as the water leaves the cave atmosphere in the form of spring. This leads to the relatively rapid deposition of the minerals forming tufa and/or marl deposits.
  15. Tufa, also known as ‘travertine’ or ‘sinter’, is a form of limestone (calcium carbonate - CaCo3) in the form of “a mineral precipitate deposited by a mineral spring, either hot or cold...light in color, generally concretionary and compact... extremely porous or cellular...”<sup>2</sup>. Marl is an unconsolidated variety of CaCO3 and is commonly found in pools or ponds mixed with clay and/or organic materials.

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<sup>1</sup> The definition of “Hazardous Sites” in the PPS does not list all potential hazards “that could be unsafe for development and site alteration”. “These *may include*... unstable soils (sensitive marine clays [leda], organic soils) or unstable bedrock (karst topography).” [my emphasis in italics]

<sup>2</sup> From Monroe (undated, ca. 1970). A glossary of karst terminology. Contribution to the Hydrology of the United States, U.S. Geol. Survey: 26p.

16. Tufa and marl are depositional features associated with springs, seepages and geysers where waters enriched in calcium carbonate emerge at the surface. The source of calcium is usually limestone or dolostone bedrock undergoing some degree of solution by circulating ground waters. Gypsum, glacial tills and other unconsolidated surficial deposits composed of these rock materials may also be a source. Groundwaters emerging from the rock or deposit are saturated in calcium carbonate at atmospheric pressures found within conduits or pore spaces.
17. Atmospheric pressures of carbon dioxide in the air, (CO<sub>2</sub> is the prime factor in driving the solution process), are lower than those in the rock mass or deposit, causing CO<sub>2</sub> to degas from the aqueous phase into the air on emergence. This results in super saturation of limestone in the emerging water which, in turn, leads to the relatively rapid precipitation of the mineral from the aqueous phase. This process is enhanced by the presence of vegetation which provides a large surface area onto which the mineral can precipitate.
18. Marl deposits are common in southern Ontario, particularly in association with springs and seepages draining from the Niagaran dolostones (Guelph, Lockport/Amabel formations) which form the upper cap rocks of the Niagara Escarpment. However, tufa deposits are much less common, being documented in only a very few localities and in low quantities during many years undertaking karst studies in Ontario.
19. Large quantities of tufa deposits are commonly found in association with older major karst springs in areas outside of the extent of Pleistocene glaciation. In Canada, the only significant known deposits are associated with large hot springs in the Cordilleran region of British Columbia, Alberta and southern Yukon. Although tufa deposits associated with these hot springs are of significant size, no significant tufa deposits have been described for coldwater springs in this country. It is not clear why these deposits are not common or of significant size other than the relatively short period since glaciation available for their formation.
20. The tufa mounds ANSI located on the Sifton Property is particularly interesting as no other tufa mound features have been previously described in Ontario and tufa deposition in general has not been well documented. Such deposition are commonly the result of karst processes whereas carbonate-rich water originating in bedrock caves, deposit marl and tufa once the water discharges to the surface. The presence of mound features indicates that the significant groundwater discharge occurs at this location under artesian conditions.
21. The presence of karst caves on the site has not been documented nor confirmed, however at least one borehole to the west places the bedrock surface at 211.9 m (document #30, Schedule B) which corresponds to the elevation of the terrace containing the mounds. On-site boreholes appear to not encounter bedrock and this complicates the hydrogeological setting with regard to karst features and processes.

ISSUES ADDRESSED

22. My evidence will address the following issues:
23. A: Conformity With Applicable Policy Planning Documents  
Do the proposed designations and implementing planning instruments, or any of them, conform with or are they consistent with or do they implement, as the case may be, relevant provincial, municipal and agency policies, including:
- a. 1(b) Provincial Policy Statement (1997) and (2005); and
  - b. 1(c) City of Brantford Official Plan.
24. B: Land Use Compatibility and Appropriateness of the Private Development Applications
- 4. Are the proposed private development applications for Official Plan, zoning by-law amendments and subdivision approvals appropriate?
25. C: Environmental, Transportation (Traffic Access) and Servicing
- 9. Will the proposed developments provide sufficient protection that appropriately conserves and protects hydraulic and hydrogeological (ground and surface water) functions including private wells and irrigation water supply?
26. G: Good Land Use Planning and The Public Interest
- 15. Do the proposed designations and implementing planning instruments, or any of them, represent good land use planning and are they in the public interest?
27. H: Land Use Compatibility and Appropriateness of the City Amendments
- 18. Is the identification of the proposed “Waterfront Boundary” at 277 Hardy Road arbitrary and without scientific merit?

1.0 SIFTON ESTATES

**1.1 Summary of Evidence**

28. Issues to be addressed: 1(b), 1(c), 4, 9, and 18.
29. **Issue 1(b):** The surface water and groundwater features on the site and in the area are subject to PPS 1997 Natural Heritage policies 2.3.1(a) and (b); 2.3.2; 2.3.3; Water policy 2.4.1; and Natural Hazards policy 3.1.1(c).
30. Comparable policies in the 2005 PPS include Natural Heritage policy 2.1.6; Water Policy 2.2.2; and Natural Hazards 3.1.1(c).
31. My evidence will indicate that the proponent was directly notified of my concerns pertaining to a hazardous site both verbally in the field and through my Tufa Mounds ANSI report (Document # 1, Schedule B) in November of 2004 pertaining;
32. The nature of the hazard associated with karst could include both unstable ground and flooding during artesian flow;
33. Supporting technical documents for the development proposal do not demonstrate that development on adjacent lands to the Natural Heritage features (PSWs and ANSI) will have no negative impact as per the PPS;
34. Although having several groundwater monitors on-site, the proponents have not released long-term water level data nor have they provided specific interpretations of such data;
35. My evidence will also address the fact that none of the sensitive water features on site (including springs and a coldwater stream) have been demonstrated to be protected by the proponents. In particular, the proponents have not developed a detailed water balance analysis for the site pre- and post-development; and
36. Unintended impacts to the Tufa Mounds ANSI as a consequence of the development will include regular access by local residents and the removal of tufa stone for decorative garden purposes.

**Issue 1(c):**

37. In my opinion the proposed Sifton development does not meet OP policies 8.2, 8.3, 8.4, nor 8.5, specifically 8.2.1(2), (4); 8.3.1(1), (2), (8), (9); 8.4.2; 8.4.3; and 8.5.3.
38. In general, my evidence is similar to that noted above for issue 1(b) in regards to groundwater recharge, flow and discharge throughout the site; and

39. Supporting studies, data, analyses have not been provided to demonstrate that these policies will be met by the proposed development.

**Issue 4:**

40. It is my opinion that the proposed Sifton development detailed in the most recent Draft Plan of Subdivision (Document #25, Schedule B) is not appropriate for this site because:
41. Although the proposed development directly avoids the ANSI including the tufa mounds, the 4 mapped springs, and the PSW's, the documents submitted to date do not demonstrate the protection of these features, specifically the protection of hydrogeologic conditions associated with their formation and maintenance;
42. The only groundwater protection measure suggested by the proponent to date is to maintain the existing rate of infiltration of precipitation across the site (Document 21, Schedule B, pages 11 and 12);
43. The documents do not detail how this will be done across the site nor do they demonstrate the role of groundwater from more distant recharge zones and possible effects of the development on pathways associated those recharge zones;
44. It is unlikely that the groundwater conditions associated with the formation of the tufa mounds can be fully understood and protected;
45. Although above the regulated floodplain, a large portion of the proposed development lies on a second order floodplain (residential development associated with Streets "B", "F", and "G" on the Draft Plan of Subdivision) which is only 2 m above the active floodplain and, with continued development in the upstream watershed, there is a high potential for flooding of this higher floodplain at some point in the future; and
46. Even without direct flooding of the lower development section, there is a very high possibility of flooding on this second order floodplain due to rising groundwater levels associated with regular overbank flooding of the Grand River onto its active floodplain; this has never been addressed by the proponents.

**Issue 9:**

47. It is my opinion that the proposed Sifton development will not provide sufficient protection that appropriately conserves and protects hydraulic and hydrogeological (ground and surface water) functions because:
48. In reviewing the supporting documents consideration of hydrogeological conditions in general and karst phenomena in particular is inadequate. There has



- been no assessment/consideration of water spout activity (why? how? what?)<sup>3</sup>; no consideration has been given to groundwater flow to on-site springs and wetlands should development go ahead (i.e., post-development infiltration consideration); no consideration of impacts from dewatering (during construction) on wetlands, springs and tufa mound hydrogeology; and no long-term groundwater hydrographs have been presented or analyzed (this is fundamental given the reported water spouts and overall high water table);
49. The stormwater management system does not reproduce existing surface hydrologic conditions as is required by the GRCA, particularly in the proposed discharge locations which are currently not part of any surface water system;
  50. The most recent revised Draft Plan of Subdivision (Document # 25, Schedule B) shows changes in the location and sizes of the stormwater management facilities than previously reported with no supporting documentation or analysis;
  51. The mapped pre-development catchments surface water divides (Document #17, Schedule B, page 5) do not appear to follow actual surface drainage/runoff conditions on the site based on slopes and the location of surface water features;
  52. There is no assessment of impacts to, nor consideration of construction techniques regarding tufa mounds (as noted in the Dougan Peer Review, Document #16, Schedule B) and regarding hydrogeology associated with these mounds;
  53. The proposal to maximize infiltration across the site has not been demonstrated as feasible and, in fact, the presence of tufa deposits will reduce infiltration capacity;
  54. There is no assessment of impacts to stream, wetlands, and springs due to the development (maintaining flows, and water levels); and
  55. No pre-development/post-development water balance has been prepared for either the current or previous draft plans of subdivision.
  56. A detailed water balance analysis is absolutely essential as the development of a subdivision changes the surface hydrology and subsurface hydrogeology by reducing infiltration (sidewalks, roofs, etc.) and increasing runoff . Further, the runoff is directed to stormwater facilities that outlet along routes not now utilized by surface water. In order to understand the impacts of a subdivision to surface and subsurface water features (wetlands, springs, rivers, etc.) one normally undertakes a pre-development and post-development water balance (quantitatively demonstrating recharge, discharge and all intervening routes). The difference is the impact. From this one can determine the nature of the impacts on surface and subsurface groundwater processes and features and determine whether or not

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<sup>3</sup> I. Kraemer (personal communication) witnessed a water spout at this location in 1994 and has photo documentation of springs emerging from the mounds She has also documented a large number of “pressure cones” that appear as conical soil mounds that have been observed to flow periodically.

specific mitigation design measures can be implemented.

57. The stormwater servicing report (Document #17, Schedule B) undertakes a surface drainage model pre- and post-development but this only relates to the surface water component and is used to decide on a location and size of the stormwater facility. It has not been used to understand present flows vis a vis wetlands and springs nor has it been updated to reflect proposed changes in the most recent Draft Plan of Subdivision (Document #25, Schedule B).

**Issue 18:**

58. It is my opinion that the position of the proposed Waterfront boundary at 277 Hardy Road is scientifically defensible based on the following:
  59. The earth science features that are captured by this boundary include the Tufa Mounds ANSI site, the full width of the lowest and active floodplain; a terrace embankment separating the active floodplain to a second level floodplain with its full width included; a second terrace embankment outlining the full extent of a 3rd order floodplain; and third and fourth terrace embankments outlining a significant portion of two higher floodplains;
  60. Geoscience representation within this boundary incorporates the full extent of modern alluvium mapped for the area as well as a significant portion of glaciolacustrine sand and silt which provides representation of a former glacial lake (glacial Lake Warren) occupying the Erie Basin (Document 35, Schedule B);
  61. Based on the presence of the tufa mounds and mapped springs, this boundary also distinguishes the dominant zone of groundwater discharge in this portion of the Grand River; and
  62. The area between the 1st and second terraces was formerly an island in an early proto Grand River as shown by the presence of a continuous (except as modified for agricultural access) meander cut-off channel, now hosting PSWs.

**1.2 Concluding Opinion**

63. This evidence leads me to the opinion that a residential subdivision is not appropriate for a significant portion of the area south of Hardy Road. The “lower” section of the proposed Draft Plan of Subdivision (Document #25, Schedule B) including, but not restricted to, housing blocks accessed by streets “B”, “F”, and “G” should not be developed and I see no mechanism whereby this area could be developed. Particular concerns in this area include: (1) not being able to fully understand the hydrogeological conditions associated with the tufa mounds; (2) the presence of a Hazardous Site (PPS 3.1.1[c]) adjacent to proposed housing; (3) complex groundwater recharge/discharge conditions supporting PSWs, a coldwater stream, and active springs; (4) the likelihood of future

- flooding of the second level floodplain; and (5) the occurrence of high groundwater levels on the second level terrace when the Grand River is under flood conditions.
64. The “upper” portion of the Draft Plan of Subdivision including housing blocks associated with streets “A”, “C”, and “D” may be developable but this would require confirmation from detailed hydrogeological studies and the production of a water balance analysis demonstrating no significant impact on the natural features associated with the lower 2 terraces.
65. In addition, there is a need to undertake a regional to sub-regional groundwater investigation including the lands to the north and northeast. This investigation should incorporate a karst assessment given that the area is underlain by the Salina Formation and Bass Islands Formation, both known to host significant karst aquifers.

2.0 GRANDVIEW RAVINES

**2.1 Summary of Evidence**

66. Issues addressed: 1(b) and 4.

**Issue 1(b):**

67. The surface water and groundwater features on the site and in the area are subject to PPS 1997 Natural Heritage policies 2.3.2; 2.3.3; and Water policy 2.4.1.
68. Comparable policies in the 2005 PPS include Natural Heritage policy 2.1.6; and Water Policy 2.2.2.
69. A water balance has been prepared (Document #12, Schedule B) for an earlier Draft Plan of Subdivision but has not been updated to reflect the revised Draft Plan of Subdivision (Document #26, Schedule B); and
70. The existing water balance analysis (Document #12, Schedule B) does not address potential impacts on surface and groundwater flows on adjacent lands including the Tufa Mounds ANSI, PSW's and springs located on the lower floodplains in this area.

**Issue 4:**

71. It is my opinion that the proposed Grandview Estates development proposed in the most recent Draft Plan of Subdivision (Document #26, Schedule B) has not been demonstrated to be appropriate for this site because:
72. The revised Draft Plan of Subdivision represents a significant revision (relative to that referenced in the 2007 Servicing Report) which will require revisions and updating of the stormwater runoff modelling;
73. The water balance provided for the former Plan of Subdivision (Document #12, Schedule B) and this should be revised to reflect changes in the revised Plan of Subdivision;
74. A sub-regional groundwater study should be undertaken for this area including, but not limited to, the lands associated with the Grandview Estates and Sifton properties in order to fully understand the implication of development on sensitive surface water features, particularly hydrogeological conditions associated with the tufa mounds, springs and groundwater contributions to PSWs in discharge zones along the Grand River;
75. The underlying bedrock in this area consists of the Salina Formation which is overlain by the Guelph Formation and underlain by the Bass Island Formation

(Document #36, Schedule B) all of which are known to host significant karst aquifers, thus the nature of karst groundwater flows in this area should be further investigated to determine the potential for impacts to on-site and adjacent sensitive surface water features; and

76. The proposed development will remove opportunities for geoscience representation within the WMP, particularly with regard to representation of the Moffat Moraine and Glacial Lake Warren (Document #35, Schedule B).

## **2.2 Concluding Opinion**

77. It is my opinion that the proponents for the Grandview Estates Application have not fully demonstrated that the proposed Draft Plan of Subdivision will have no significant impact on sensitive surface water features on and adjacent to the site. The following is required to demonstrate no impact:
  78. Updating of the water balance and Stormwater Management servicing analysis to reflect recent changes to the Draft Plan of Subdivision;
  79. Undertaking a regional/sub-regional investigation of groundwater recharge, discharge and flows in order to fully understand functions and processes associated with sensitive surface water features both on the site and adjacent to the site (particularly in the discharge zone(s) along the Grand River;
  80. Undertaking a karst investigation to determine the likelihood and nature of any karst associated with the underlying bedrock (presence of karst is inferred from the presence of the tufa mounds); and
  81. The proposed Draft Plan of Subdivision should be assessed with regard to the protection/loss of geoscience features that otherwise could be represented within the WMP. Such an assessment would include recommendations for construction methods and appropriate site design measures including possible clustering techniques as, for example, outlined in the Oak Ridges Moraine Conservation Plan and its various Background Reports.

3.0 WATERFRONT MASTER PLAN (WMP)

**3.1 Summary of Evidence**

82. Issues addressed: 1(b) and 15.

**Issue 1(b):**

83. In respect to the 2005 PPS, the approval of the WMP, it is my opinion that policies 2.1.1; 2.1.2; 2.2.1(c), (d)(2), (e), and (f); and 3.1.1(c) will be fully met.

**Issue 15:**

84. My evidence in regards to this issue is twofold: (1) identification of the geoscience features represented in the Waterfront Master Plan and their significance; and (2) the basis in incorporating landform protection policies in municipal planning in Ontario.

**Geoscience Features and Their Significance:**

85. The Northwest Sector of the WMP area is the least altered and most complex sequence of geological features in the City of Brantford. In this regard the area provides excellent opportunities for protection of key elements of Brantford's natural history that will otherwise be lost.

86. Within the area south of Hardy Road are four distinct river embankments separating four distinct former and active floodplains (Document #1, Schedule B). These embankments and floodplains reveal a complex geological history going back at least 12,500 yrs Before Present (BP) to when the continental Wisconsin Ice Sheet withdrew from this area for the last time. It reveals the entire history of the Grand River at this location. The geology incorporates four periods of river incision, creating 4 distinct floodplains. The active river reach south of the Sifton property includes an island and a secondary channel to the north of the island. This river morphology also occurred in the past as the second order floodplain is encircled by a continuous meander cut-off channel (now occupied by PSWs) along the foot of the second embankment. This indicates that all or most of the second floodplain formed an island at some time in the past as the river shifted to the south.

87. This fluvial representation provides the best undeveloped example of the entire geological history of the Grand River within the City of Brantford.

88. The second order floodplain also contains the Tufa Mounds ANSI which demonstrate the presence of artesian groundwater discharge. Although these discharges are not as frequent as when this floodplain was active, evidence provided by local inhabitants (Ilse Kraemer) indicate that such events continue to

occur. The formation of the tufa mounds indicate a complex hydrogeological condition at this site for which the exact mechanism of formation is not known.

89. The tufa mounds representation provides the best documented example of such a feature in the province and has been assigned Provincial Significance by OMNR<sup>4</sup>.
90. Document (map) #35 (Schedule (B) shows the glacial and postglacial history of the Northwest Sector. The area includes representation of the following map units including material deposited/associated landform features:
- 5a: Wentworth Till/Moffat Moraine Position of Ice Front
  - 5b: Wentworth Till/Glacial Advance
  - 7: Glaciofluvial Outwash (sand and gravel)/Grand Meltwater Channel
  - 9c: Glaciolacustrine Shallow Water/Glacial Lake Warren
  - 12: Pre-modern Alluvium in Terrace Remnants/proto Grand River
  - 14: Modern Alluvium (14a&b)/active Grand River

91. Thus within this Sector every major glacial and postglacial landform feature that formed Brantford's landscape (with one exception) is represented. The features largely remain undisturbed.
92. The surficial geology representation in the Northwest Sector is the most complete representation of glacial and postglacial geology in the City of Brantford.
93. Thus it is my opinion that the Northwest Sector of the WMP area provides the best representation of the fluvial history (Grand River) and glacial history available for the City of Brantford. Further, the Tufa Mounds ANSI provides the only known representation of artesian groundwater tufa deposition in the Province of Ontario.

**The Basis for Landform Protection in Planning:**

94. The basis for including landform as a land use designation began when the Province of Ontario first underpinned the significance of landform in a land use planning context when it passed the Niagara Escarpment Planning and Development Act in 1970. Significantly, this was followed some years later, and following substantive debate, with the Oak Ridges Moraine Conservation Act (2001).
95. These two provincial statutes have served to galvanize the concept of landform protection and conservation and, more importantly, establish an explicit understanding that development must take place within a framework that allows for a diversity of natural forms. Specifically, it pushed the province past the early

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<sup>4</sup> The ANSI has been confirmed as Provincially Significant by the Ontario Ministry of Natural Resources (personal communication, David Webster, Senior Conservation Geologist, Parks and Protected Areas Policy Section, Peterborough, ON).

- conservation movement's fixation on simply recognizing and "protecting" remnant biological communities. Clearly to have biological diversity, landform diversity must come first...the latter defines landscape in all manner and at all scales.
96. The initial development of parallel programs delineating areas of significant earth science and life science for protected area designation and planning in the province quickly followed the establishment of the NEPDA. As a result the Ontario Ministry of Natural Resources undertook field investigations to delineate significant life science and earth science areas. These areas are designated as ANSIs or Nature Reserves and those within the current Niagara Escarpment Plan Area have been formally zoned by the NEC as forming part of the Niagara Escarpment Parks and Open Space System (NEPOSS).
97. Provincial recognition of a significant complex landform such as the Niagara Escarpment (the "backbone of Ontario") soon spurred the incorporation of landform protection criteria into newly developing Environmentally Significant Areas (ESAs) programs being formulated by municipal jurisdictions. Forefront in this movement was new ESA programs in the Regional Municipality of Waterloo, the Regional Municipality of Halton, and the Regional Municipality of Hamilton-Wentworth.
98. Although recognized as being significant, the early years of landform criteria development at the municipal level incorporated fairly simple concepts of protecting "unusual or distinctive landforms" without much elaboration as to what these were or what role landforms play in the larger landscape context. However, importantly, these were already developed as "primary" criteria, that is, not requiring other supporting ecological or hydrogeological values to trigger the designation of landform units.
99. Eventually, the incorporation of landform criteria into ESA programs evolved in two ways (1) by becoming more ecologically oriented whereby the role of landforms in supporting ecological functions was recognized; and (2) by the acknowledgement that one of the most important concepts in landform designation within the context of a municipal jurisdiction was its role in representing the visual landscape that forms the jurisdiction's character. I was directly associated with both of these concepts; the first in terms of using landform to assist corridor definition within the Oak Ridges Moraine core/corridor selection process (1993) and the second in the revision to the Halton criteria (1991). Today, these concepts make up an essential part of Greenlands and Natural Heritage strategy development both at the provincial level and for municipalities (e.g., Halton, City of Guelph).
100. The importance of recognizing landforms in protected areas programs and land use zoning can be summarized as follows:
- i) As a record of natural history – important in illustrating the



- environments and processes which shaped the earth's surface as a key to the past and assisting in adapting to future events;
- ii) As a benchmark for education and research – important to provide natural laboratories for a wide range of educational activities as well as to provide undisturbed benchmarks against which processes on disturbed areas can be evaluated;
  - iii) As a prerequisite for ecological diversity – as substrates for floral and faunal diversity and occurrence (as regulated by climate);
  - iv) As an area for outdoor recreation – subject to prevailing property rights, different landforms afford differing opportunities for recreation including activities related to climbing, viewing, caving, downhill skiing, cross-country skiing, hiking, art, etc.;
  - v) As a part of our heritage – as a linkage between humans and the natural landscape to provide a full appreciation of our natural heritage and the existing environment; and
  - vi) As a linkage mechanism through the natural landscape - the value of landform in enhancing natural functions, including ecological functions, within the extant landscape. In this regard, landform criteria have been employed in corridor functions in numerous natural heritage strategies (ORM, Halton, Ontario Greenlands , City of Guelph).

### **3.2 Concluding Opinion**

101. It is my opinion that the geoscience features present in the Northwest Sector of the WMP are unique in the City of Brantford, offering an excellent opportunity to provide relatively undisturbed examples of landforms and features that were instrumental in creating Brantford's natural landscape. The story begins during main Late Wisconsin time about 15,000 years BP (Wentworth till), continues to the late glacial/immediate post glacial retreat (Moffat Moraine and glaciofluvial meltwater channel deposits) through development of a proto Grand River (upper terraces and embankments) to the terraces and embankments of the modern Grand River. This area clearly provides the best representation in the City of Brantford. It could easily be ranked one of the best examples on the Grand.

102. The Tufa Mound Provincially Significant ANSI is also located in this Sector and provides evidence of a complex groundwater system that is poorly understood and for which karst hazards, as defined in PPS policy 3.1.1(c), exist.

## **QUALIFICATIONS SUMMARY**

### ***Education:***

Undergraduate Honours degree from McMaster University (B.A., 1973) in the combined Geology and Geography Program with specialization in karst geomorphology. Graduated *Summa Cum Laude*.

Graduate degree from McMaster University (M.Sc., 1976) in Geography with specialization in Karst Geomorphology, Hydrochemistry and Hydrogeology.

Certificate course in environmental inspections from the Environmental Assessment Association (Certified Environmental Inspector, 1993).

### ***Professional Certification:***

Certified as a Professional Geoscientist (P.Geo.) under the Association of Professional Geoscientists of Ontario.

### ***Career History and Expertise:***

1973-1976: contract geomorphologist, Ontario Ministry of Natural Resources  
1976-1989: environmental scientist, Environment Canada  
1989-1990: environmental consultant, Daryl W. Cowell & Associates Inc.  
1990-1999: manager and environmental consultant, Geomatics International Inc.  
1999-2004: principal and manager of consulting services, North-South Environmental Inc.  
2004-present: consulting geomorphologist, Daryl W. Cowell & Associates Inc.

My professional experience spans a period of 39 years and has involved detailed technical work, often incorporating extensive field studies, related to karst geomorphology; soils; wetlands; ecological land classification; water chemistry; water, sediment and biota contamination; environmental impact assessment; acid rain; and protected areas delineation and management.

I have written or co-authored over 400 technical reports and published papers. My university degrees were in geology and geomorphology, specializing in karst research along the Niagara Escarpment in Southern Ontario. My undergraduate degree involved detailed studies of a complex karst drainage system near Markdale, Ontario (Wodehouse Creek Karst). My Master's Thesis work developed a thorough understanding of karst landforms, hydrogeology and hydrochemistry on the Bruce Peninsula. I have also studied and reported on a wide range of glacial and fluvial geomorphological processes and features throughout Ontario and elsewhere in Canada.

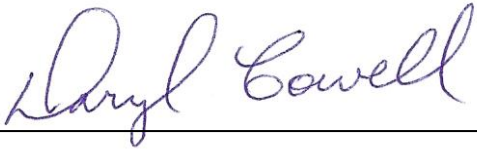
I have been qualified as an expert geoscientist in approximately six Ontario Municipal Board Hearings.

Brief descriptions of most projects which I have worked on are provided in my C.V. provided as Schedule A.

**DISCLAIMER**

This witness statement has been prepared based on information listed in Section 4 (List of Documents). If new information is provided prior to the hearing, modifications to this statement may be necessary.

Further, I will speak to any matters for which an update is required.



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Daryl W. Cowell, P.Geo. (#0791)  
June 15, 2012

**SCHEDULE A**

**C.V. of DARYL W. COWELL**

#### PERSONAL DATA

Citizenship: Canadian  
Languages: English (fluent)  
Portuguese (working)  
Spanish (working)

#### EDUCATION

B.A. Honours Geology and Geography, 1973, McMaster University, Ontario with a major in karst hydrogeology (research thesis: "Karst Geomorphology and Characteristics of Dolomite Solution on the Niagara Escarpment Near Kimberley, Ontario")

M.Sc. Karst Geomorphology, 1976, McMaster University, Ontario (research thesis: "Karst Geomorphology of the Bruce Peninsula, Ontario")

#### PROFESSIONAL CERTIFICATIONS

Certified Environmental Inspector, Environmental Assessment Association.

Professional Geoscientist (P.Geo.) certified under the Association of Professional Geoscientists of Ontario.

#### AWARDS

Canadian Project Manager and Contributor to the "Great Lakes: An Environmental Atlas and Resource Book" (Environment Canada and U.S. EPA) winner of the British Cartographic Design Award in 1986 and personally acknowledged by the Assistant Deputy Minister of Environment Canada.

Awarded special certificate in recognition of work supporting Canadian initiatives during negotiations between the U.S./Canada relating to the Memorandum of Intent on Long Range Transport of Airborne Pollutants proposed Transboundary Treaty.

#### CAREER SUMMARY

1973 to 1976, Ontario Ministry of Natural Resources:

Projects included detailed research into the karst landforms and processes of the Bruce Peninsula and the delineation of protected areas within the Niagara Escarpment Planning Area from Tobermory to Milton, Ontario. These areas have since been incorporated into the Niagara Escarpment Parks and Open Space System (NEPOSS).

1976 to 1989, Environment Canada:

1976 to 1984: Served as a senior Land Research Specialist for the Lands Directorate played a lead role in the development and application of ecological land classification techniques, undertook detailed wetland soil studies in the Hudson Bay Lowland, and developed assessment methodologies pertaining to impacts from acidic precipitation. This latter work included participation on the impacts assessment working group under the Canada/U.S. Memorandum of Intent between Canada and the U.S. Field studies

included numerous locations in Ontario including the Hudson Bay Lowlands, Long Point (Lake Erie), Kenora, and the Algoma Highlands.

1984 to 1985: Physical Scientist with the Atmospheric Environment Service providing technical support and advice to the Assistant Deputy Minister relating to the federal acid rain program.

1985 to 1989: Program Coordinator with the Great Lakes Office under the direction of the Director General for Ontario. Provided technical evaluation and policy advice on a number of projects including the Great Lakes Toxic Chemicals Program, Great Lakes water quality issues, wetland issues, and the development of Remedial Action Plans for heavily polluted portions of the Great Lakes (“Areas of Concern”). This latter work involved serving as Canadian Co-Chairman of the Upper Great Lakes Connecting Channels Study; a four-year, \$20 million Canada/U.S. study of pollution sources and problems in the St. Marys, St. Clair and Detroit Rivers.

1989 to Present, Environmental Consulting:

1989 to 1999, Geomatics International Inc.: Co-founder of Geomatics International Inc., one of the world’s first private firms developing and applying GIS mapping and database development. Managed the environmental consulting division which included overseeing approximately 20 technical support staff. Also active as a project manager and principal research scientist for projects relating to landform analyses, landscape and land use planning, protected areas, environmental impact analysis, water quality, wetlands, forest ecosystem classification environmental constraint analysis, environmental policy analysis, and contaminated site audits (Phase 1 EA’s). Many of these projects involved database development and the application of GIS and remote sensing techniques.

1999 to 2004, North-South Environmental Inc.: Co-founder of NSE, an environmental consulting firm specializing in the ecological and earth sciences in support of municipal policy reviews, peer reviews of development proposals for municipalities, environmental studies in support of selected residential development proposals, various environmental impact assessments, protected areas delineation and management, and others.

2004 to present, Daryl W. Cowell & Associates Inc.: Specializing in international and domestic environmental impact assessment. Work has included the preparation of EIA documents in support of eucalyptus plantation establishment in support of proposed pulp mills, facilities and operations related to a proposed iron ore mine, detailed karst hydrogeological peer reviews relating to proposed dolostone quarry developments, karst hydrogeological and geomorphological investigations in support of selected residential and quarry applications, landform analysis, landform policy development/support, impacts to landforms associated with development applications, and Phase 1 EA’s.

Over the course of my career I have prepared all or significant portions of over 400 reports and papers; prepared and delivered lectures, short courses, and public interest presentations; and have undertaken work including field and/or supervisory activities throughout Canada (Yukon, Nunavut, Northwest Territories, Manitoba, Ontario, Alberta) as well as in Romania, Nigeria, Colombia, Peru, Argentina, Uruguay and Brazil.

## PROJECT EXPERIENCE

### **International Projects**

Canadian Co-chair of the technical management committee of a four-year, \$20 million U.S./Canada Upper Great Lakes Connecting Channels Study (Environment Canada).

Two field programs in support of a land use/impact study throughout Nigeria including the documentation of land use and vegetation in every major ecological zone in the country, development of a mapping legend, mapping the country for two time periods 20 years apart (using satellite imagery), testing and proofing the maps, and training of Nigerian forestry staff (World Bank).

Independent supervision of soil, vegetation, landform, wildlife, hydrogeology, geology, GIS, database development, socio-economic, and landscape planning studies being undertaken in Mato Grosso and Rondônia, Brazil (World Bank).

Due diligence of environmental and social documentation and construction monitoring of a natural gas export pipeline in northern Argentina (Inter-American Development Bank and the Overseas Private Investment Corporation).

Prepared and delivered a course on Strategic Environmental Assessment (Peruvian Ministry of Transport).

Researched and wrote detailed EIAs on eucalyptus plantations in Uruguay in support of detailed Environmental Impact Assessments pertaining to two proposed pulp mills in Uruguay (International Finance Corporation of the World Bank, Montes del Plata).

Researched and wrote a detailed EIA section on terrestrial impacts, mitigation and monitoring on a proposed iron ore mine in Uruguay (Zamin Ferrous).

### **Geomorphology/Landforms (non karst)**

Investigations of soils, coastal geomorphology and raised beach ridges of southwestern James Bay Coast (Environment Canada).

Extensive surveys of wetland and upland soils as well as landforms within the Hudson Bay Lowland coastal zone in Ontario from the Manitoba to Quebec borders (Environment Canada).

Detailed field studies and mapping of landform and bedrock features in and surrounding Wabakimi Provincial Wilderness Park (Ontario) for evaluation of their significance for representation in the Provincial Parks system (Ontario Ministry of Natural Resources).

Field studies, mapping and report preparation for Conservation Reserves, a Signature Site and several park extensions in northern Ontario (approximately 30) and Areas of Natural and Scientific Interest in southern Ontario (approximately 50) covering a broad range of earth science subjects including glacial, fluvial, lacustrine, karst, and Aeolian (Ontario Ministry of Natural Resources).

Principal field researcher and report and map author of a detailed geomorphological inventory of landforms and of the upper Bruce Peninsula, islands between Tobermory and Manitoulin, and several underwater locations (Parks Canada).

Over 10 detailed peer reviews of landform issues pertaining to development applications on the Oak Ridges Moraine under the ORM Conservation Plan (Municipalities of Richmond Hill, Aurora and Newmarket).

Qualified and served as an expert landform (glacial geomorphology) witness in 3 Ontario Municipal Board land use hearings and participated in 2 others.

Prepared surficial geology maps and earth science description reports for 32 ANSIs plus Polar Bear Provincial Park in Ontario's Hudson Bay Lowland totalling more than 7 million ha (Ontario Ministry of Natural Resources).

Evaluated and provided technical advice pertaining to a landform criterion associated with the Paris and Galt moraines (City of Guelph).

### **Karst Hydrogeology and Hydrochemistry**

Undergraduate thesis research involving chemical and physical studies of a significant sinking stream system (Wodehouse Creek) including dye tracing of a connecting cave to two springheads.

Masters thesis research of karst geomorphology, hydrochemistry and hydrogeology of the Bruce Peninsula and Niagara Escarpment in Ontario.

Karst geomorphology reconnaissance field studies on Baffin Island and in the Hudson Bay Lowland near Moosonee, Ontario (Environment Canada).

Detailed karst geomorphology and hydrogeology of a young karst system forming within a large peatland complex in Ontario's Hudson Bay Lowland along the Attawapiskat River (Environment Canada).

Undertook karst inventories of several Areas of Natural and Scientific Interest (ANSI's) in southern Ontario (Ontario Ministry of Natural Resources).

Investigated and prepared ANSI report on unique area of tuffa mounds adjacent to the Grand River in Brantford.



Qualified for and served as a karst expert witness on 4 Ontario Municipal Board Hearings related to quarry applications (Town of The Blue Mountains, Niagara Escarpment Commission, Grey Matters, Region of Halton).

Detailed karst peer reviews for a proposed dimension stone quarry and a proposed aggregate quarry in southern Ontario (County of Bruce, Township of Melancthon).

Principal karst research investigator in support of a quarry expansion proposal near Owen Sound (Harold Southerland Construction Ltd).

Karst constraint analysis of an above-the-watertable quarry application in the southern Bruce Peninsula (Harold Sutherland Construction Ltd).

Karst constraint analyses in support of 3 applications for residential development or severances in Grey and Bruce Counties (various applicants).

Detailed peer reviews and technical advice pertaining to impacts of proposed residential developments on the Niagara Escarpment (Regional Municipality of Hamilton and Halton Region Conservation Authority).

Field research and reporting in support of proposed residential developments near Markdale, near Wodehouse, Little Pike Bay and in Hamilton (Nebo Road) in the vicinity of the Ontario's Niagara Escarpment (various applicants).

Review and evaluation of potential impacts to karst landforms and processes due to the development of a diamond mine near Attawapiskat, Ontario (Ontario Ministry of Natural Resources).

Field studies and preparation of an evaluation of the feasibility of establishing surface impoundments for habitat enhancement in karst at Shallow Lake, Ontario (Sydenham Conservation Foundation).

Field studies and evaluation of karst features and processes in support of a large sports park complex (City of Burlington).

Develop a technical framework for use in the selection of karst features/areas within Ontario's Protected Areas Program (Ontario Ministry of Natural Resources).

Peer reviews and analyses of karst implications for Vulnerable Areas Delineation modelling for approximately 33 Drinking Water Source Protection areas of municipal well supply systems in Grey, Bruce, Huron and Wellington counties (Saugeen Valley and Ausable-Bayfield Conservation Authorities).

## **Environmental Impact Assessment**

Regional terrestrial and aquatic sensitivity mapping and analyses of eastern Canada for the U.S/Canada Memorandum of Intent on Transboundary Air Pollution (Environment Canada).

Several Phase I environmental site assessments for real estate transactions, mortgage approvals and construction (various clients).

Field studies and EIA documents relating to soils, landforms and wetlands for several environmental assessment projects including:

- Co-generation electrical facility at Iroquois Falls, Ontario;
- Nuclear and oil-fired electric power facilities proposed for the North Channel of Lake Huron, Ontario;
- Uranium mine siting on the tundra in the Northwest Territories west of Baker Lake;
- Forest management programs and pulping facilities for a large forestry company with timber harvesting license covering one-third of the Province of Manitoba.

Peer review of EIA documents and construction monitoring of a gas export pipeline in Argentina (Inter-American Development Bank).

Participated in an operational EIA/audit of a gas transportation company in Argentina (Inter-American Development Bank).

Soil and landform studies in support of EIA document preparation pertaining to urban developments in southern Ontario (various applicants).

Review and evaluation of potential impacts to karst landforms and peatland ecosystems along the Attawapiskat River as the result of a proposed diamond mine (Ontario Ministry of Natural Resources).

Prepared and delivered a short course on Strategic Environmental Assessment (Peruvian Ministry of Transport).

Participated and wrote several sections of a major Cumulative Impact Statement for two proposed pulp mills in Uruguay (International Finance Corporation of the World Bank and Montes del Plata).

Researched and wrote a detailed report on terrestrial impacts, mitigation and monitoring on a proposed iron ore mine in Uruguay (Zamin Ferrous).

## **Water Quality**

Coordination of technical activities summarizing water quality, impacts and pollution sources of the St. Marys, St. Clair and Detroit Rivers and Lake St. Clair as part of the Upper Great Lakes Connecting Channels Study (Environment Canada and U.S. EPA).

Primary technical writer for virtually all technical documents pertaining to the St. Clair River Remedial Action Plan between 1990 and 2005 (Ontario Ministry of Natural Resources).

Primary technical writer to all four Lake Superior RAPs (Ontario Ministry of Environment).

Technical input to the St. Marys River RAP and the St. Lawrence River RAP (Ontario Ministry of Environment).

Analyzed and interpreted raw data on surface water quality, including metals, nutrients and major ions, for waters of the Bruce Peninsula National Park and Fathom Five National Marine Park, Ontario (Inland Waters Directorate, Environment Canada).

Analyzed and interpreted raw data collected during intensive and extensive surveys of the Detroit River identifying upstream downstream and cross river trends as well as sources relating to bacterial contamination, trace organics, nutrients and metals (Ontario Ministry of Environment).

## **Soils**

Investigated the chemistry and physical properties of mineral soils over large areas in northwestern, central, and northeastern Ontario for assessment of impacts due to acid precipitation (Environment Canada).

Undertook field studies and data analyses to describe the chemical and physical properties of organic and mineral of greater than 1000 soil profiles in the Hudson Bay Lowland and relate soils to landform and vegetation (Environment Canada).

Studied the mineralogy and soil chemistry of the Turkey Lakes area of Central Ontario as part of a calibrated watershed study in support of the Canadian federal Long Range Transport of Airborne Pollutants Program (Environment Canada).

Described and inventoried soils along the North Channel of Lake Huron as part of an EIA for proposed new thermal and nuclear electrical generating stations (Ontario Hydro).

Detailed soil surveys incorporating over 400 soil profiles in mineral and wetland sites as part of ecological and forest land classification projects in Manitoba and Yukon (Manitoba and Yukon governments).

Taught courses on soils and landforms for foresters in Northwestern Ontario (Ontario Ministry of Natural Resources).

### **Ecological Evaluation and Planning**

Method and technique development for Ecological Land Classification with the Canadian Committee on Ecological Land Classification (Environment Canada).

Detailed ecological land classifications and maps for the presentation of resource data and for mapping of ecosystems in the northern Ontario, Long Point (Lake Erie), Manitoba and Southeast Yukon (Environment Canada, Yukon and Manitoba governments).

Development of ecologically based criteria and GIS database assembly for the identification and selection of core areas and corridors constituting the Natural Heritage System for the Oak Ridges Moraine; prepared detailed (1:10 000) maps of the NHS using GIS data and analysis (Ontario Ministry of Natural Resources).

Ecological planning framework including the assembly and analysis of a GIS database for the Ottawa region and undertook analysis to prepare an ecological land classification as well as ecological sensitivity analysis (Regional Municipality of Ottawa-Carleton).

Detailed methodology to determine enduring features and undertake gap analysis of terrestrial protected areas for the Canadian Council on Ecological Areas (World Wildlife Fund Canada).

Gap analyses of New Brunswick, portions of northern Ontario and identified, evaluated and selected a system of ecological core areas and corridors for long-term ecological planning requirements (New Brunswick Department of Natural Resources).

Ecological planning framework and detailed methodology for determining enduring features and undertaking gap analysis for marine and lacustrine ecosystems for the World Wildlife Fund (Canada).

Ecological classification development and methodologies to undertake gap analysis for lakes (Lake Superior) and marine (Scotian Shelf) ecosystems (World Wildlife Fund Canada).

### **Park Planning and Natural Areas Delineation**

Identified and evaluated earth science features in more than 200 locations in Ontario for delineation as Nature Reserves, Conservation Reserves, Park Extensions or Areas of Natural and Scientific Interest (ANSI's) (Ontario Ministry of Natural Resources).

Assisted with the identification and subsequent protection of Environmentally Sensitive Areas (ESA's) of the Regional Municipality of Halton's ESA Program (Regional Municipality of Halton).

Analyzed cumulative environmental impacts to, and updated information on, Environmentally Sensitive Areas (ESA's) in the Regional Municipality of Hamilton Wentworth.

Developed criteria for the identification and selection of ESAs; described the geomorphological component of selected areas; and subsequently updated the ESA database (City of Toronto).

### **Public Consultation, Education and Training**

Contributed to the formulation of binational public consultation committees supporting the Detroit, St. Clair and St. Marys Rivers Remedial Action Plan Programs (Environment Canada and Ontario Ministry of Environment).

Project manager and contributor to the award winning (British Cartographic Society award) *The Great Lakes: An Environmental Atlas and Resource Book* (Environment Canada and U.S. EPA).

Prepared numerous brochures and fact sheets for Environment Canada on environmental issues and programs including Great Lakes Toxic Chemicals, Flood Damage Reduction, and climate warming (Environment Canada).

Numerous presentations for public and professional groups; development and delivery of interpretive programs (provincial and national parks); interviews on television and radio; major contributor to documentary programs on two national parks in Canada (various agencies and associations).

Voluntary participated for seven years on an environmental public advisory committee (EEAC) for the Region of Halton; served as Chairperson for 2 years (Region of Halton).

Suggested the concept of geological plaques for the Niagara Escarpment Commission to identify significant earth science features of the Niagara Escarpment (Niagara Escarpment Commission).

Several courses on soils and landforms to practising foresters and wildlife biologists in support of applications of ecosystem classifications (various clients).

Co-authored a book on the Geology and Landforms of Grey and Bruce counties (Ontario) for public distribution (Owen Sound Field Naturalists).

### **Environmental Policy Development and Analyses**

Extensive experience developing and recommending federal policy initiatives for senior management (DM/ADM levels) for issues on acid precipitation and Great Lakes water quality issues (Environment Canada).

Sensitive area and landform policy preparation, advice, and review for municipal official plans and official plan amendments (Regional Municipality of Halton, Town of Oakville, City of Guelph, City of Richmond Hill, Town of Aurora, Regional Municipality of Hamilton-Wentworth).

Undertook analysis of Federal legislation policy and programs as they relate to federal responsibilities for clean up funding in the 17 Canadian Great Lakes Areas of Concern (Environment Canada).

Developed operational guidelines and operational GIS database on pollution spills prevention, reporting and response; analysed federal and provincial policies, programs and legislation; and synthesized spills data and spill contingency planning undertaken by various jurisdictions (Trent-Severn Waterway, Parks Canada).

Assisted in the development of a protected areas programs (new national parks system) for the Government of Romania, including institutional strengthening and high-level negotiations with Minister and Secretary of State for Romania (World Bank).

Analyses and interpretation of landform policies within the Oak Ridges Moraine Conservation Plan in regards to proposed developments (Town of Newmarket, Town of Aurora, City of Richmond Hill).

Analysis and interpretation of landform and hydrogeological policies in the Niagara Escarpment Plan (various municipalities and private clients).

SELECTED PUBLICATIONS

- Cowell, D.W. and D.C. Ford. 1975. The Wodehouse Creek Karst, Grey County, Ontario. *Can. Geog.* 19(3): 196 205.
- Brook, G.A., D.W. Cowell and D.C. Ford. 1977. Comment on "Regional hydrochemistry of North American carbonate terrains" by R.S. Harmon, W. B. White, J.J. Drake and J.W. Hess and "The effect of climate on the chemistry of carbonate groundwater" by J.J. Drake and T.M.L. Wigley. *Water Res. Research*, 13(5): 856 858.
- Cowell, D.W., J.K. Jeglum and J.C. Merriman. 1978. Preservation of seasonal frost in peatlands, Kinoje Lakes, southern Hudson Bay Lowland. *Proc. 3rd Int. Conf. Permafrost, Edmonton, Alta., vol. 1: 453 459.*
- Cowell, D.W., G.M. Wickware and R.A. Sims. 1978. Ecological Land Classification of the Hudson Bay Lowland Coastal Zone, Ontario. *Proc. 2nd Meet. Can. Com. Ecol. Land Class., Victoria, B.C., Ecol. Land Class. Series #7, Lands Dir., Environment Canada: 165 175.*
- Haworth, S.E., D.W. Cowell and R.A. Sims. 1978. Bibliography of published and unpublished literature on the Hudson Bay Lowland. *Can. Forestry Service Info. Rept. O X 273. Sault Ste. Marie, Ontario: 270p.*
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- Cowell, D.W. and D.C. Ford. 1980. Hydrochemistry of a dolomite karst: The Bruce Peninsula of Ontario. *Can. J. Earth Sci.* vol. 17(4):520-526.
- Martini, I.P., D.W. Cowell and G.M. Wickware. 1980. The geomorphology of southwestern James Bay; a low energy emergent coastline. In: *The Coastline of Canada. Geol. Surv. Can. Paper 80 10; 293 301.*
- Wickware, G.M., D.W. Cowell and R.A. Sims. 1980. Peat resources of the Hudson Bay Lowland Coastal Zone. *Proc. 6th Int. Peat Congress, Duluth, Minnesota: 138 143.*
- Cowell, D.W., A.E. Lucas and C.D.A. Rubec. 1981. The development of an ecological sensitivity rating for acid precipitation impact assessment. *Working Paper #10, Lands Directorate, Environment Canada: 42p.*
- Cowell, D.W. 1982. Earth Sciences of the Hudson Bay Lowland: Literature Review and Annotated Bibliography. *Environment Canada, Lands Directorate, Working Paper No. 18: 309p.*
- Cowell, D.W., R.A. Sims and G.M. Wickware. 1982. Frozen beach ridge soils in the Hudson Bay Lowland, Ontario. *Can. J. Soil Sci.* 62: 421 425.
- Jeglum, J.K. and D.W. Cowell. 1982. Wetland ecosystems near Kinoje Lakes, southern interior Hudson Bay Lowland. *Hudson/James Bay Symp., Guelph, Ontario, Nat. Can.* 109: 621 635.
- Sims, R.A., D.W. Cowell and G.M. Wickware. 1982. Classification of fens near southern James Bay, Ontario, using vegetational physiognomy. *Can. J. Bot* 60(12): 2608 2623.



- Sims, R.A., D.W. Cowell and G.M. Wickware. 1982. Using vegetational physiognomy to classify treed peatlands near southern James Bay, Ontario. Hudson/James Bay Symp., Guelph, Ontario. Nat. Can., 109: 611-619.
- Cowell, D.W. and D.C. Ford. 1983. Karst hydrogeology of the Niagara Escarpment, Bruce Peninsula, Ontario. Proc. V.T. Stringfield Symp. Karst Hydrology, J. Hydrol. 16:163-168.
- Cowell, D.W. 1984. The Canadian Beaver (*Castor canadensis*), as a geomorphic agent in karst terrain. Can. Field Nat. 98(2): 227-230.
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- Cowell, D.W. and E.J., Bottomley. 1987. Oshawa Second Marsh: A case study in marsh conservation. Proc. Symp '87 Wetlands/ Peatlands, Edmonton, Alta, August 1987: 609-616.
- Sims, R.A., G.M. Wickware and D.W. Cowell. 1987. Wetlands of the Southern Hudson Bay Coast in Ontario. Proc. Symp. '87 Wetlands/Peatlands, Edmonton, Alta, August 1987: 435-442.
- Cowell, D.W., L. Barrie, L. Mortsch, P. Summers, and G. Wickware. 1990. Boreal and SubArctic Wetlands of Eastern Canada: A Reference Document. Atmospheric Environment Service, Environment Canada, Climatological Studies, No. 42: 189p.
- Cowell, D.W., G.M. Wickware and R.A. Sims. 1991. Organic and mineral soils of the southern James Bay coastal zone in relation to landform and vegetation physiognomy. Can. For. Service Info. Rept. Series, Sault Ste. Marie, Ontario.
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- Cowell, D.W., M.J. Sharp, and M.E. Taylor. 1995. A natural heritage system for the Niagara Escarpment Plan Area. Proc. Leading Edge '95 Conference, Collingwood, Ontario Ministry of Environment and Energy, Toronto, ON: p. 74-78.
- Cowell, D.W. and P.S.G. Kor. 1995. On the value and rationale for earth science features within natural area programs, with reference to the Niagara Escarpment Plan Area. Proc. Leading Edge '95 Conference, Collingwood, Ontario Ministry of Environment and Energy, Toronto, ON: p. 106-111.



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Kor, P.S.G. and D.W. Cowell. 1998. Evidence for catastrophic subglacial meltwater sheetflood events on the Bruce Peninsula, Ontario. *Can. J. Earth Sci.*, Vol 35 (10): 1180-1202.

Cowell, D.W. 2004. Karst Geomorphology and Implications for Environmental and Development Planning on the Niagara Escarpment. Paper Presented at the 2004 Geological Association of Canada Conference, St. Catharines, Ontario, May 2004.

Cowell, D.W. 2004. Karst Landforms. In *The Geology and Landforms of Grey and Bruce Counties*. Special Publication of the Owen Sound Field Naturalists, Stan Brown Printers Limited, Owen Sound, Ontario.

Cowell, D.W. 2005. Territorial Zoning in Brazil: A Valuable Tool to Undertake Strategic Environmental Assessment. Paper Presented to the VI Congreso Nacional de Ecología, Ambiente y Desarrollo Sostenible, November 23-26, 2005, Cerro de Pasco, Peru: 12p.

Kor, P.S.G., D.W. Cowell, P.F. Karrow, and F.J. Kristjansson. 2012. The Cabot Head Archipelago: Evidence of Glacial Lake Algonquin on the Northern Bruce Peninsula, Ontario. *Canadian Journal of Earth Sciences*, 49(4): 576-589, 10.1139/e2012-007.

**SCHEDULE B**  
**LIST OF DOCUMENTS REVIEWED**

**Documents prepared by me include:**

1. Brantford Tufa Mounds Earth Science Area of Natural and Scientific Interest, Guelph District, Southcentral Ontario, North-South Environmental Inc., January 2005: 15p;
2. Comments on Addendum to Scoped EIS – re. Road Corridor Between Sifton and Rizzo Lands; Daryl W. Cowell & Associates Inc., March 22, 2012;
3. Comments on Revised Plan of Subdivision, Grandview Ravines, Inc., Daryl W. Cowell & Associates Inc., April 3, 2012.

**Documents directly associated with the applications by Sifton Properties and Grandview Ravines Inc. include:**

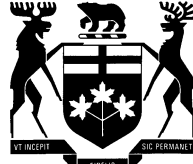
4. “Environmental Impact Assessment Phase 1 – Existing Conditions, Hampton Estates/Hardy Road”, prepared by Ecoplans Limited, May 2000;
5. “Northwest Master Plan, City of Brantford”, prepared by Weslake Inc., December 2000;
6. “Eastern Portion of the North-West Area, city of Brantford, Comprehensive Environmental Review”, prepared by Howes-Jones & Associates/Cohoon Engineering / Hardie Planning/Stantec Consulting, August 2001;
7. “Schedule “B” Class EA Study East Portion of the Northwest Area of the City of Brantford and Adjacent Areas Sanitary Sewage Servicing Study”, J. H. Cohoon Engineering Ltd./ Howes-Jones & Associates Inc./ Richard A. Hardie & Associates Inc., March 2003;
8. “Geotechnical Investigation Hampton Estates Subdivision Hardy Road, Brantford, Ontario” J.H. Cohoon Engineering Ltd., December 18, 2003;
9. GRCA’s comments (letter to City) on the McNeill/Barcham (Grandview) subdivision, April 7, 2005;
10. GRCA letter to the City providing comments on the Grandview Private Applications and environmental issues, May 10, 2005;
11. GRCA letter to the City providing comments on CRA’s June 6, 2005 Report prepared for Grandview’s proposed subdivision, July 8, 2005;
12. CRA letter to GRCA providing a water balance report in support of the McNeill/Barcham (Grandview) Subdivision. The water balance calculations are intended to meet the requirements of the “Comprehensive Environmental Review Final Report” dated August, 2001, September 15, 2005;
13. GRCA letter to the City providing comments on Grandview’s Rezoning and Subdivision Applications based on the Draft Plan of Subdivision Environmental Constraints Map prepared by CRA (stamped as received on October 13, 2005), February 8, 2006;
14. GRCA letter to the City providing comments on the draft Hardy Road Peer Review Report as it relates to the Sifton and Grandview Subdivision Applications, July 21, 2006;
15. “Grandview Ravines, City of Brantford, Functional Servicing and Stormwater Management Report”, Metropolitan Consulting Inc., December 21, 2007;

16. “Hardy Road Peer Review – McNeill/Barcham & Hampton Estates”, prepared by Dougan & Associates, February 2008;
17. “Functional SWM Servicing Report – Hardy Road Subdivision, City of Brantford”, Earth Tech Canada Inc., July 2008;
18. “Hardy Road Subdivision Preliminary Servicing Report”, Earth Tech Canada Inc., July 2008;
19. “Hardy Road Plan of Subdivision Environmental Management Plan”, Earth Tech Canada Inc., July 2008;
20. “Response to MNR letter of March 2, 2009 Official Plan Amendment, City of Brantford Sifton and Rizzo Draft Plans of Subdivision, Lots 21, 22 and 23 Concession 3, Brantford”, Howes-Jones & Associates, June 25, 2009;
21. “277 Hardy Road Subdivision Application Supplementary Hydrogeology Investigation”, LVM-Naylor, August 28, 2009;
22. City of Brantford, Report No. CD2011-022, Official Plan Amendment OP-04-10, Zoning By-Law Amendment PZ21-10; February 22, 2011;
23. Draft Peer Review Comments, Sifton Draft Plan of Subdivision, Prepared by PLAN B Natural Heritage, February 28, 2012;
24. “Addendum to Scoped EIS Road Corridor between Sifton and Rizzo Properties, Northwest Community, Brantford, Ontario”, prepared by Howes-Jones for Samuel Rizzo Estates Inc., September 2011;
25. Sifton’s revised draft plan of subdivision (last Revised Date: August 15, 2011), Circulated by City on February 15, 2012;
26. Grandview’s revised draft plan of subdivision (Revised Date: March 21, 2012), Circulated by City on March 22, 2012.

**Other Documents that may be used in support of my evidence include:**

27. The Provincial Policy Statement 1997;
28. The Provincial Policy Statement 2005;
29. City of Brantford Official Plan;
30. Draft Plan & Environmental Protection Plan for the Northwest Industrial Area Brantford, Ontario, Prepared by Weslake Inc., September 1999, Section 3 (Geotechnical & Hydrogeological Considerations) and Section 8 (Environmental Protection Plan);
31. Final version of the WMP posted on the City’s web-site prior to the June 14, 2010 COW Meeting, June 2010;
32. Natural Heritage Analysis, 277 Hardy Road & 125 Golf Road, City of Brantford, Prepared by PLAN B Natural Heritage, January 2011;
33. “Northwest Master Plan Phase 3”, prepared by Weslake Inc., October 2001;
34. Holocene Floodplain History Along the Grand River Near Brantford, Ontario, B.Sc. Thesis by Suzanne Brooks, UofT, 2004;
35. Pleistocene Geology of the Brantford Area, Ontario Geological Survey, Map 2240 by W.R. Cowan (undated), 1:63,360;
36. Paleozoic Geology of the Brantford Area, Ontario Geological Survey, Preliminary Map P.1984 by P.G. Telford, 1979, 1:50,000;
37. National Topographic Series, Sheet No.40P/1.

**SCHEDULE C**  
**AFFIRMATION OF EXPERT'S DUTY**



Ontario

Ontario Municipal Board  
Commission des affaires municipales de l'Ontario

**ACKNOWLEDGMENT OF EXPERT'S DUTY**

<b>Case Number</b>	<b>Municipality</b>
<b>PL100472</b>	<b>Brantford</b>

1. My name is.....Daryl Cowell.....(name)  
I live at.....27 Rita Crescent, RR#1 Tobermory.....(municipality)  
in the.....County of Bruce.....(county or region)  
in the .....Province of Ontario.....(province)
2. I have been engaged by or on behalf of the City of Brantford, to provide evidence in relation to the above-noted Board proceeding.
3. I acknowledge that it is my duty to provide evidence in relation to this proceeding as follows:
  - a. to provide opinion evidence that is fair, objective and non-partisan;
  - b. to provide opinion evidence that is related only to matters that are within my area of expertise; and
  - c. to provide such additional assistance as the Board may reasonably require, to determine a matter in issue.
4. I acknowledge that the duty referred to above prevails over any obligation which I may owe to any party by whom or on whose behalf I am engaged.

Date.....June 15, 2012.....

Signature