# ***PERSPECTIVES ON THE BRAS D'OR's FRESH WATER***

By Fred Baechler

The key to managing and protecting the fresh water resources of our Biosphere is based upon the concept that:

***'You can't effectively manage what you only have a limited understanding of.'***

To develop that understanding requires a discussion around five key perspectives.

## 1. WATERSHED

The first perspective is to identify the Bras d'Or watershed; the land area (Figure 1) which contributes or "sheds" water to the marine waters of the Bras d'Or lake-estuary system. It encompasses some 2,512 $km^2$, more than twice the size of the lake (1,085 $km^2$). It is this watershed which determined the boundary of the UNESCO Bras d'Or Lake Biosphere

***How the land talks to the sea is through the fresh waters of its streams (the water we walk in) and groundwater (the water we walk on).***


*Figure 1: Bras d'Or Watershed outlined in red*

## 2. TIMESCAPE

The second perspective requires an understanding that the factors controlling the Bras d'Or's fresh water evolved over about 600 million years through diverse, complex and massive geological forces. These created and continue to modify the matrix, or structure, in which the water moves.

Cape Breton Island was conceived on both sides of an ancient ocean, then the pieces welded together in the tropics near the equator by plate tectonics as the Appalachian mountains were thrust up between 1000 to 365 million years ago (Ma). Subsequent erosion of the mountains between 365 to 65 Ma infilled inter-mountain basins to form a relatively flat plain with a variety of sedimentary rocks, including sandstones, conglomerates, shales, evaporites (e.g. gypsum, salt, potash), coals, some of which generated hydrocarbons. Between 65 to 1 Ma –this plain was uplifted, tilted and eroded, creating the geomorphic features of the watershed, with the more resistant crystalline rocks (e.g. granite) forming the highlands and the softer sedimentary rocks creating the lowlands. Between 1 Ma to 10,000 years ago, the ice age modified the watershed through four major glacial periods as continental scale ice sheets gouged, chiselled and deposited thick glacial debris. The recent Interglacial period (10,000 to present), in which we now find ourselves, started with the retreat of the last remnants of ice. The interplay of rising sea level, ice sheet recession and a diverse terrain facilitated the development of important groundwater aquifers, rivers, lakes, wetlands, forest cover and karst terrain (sinkholes).

This timescape provides the watershed's rocks and soil with memories of mountain ranges, volcanoes, earthquakes, faults, tropical climates, flooding by salty seas, erosion by rivers, dense tropical forests, opening and closing of oceans, blanketing, chiselling, gouging by glaciers and the rise and fall of sea level as the Island drifted northward from the equator to its present position. Now it resides within an island, surrounded by and bathed by the rise and fall of the sea. It is this legacy that provides the matrix which exerts control over the Bras d'Or's fresh waters.

## *3.* WEATHERSCAPE

The third perspective is the concept of the *Weatherscape* (climate), as it drives the movement of water (hydrological cycle) through the watershed. Acting as a water pump it showers precipitation onto the land, then along with vegetation, pumps the water back into the atmosphere through evaporation and transpiration to begin the cycle anew.

A humid, continental climate characterizes the watershed's weatherscape. The continental aspect evolves from the watershed's position which spans the converging tracks of most major, eastward moving storms over North America. Consequently the *Airshed* or the geographical area covered by a common air supply - controls the weather input to the watershed. Since it is continental in scope it is much larger and more difficult to manage. The watershed's maritime setting provides a moderating effect through the influence of the Gulf of St. Lawrence to the west and north, as well as the Atlantic Ocean to the northeast and east.

The weatherscape provides approximately 1500 mm of annual precipitation, thereby positioning the watershed within only one of two regions in the entire country receiving greater than 1000 mm. The dominant precipitation events derive from long duration - low intensity hurricanes from June to November and Nor'easters from October to April. Approximately a third of the annual precipitation is

removed by evaporation and transpiration by trees, before it enters streams and groundwaters. Snow forms approximately 25% of annual precipitation in the lowlands, falling mainly between early December and March. A snowbelt is present over the highlands in the headwaters of the Middle and Baddeck rivers. This results from westerly winds picking up moisture as they cross the open Gulf of St. Lawrence, then rising and cooling as they encounter the Cape Breton Highlands creating snow, falling between November and April.

## *4.* WATERSCAPE

The fourth perspective encompasses the concept of *Waterscape,* which is where the *Weatherscape* meets the *Landscape.* It is that uniquely habitable zone of the Watershed where humans can comfortably dwell.

During the peak of glaciation approximately 22,000 years ago there was no *Waterscape*, just an *Icescape.* By 9,000 years ago sea level was approximately 50 m below present. The watershed was therefore much larger then present, covering an additional approximately 1800 $km^2$, including three large fresh water lakes. The main outlet river transported water down what is now the Great Bras d'Or channel and out to meet the sea near Wreck Cove. Sea level rise after approximately 6,000 years ago gradually flooded out a large part of this watershed creating what we now know as the Bras d'Or Lake. Therefore, rivers within our present-day watershed are now just the upper headwater portions of an historically much large drainage system.

The watershed exhibits five different Waterscape*s*, or Hydrological Regions. The building blocks which create these regions comprise 15 Hydrostratigraphic Units. These are geological units which have similar properties which control how and where water moves and its quality. When combined in different combinations and orientations, along with topography, forest cover and climate they have created five unique *Waterscapes.* These include the Highland Region (comprising 30% of the watershed) e.g. Cape Breton Highlands, Creignish Hills, Marble Mountain, the Mountain Flank Region (24%) e.g. the steep slopes along the edge of the highlands as noted along the Trans-Canada Highway between Wagmatcook and Whycocomagh, the Foothills Region 4%) e.g. Iona, the Lowland Region (35%) e.g. Denys Basin and the Canyon Region (7%) e.g. Middle River.

Two of the largest rivers within the Bras d'Or watershed (Middle and Baddeck) cross all these waterscapes. They start over the gently rolling highland plain as small, short-lived, rivulets and perennial streams linked with numerous wetlands through straight channels with low slopes and erosive power (Plate 1). The building blocks creating this Highland waterscape, which are characterized by granites and metamorphic rocks, creates a water quality characterized as hyperfresh, with high colour, low turbidity and minimal interaction with groundwaters.

*Plate 1: Headwaters of the Middle River draining part of the Big Barren wetland complex in the Cape Breton Highlands*

As these streams transition to rivers through the steep slopes of the Mountain Flank Region, they pick up groundwater input, size, speed and erosive power, as they cascade, tumble and swirl around and over bedrock outcrops in narrow gorges on their way down to the lowland plains (Plate 2).

*Plate 2: Headwaters of the Middle River Canyon incised into the highlands, within the Middle River Wilderness Area*

Over the lowlands, these rivers can encounter a wide variety of runoff and groundwater conditions, including thick glacial debris, large lakes, buried bedrock valley aquifers, springs, different forest cover, sinkholes in underlying gypsum and limestone and erodible river beds and banks. All of these act to control the rivers' form, size, ability to transport sediment and water quality before they encounter the

Bras d'Or Lake.  Here these rivers can change their form as they cross broad valley floors from straight to sinuous, to meandering, and at times braided, (Plate 3) when there is too much sediment to transport.

*Plate 3: Middle River meandering across its broad valley floor near Yankee Line*

They then finally end their journey as they flow into the Bras d'Or Lake, sometimes creating large deltas of sediment (Plate 4)

*Plate  4: The Middle River delta where the river empties into the Bras d'Or Lake at Wagmatcook*

## *5.* WHERE THE WATERSCAPE MEETS THE SEASCAPE: THE BLUE-GREEN WATER PARADIGM

The fifth perspective focuses on the boundary where the *Waterscapes* of the watershed meets the *Seascape* of the lake; which can be best characterized through the new idea (or paradigm) of "Blue-Green Water" . From the lake's point of view the blue water is the lake and the green water comes from the land (Plate 4). From the watershed's point of view the blue water comprises the streams and groundwater and the green water is that controlled by the forests through evaporation and transpiration. This boundary or interface also controls the legal management of the water resources, as the blue water of the watershed is owned and governed by provincial legislation, but the green water is controlled by landowners through land use, in terms of how they manage the forest cover. As well, the interface is where provincial legislation controlling the waterscapes, meets federal legislation controlling the seascape.

This perspective encompasses two concepts governing this watershed-seascape interface. The two-dimensional (2D) concept involves the 1,272 km of lake shoreline. This includes both distinct locations where streams enter, (Plate 4), as well a diffuse source along the entire shoreline where groundwater enters through seepage and springs. Over 400 barachois ponds occur along this interface, which can combine both fresh and marine waters. The three dimensional (3D) concept incorporates fresh groundwater transported vertically upward through the bed of the Bras d'Or lake, either through diffuse seepage, or at distinct points referred to as submarine groundwater discharge (SGD). Therefore, the watershed must also be considered to be "under" the lake.

## MANAGEMENT

These five perspectives lead to the understanding that the Bras d'Or's freshwaters are complex, as they change with space and time, within different waterscapes of the watershed. Therefore, how the land talks to the sea has developed its own rhythm and language. Our changing climate is altering this discourse, in ways we are struggling to understand. To paraphrase Dr. Brendan Murphy of St. Francis Xavier University, we first have to understand that natural rhythm, before we can detect a skip in the beat created by man.

As a result, what management strategy works in one Waterscape to protect the Bras d'Or's fresh water may not necessarily be extrapolated to another. Best management practices that are brought in from off-Island, may not work at all. What works now, may not work as climate changes.

To develop the appropriate management practices to protect these fresh waters and understand how the waterscape will and is responding to changing climate, requires monitoring and research. However, these are in short supply within the Bras d'Or watershed.

Government sponsored monitoring presently includes stream flow within sections of only the Middle River and River Denys sub-watersheds. Weather is being monitored at one Environment Canada station (Eskasoni). There is no monitoring of groundwater, wetlands, vernal pools, barachois' or springs (within the Bras d'Or watershed). In spite of this, monitoring by industry and other private interest groups have reduced this deficit with monitoring of eight additional sub-watersheds of the Bras d'Or, 14 (private)

weather stations, one wetland, nine groundwater wells, one vernal pool, four barachois ponds and eleven springs.

On a personal note, over the past 15 years, my wife, Lynn, and I have gradually been assembling all the relevant information on the physical, chemical and sedimentological characteristics of the Bras d'Or's fresh waters. These have been incorporated within a digital mapping system (GIS). We are gradually analyzing the information to see what it is telling us; but this is still in its beginning stages. So far, six technical papers have been published. They include: defining hydrological regions, the impact of changing climate, karst, fault aquifers, buried bedrock valley aquifers and springs. More will come.

Fred Baechler is EXP Services Inc. Chief Hydrogeologist and Senior Hydrologist operating out of the Sydney Regional Office. He has over 40 years of experience primarily throughout Atlantic Canada, but with a focus in Cape Breton. This has also included international projects in Mexico and Thailand, as well as technical field trips in Scotland, Germany, the United States and Greenland, as well as throughout Canada. During this time he has addressed water related issues from a regulatory (Nova Scotia Department of Environment), consultant, researcher and educator (Adjunct Professor at Cape Breton University) perspective.