3.2 Hydrological Features of the Ottawa River Drainage Basin

Hydrology is the science that deals with the distribution, circulation, and physical and chemical properties of water on the Earth's surface. This includes the amount of water flowing down a river, the velocity at which it travels, the fluctuations of these parameters over time, and the water's chemical composition. Examining each of these factors with regards to the Ottawa River fosters a better understanding of how the Ottawa functions, its impact on the surrounding floodplain ecosystems, and the ways in which humans interact with it.

3.2.1 Size of the Ottawa River

River size is defined by two characteristics: discharge volume and river length. Discharge volume is the amount of water passing through a cross-section of a river over a certain unit of time. The most common unit of measurement for discharge volume is cubic meters per second (m^3/s).

Table 3.4 displays the discharge volume of the Ottawa River at Carillon dam, the last dam before the Ottawa's confluence with the Saint Lawrence. Measurements taken at Carillon therefore indicate the magnitude of the river at its greatest point. The yearly discharge of the Ottawa averages just under 2000 m^3/s, with maximum flows as high as 5947 m^3/s in the past five years.

Table 3.4 Ottawa River Discharge Volume as Measured at Carillon Dam

Year	Maximum Flow	Minimum Flow	Yearly Average
2004	4917 m^3/s	534 m^3/s	1960 m^3/s
2003	4792	519	1811
2002	5947	666	2064
2001	4070	563	1700
2000	3205	971	1801

(Source: ORRPB: "Historical Streamflow Summary")

The CHRS categorizes rivers into five classes based on their discharge volumes at low flow. Low flow (also known as base flow) refers to the volume of water discharged by a river during one of two seasons, generally summer or winter, when discharge volume is at its lowest of the year. In the case of the Ottawa River, low flow generally occurs between July and October.

Based on discharge volumes measured at Carillon and other dams along its course, the Ottawa is classified as a second-order river within the CHRS low-flow volume classification system. As indicated in Table 3.5, the second order represents those rivers with low-flow discharge volumes between 2000 and 4000 m^3/s, and also includes the Fraser, Peace, and Yukon rivers. The Ottawa ranks as Canada's 8^{th} largest river in terms of mean discharge (NRC: "Rivers").

Table 3.5 Low Flow Volume Classes of Canadian Rivers

Tier / Order	Discharge Range	Example Rivers
V	<500 m^3/s	Thames, Margaree, Restigouche, Grand
IV	500 to 1,000	Kazan, Thelon, Seal
III	1,000 to 2,000	Churchill, N. Saskatchewan
II	2,000 to 4,000	Peace, Fraser, Yukon, **Ottawa**
I	> 4,000	Mackenzie, Saint Lawrence

(Source: CHRS Framework for Natural Values 1997)

On average, the lowest flow volume of the Ottawa River at Carillon between 1964 and 2005 was 736 m^3/s (ORRPB: "Historical Streamflow"), making it a "Large River" according to CHRS, which currently defines Large Rivers as those with a flow volume at the lowest point of nomination between 400 and 800 m^3/s (CHRS 2001: 19).

The Ottawa stretches 1271 kilometres from its source east of the Dozois Reservoir to its confluence with the Saint Lawrence. It is this full length that is being put forward for nomination under the CHRS. According to Table 3.6, the Ottawa's great length and discharge volume qualify it as a 'Large', almost 'Major' river. The Ottawa River is Canada's 12th longest-river, and is the 2nd-longest Canadian river that flows to the Atlantic Ocean (NRC: "Rivers").

Table 3.6 River Size Classes with Examples

Flow Volume at Lowest Point of Nomination (m^3/s)	Total Length of River		
	<500 km	**500 km to 1,000 km**	**>1,000 km**
Small Rivers <85	Main, Margaree, Hillsborough	Shelburne, Kicking Horse, Bonnet Plume	Thames, Boundary Water, Clearwater
Medium Rivers 85 to 400	St. Croix, Restigouche, Seal	Grand, Arctic Red	S. Nahanni, Athabasca
Large Rivers 400 to 800		Kazan	Thelon, St. Mary's, **Ottawa**
Major Rivers >800		Fraser	Yukon, Detroit, St. Mary's

(Source: CHRS 1997)

Many factors contribute to determining a river's discharge volume: climate, watershed area, drainage pattern, slope, land use, and soil type. On the Ottawa River, low flow discharge rates have been influenced over time by human activities such as:

- Dam construction for storage, flood control, and power generation;
- Withdrawals for irrigation, human use and industrial purposes;
- Agricultural, industrial and urban run-off;
- Deforestation.

Of these, the high number of dams has had a particularly significant effect of the Ottawa's hydrology. There are over 30 major reservoirs in the Ottawa River Basin. See Appendix G for a list of reservoirs along the Ottawa River's main course.

Many dams produce electricity in addition to regulating flooding. In all, the Ottawa River Basin houses 43 hydroelectric generating stations with a combined capacity of 3,500 megawatts. This represents an economic value of roughly $1 million per day (ORRPB: "Managing the Waters"). Seven of the dams are located on the main course of the river. This high number of dams and reservoirs makes the Ottawa River basin one of the most highly regulated catchments in Canada. Please refer to Chapter 2.9.7: Generating Stations, Dams and Reservoirs on the Ottawa River, for a detailed description of these structures.

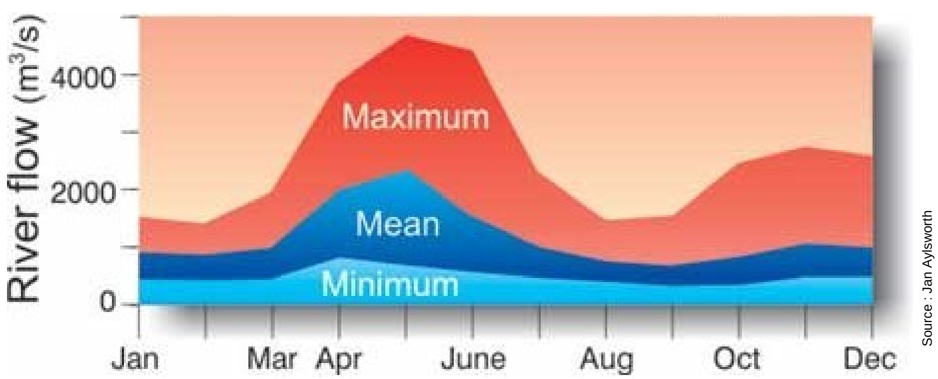
3.2.2 Drainage Basin of the Ottawa River

Overall, the Ottawa River's basin occupies some 146,300 km² of territory, of which 65% lies in Quebec and 35 % in Ontario (ORRPB: "Managing the Waters"). This makes it the 12th largest drainage basin located in Canada (NRC: "Rivers"). According to the CHRS Guidelines for Natural Heritage Values, rivers flowing directly into the ocean are Number 1 streams (CHRS 2001: 11). The St. Lawrence River is, therefore, a Number 1 stream, flowing into the Atlantic Ocean, and making its greatest tributary, the Ottawa River, a Number 2 stream. In fact, the Ottawa River's drainage basin accounts for approximately 11.2% of the total drainage area of the St. Lawrence (Haxton and Chubbuck 1).

3.2.3 Seasonal Variations

Seasonal variations include the regular periods of high and low flows and secondary peaks in the discharge volume of a river over a year. Peak flows of many Canadian rivers, including the Ottawa, occur as a result of the springtime snowmelt, and low flow occurs during dry summer periods or during winter freeze-up. Secondary peaks can occur in late summer or fall.

Figure 3.22 Average Monthly Flow - Ottawa River at Chats Falls



The flow of the Ottawa varies seasonally, with a peak in the spring and a secondary peak in the fall. The extent of this flow variation also changes with each year.

The average maximum monthly flow over the past 40 years has been 5374 m³/s, while the average minimum flow has been 736 m³/s (ORRPB: "Historical Streamflow"). The degree of seasonal variation of the Ottawa River's flow has been greatly reduced by the reservoirs and dams along the river and in the watershed. Many of these dams serve to reduce potential damage of peak flow and ensure adequate flow for hydroelectric production throughout the year. In 1870, the ratio of maximum to minimum flow was about 10:1, while by 1930 it was reduced to 5:1 (Legget 1975: 16). Regulation for hydroelectric power generation has also created *daily* fluctuations in the reservoirs, such as in the Carillon reservoir during winter (Haxton and Chubbuck 9-10).

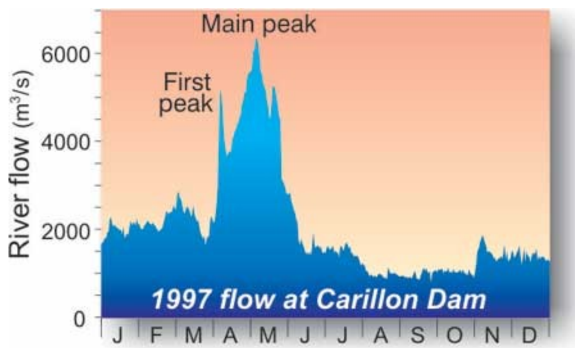
Despite regulation by dams and reservoirs, the Ottawa River still experiences the same general pattern of flow, with low flow in the fall, and a sudden increase in flow with the spring melt and flood around April. From year to year, seasonal variations differ due to varying rainfall and how quickly the snow melts (Legget 1975: 16). The Upper Ottawa River basin (above Lake Temiskaming) experiences two annual peaks. The spring flood is the largest, beginning in early April and ending at the end of May (Hydro Québec: Bassin supérieur 1-1).

Figure 3.23 High Water on the Ottawa River, 1936

Source : William James Topley/Library and Archives Canada/PA-009394

At Carillon, the spring peak extends from mid-March to mid-May. There are, within this, two distinct spring peaks. The first occurs around mid-April and results from the increased discharge volume of the non-regulated tributaries along the Ontario shore. The second, usually larger flood peak usually occurs about three weeks later and results from the swelling of the partially regulated tributaries along the Quebec shore and the floodwaters of the Upper Ottawa River (Hydro Québec: Bassin inférieur 1-1). Spring peaks in the river basin can cause flooding in the downstream areas around Laval and Montreal. The uncontrolled tributaries can contribute up to 80% of the volume of water passing through the Ottawa River's flood risk areas (Andrews 151).

Figure 3.24 Peak Flow of the Ottawa



Source : Jan Aylsworth

The Lower Ottawa River experiences two peak flow periods in springtime. Spring arrives earlier along the southern, unregulated tributaries (the Mississippi, Rideau, and South Nation rivers) causing the Ottawa River to rise to its first peak. The second, and normally higher, flow peak occurs about three weeks later as a result of snowmelt in the northern regions of the basin.

The Ottawa River Regulation and Planning Board, an organization that coordinates the integrated management of the principal reservoirs of the Ottawa River basin, brings together the owners and managers of the Ottawa River basin dams and reservoirs to reduce the possibility of damaging floods and to ensure there is adequate flow for the many different uses of the Ottawa River.

3.2.4 Water Content

The term water content refers to both physical and chemical properties, including clarity (turbidity), acidity, and other dissolved solids. This section will also discuss water quality in terms of nutrients, bacteria, heavy metals, and pollutants contained in the water. These properties influence the biological productivity and appearance of the river, as well as its utility to humans.

Turbidity

Turbidity reflects how much sediment is suspended in the water, and is measured by the amount of light that can pass through a sample of water. This sediment is significant because it deposits along riverbanks and bottoms, giving the river its ever-changing physical shape. Sediment also impacts on the suitability of a river for aquatic life because turbidity may reduce the amount of oxygen that can dissolve in the water (CHRS 2001: 15). Water can be classified based on its turbidity into one of three categories: high, medium, and low turbidity.

The Ottawa River transports sand, silt, gravel and clay from the erosion of glacial deposits (Hydro Québec: Bassin inférieur 1-1). Clay effluent from tributaries such as the Petite-Nation increases the turbidity of the river's lower stretches (Hydro Québec: Bassin inférieur ii). The section from Carillon to Chaudiere Falls experiences high turbidity due to a high content of fine clay particles, often resulting in poor dissolved oxygen levels (Haxton and Chubbuck 10). Near Lake Temiskaming, the water is also high in clay, making it more turbid and therefore reducing water clarity (Hydro Québec: Bassin supérieur 1-1, 4-5).

Acidity

Surface water acidity is measured by pH. A high pH, above 7.3, indicates alkaline surface water. A pH of 6.6 - 7.3 is considered neutral. Below 6.6 indicates low pH, or high acidity.

In general, the Ottawa River has a lower pH, or higher acidity, around Lake Temiskaming. This diminishes and becomes increasingly neutral and slightly alkaline further downstream (Hydro Québec: Bassin inférieur 1-1). Mine run-off in the upper stretches of the river lowers the pH of surface water in the lakes of the Upper Ottawa River. This is exacerbated by the acidic sub-soil (Hydro Québec: Bassin supérieur 4-5).

Nutrients

Nutrients such as nitrates and phosphates are common elements in watercourses that receive runoff from agricultural and urban areas. Both are key components in many organic and commercial fertilizers. Sewage also contains high levels of these elements.

Below Chaudiere Falls, the Ottawa River has historically experienced high levels of phosphorous and nitrogen-containing compounds (Haxton and Chubbuck 10). Agricultural runoff from tributaries such as the Petite-Nation increases the nutrient content of the lower stretches by adding phosphorus and nitrogen, encouraging the growth of algae. The South Nation River flows through agricultural lands and contributes nutrients to the Ottawa River (DDEPQ: "Qualité des eaux"). The construction of wastewater treatment plants over the past 20 years has helped reduce nutrients contained in the water (Hydro Québec: Bassin inférieur ii, 4-4). Water quality has also increased since the 1980s in the vicinity of Lake Temiskaming because of lower nutrient levels (phosphorus). Pig farming in one of the tributaries to Lake Temiskaming raises the nutrient levels in the lake (Hydro Québec: Bassin supérieur 4-5).

Bacteria

Bacteria from human and animal wastes are commonly found in natural waters and are concerning from a public health perspective. Swimmers can experience skin irritation, ear and eye infections, and, if swallowed, intestinal disorders.

Overall, the water quality of the Ottawa River is considered good, with localized cases of high bacteria levels. High bacteria levels have been reported in the Lac Dollard des Ormeaux reach (Haxton and Chubbuck 76). A wastewater treatment plant with inadequate disinfection practices in Gatineau results in higher levels of bacteria in the lower stretches of the Ottawa River (Hydro Québec: Bassin inférieur ii). Urban and industrial wastewater from Ottawa-Hull contaminates the Ottawa River with bacteria, sometimes exceeding the safe limit for swimming (DDEPQ: "Qualité des eaux"). Tributaries with high bacteria contents such as the Rouge, the Lièvre, and the Bonnechere degrade the water quality of the Ottawa River. Underground water is contaminated by bacteria around Lake Temiskaming because of the clay-like soil that prohibits the construction of proper septic tanks. This contaminates many wells and impacts on surface water as well (Hydro Québec: Bassin supérieur 4-5).

Water Quality

Overall water quality depends on the properties described above, as well as on the presence or absence of heavy metals and other pollutants. Water quality in the Ottawa River basin is considered good overall as a result of the high velocity of the water and the numerous wastewater treatment plants that have been established (DDEPQ: "Qualité des eaux"). Most problem areas are localized, such as around densely urbanized areas. The Ottawa River's many tributaries affect the overall water quality of the river itself. Despite localized problems, the majority of the Ottawa River is considered suitable for recreational uses such as swimming and fishing.

Water quality is generally considered good in the Ottawa River between Lake Temiskaming and the Gatineau River. Around Lac Coulonge, the water is considered polluted. Water quality in this stretch has been improving since the 1980s, as is the visible appearance of the water, which is affected by solid waste in the water as well as the water's colour (Hydro Québec: Bassin inférieur 4-4). Historically, PCBs and DDT have been found in high levels between Chaudiere and Carillon (Haxton and Chubbuck 10). Nickel and copper are heavy metals found in small concentrations along the river.

Water quality above Lake Temiskaming is considered good, although the water table has been polluted in numerous places due to the absence of adequate septic tanks because of the clay-like soil (Hydro Québec: Bassin supérieur iii). Wastewater treatment around Ville-Marie has improved water quality for swimming. In the upper stretches, wastewater from industry such as paper mills decreases water quality (Hydro Québec: Bassin supérieur 4-5). The presence of cottagers in lakes within the river basin tends to lower the quality of the water.

Table 3.7 Water Properties Along the Lower Ottawa River

River Reach	Turbi-dity	Nitrogen (mg/l)		Phosphorous (mg/l)	Biological Oxygen Demand (mg/l)	pH	Avg. Temp. in °C
		Average	High				
Lac Dollard des Ormeaux (Carillon to Chaudiere Falls)	High	0.30-0.50	2.65	0.025 to 0.10	0.5 to 2.5	7.5	24
Lac Deschênes (Chaudiere Falls to Chats Falls/Fitzroy)				0.01 to 0.02		7.5	24
Lac des Chats (Chats Falls/Fitzroy to Chenaux Dam)		0.35	1.12	0.01 to 0.08	0.2 to 3.0		
Lac du Rocher Fendu (Chenaux to La Passe Dam)		0.25	0.40	0.01 to 0.04	0.25 to 3.0		
Allumette Lake and Lac Coulonge (LaPasse to Des Joachims)						7.0	
Holden Lake (Des Joachims to Otto Holden Dam)						6.5	
Lac la Cave (Otto Holden Dam to the Dam at Lake Temiskaming)		0.45	2.20	0.02 to 0.05	0.5 to 3.0		

Source: Haxton and Chubbuck 76

The water quality of the Ottawa River is extremely important, as it is the source of drinking water for many local communities. The City of Ottawa is the heaviest of these users, drawing 341 million litres of water from the river each day at the Britannia and Lemieux Island water purification plants (Geoscape Canada: “Ottawa River”.