3 Physical and Biological Environment

The following summarizes the information provided in full in the Background Information Report (A&A, 2003a).

3.1 Physical Environment

3.1.1 Climate

The climate of the Muskoka River watershed study area is continental with a moderating influence due to the presence of Georgian Bay. Winters are cool and summers are warm, and it is one of the wetter areas in the province. January is the coldest month with a mean daily minimum temperature of -16EC and July is the warmest month, with a mean daily maximum temperature of 24EC. The average number of continuous frost-free days is 113 for Muskoka Airport, beginning in late May and continuing till mid September (Environment Canada, 1982). Lakes and streams typically begin freezing in December, and thaw in late March to early April (MNR, 1997). The average annual precipitation at Huntsville is 1032 mm with 746 mm falling as rain and 286 cm as snow. Muskoka Airport has slightly more precipitation than Huntsville with an annual average of 1099 mm (809 mm as rain and 334 cm as snow). Snowfalls can occur from October to May with the heaviest snowfall occurring in December and January. September has the highest rainfall, with September and November being the wettest months. February to April is the driest period. Snowpack accumulation is usually at its maximum at the beginning of March (MNR, 1997). Lake evaporation is an important consideration during extended dry periods in the summer when flows are reduced, compounding the reduction in lake levels. Evaporation rates are highest in June, July and August.

3.1.2 Physiography

The Muskoka River watershed crosses three north-south trending physiographic units (Chapman and Putnam, 1984). The river rises on the western slopes of the Algonquin Highlands physiographic unit. This domed area is underlain by gneiss and other metaphoric rocks of the middle and late Precambrian Age. Moving westward, there is a strip of sand, silt and clay deposits that follow the alignment of Highway 11 (i.e., from Gravenhurst,

through Port Sydney and north to Huntsville) and is known as the Number 11 Strip physiographic unit. This strip formed just below a shoreline of glacial Lake Algonquin and received deposits from streams entering the lake from the adjacent highlands to the east. The western half of the watershed crosses the Georgian Bay Fringe. This physiographic unit was washed by waves from glacial Lake Algonquin leaving only very shallow, coarse soils and exposing bare rock knobs and ridges of the Precambrian Age.

3.1.3 Topography and Surficial Geology

The watershed reaches an elevation of over 525 m at its boundary in the northeast, dropping to the lowest elevation of 177 m at the Georgian Bay shoreline. The terrain maps for the area (Mollard, 1981) classify the topography in the extreme northeast as high local relief that is ridged and hummocky. Throughout the central section, relief is defined as moderate, with a variety of local features including gulleying, knobs, plains and undulating. In the lower sections of the watershed (west of Lake Joseph/Lake Muskoka), the topography is mapped as low local relief varying from plains to undulating and hummocky conditions.

Generally, surface drainage in the upper and central portions of the watershed is good, providing dry soil conditions with rapid runoff occurring from the exposed bedrock areas. Wet surface conditions are restricted to isolated organic terrain sites (i.e., local low lying areas). In the lower part of the watershed (Moon and Musquash Rivers), much of the landscape is low relief, and is traversed by a series of parallel bedrock ridges and intervening bogs.

Overall, the surficial geology mirrors the physiographic units. Soils are thin in the upper and lower stretches of the watershed that contain extensive areas of exposed bedrock. Local patches of thicker sandy, gravelly deposits are found within the upper valleys. Deposits of sand, till and silt are extensive within the Number 11 Strip physiographic unit. These have weathered to give deep, often sandy loam soils that can support limited agricultural activities (Chapman and Putnam, 1984).

3.1.4 Geology, Mineral and Aggregate Resources

The entire watershed is situated on the Canadian Shield with formations from the middle and late Precambrian Age. The majority of the bedrock is composed of banded, veined and homogeneous pink and grey migmatitic gneisses (Hewitt, 1967). Mineral potential is moderate in the very western part of the watershed but there is now no active mineral mining anywhere within the watershed (MNDM, website 2002). There are a number of stone quarries in the watershed, particularly in the Finlayson/Lake of Bays area (MNDM, 2002). Mainly decorative pink granite and gneiss are being quarried for flagstone, building stone and landscaping purposes. Extensive sand and gravel deposits are located within the Highway 11 corridor. There are numerous pits here that have been predominantly used for local road and building construction requirements. Peat deposits are found throughout the area, with major deposits in the geographic townships of Oakley, McLean and Macauley (now all part of the Town of Bracebridge) (MNR, 1983).

3.1.5 Watershed Characteristics

The Muskoka River watershed is located in Central Ontario's lake country and belongs to the southern Lake Huron/Georgian Bay drainage basin. The watershed is divided into three subwatersheds: the North and South Branches, which comprise approximately the eastern two-thirds of the watershed, and the Lower Muskoka subwatershed, which comprises the western one-third. The North Branch originates in Algonquin Park in a number of small lakes (McCraney and West Harry Lakes), whose discharges converge to form the Big East River. Tributaries of the Big East include Cripple and Tasso Creeks, which meet the river at the site of the former Finlayson Reservoir, and the Little East River. The Big East River drains into the eastern edge of Lake Vernon. The other main inlet of Lake Vernon, located at the northern end of the lake, is the Buck River, which drains Axe, Round, Buck and Fox Lakes. Outflow from Lake Vernon flows past the Town of Huntsville into Fairy Lake, which also receives inflow from Peninsula Lake. These three Lakes (Vernon, Fairy and Peninsula) are collectively known as the 'Huntsville Lakes'. Outflow from Fairy Lake, through Huntsville Dam, forms the North Branch of the Muskoka River, which flows through Mary Lake and a cascading series of waterfalls (High, Wilson and Bracebridge Falls) and

hydropower generating stations. The North Branch then converges with the South Branch just south of the Town of Bracebridge.

The South Branch of the Muskoka River is also divided into two distinct headwater areas. The Oxtongue River originates in Algonquin Park in a series of small lakes (with Burnt Island, Little Joe, Joe, Canoe, Ragged, Smoke and Tea Lakes being the major ones). The river flows through Oxtongue Lake and drains into the north end of Lake of Bays, near the Town of Dwight. South of the Oxtongue River subwatershed, a number of small lakes (Fletcher, Livingstone, Rockaway and Wildcat, among others) empty into Kawagama Lake (formerly known as Hollow Lake). The outflow of this lake forms the Hollow River, which flows into the southeast corner of Lake of Bays, near the Town of Dorset. The outflow of Lake of Bays, which is the fourth largest lake in the watershed (by surface area), passes through the Baysville Dam, in the Town of Baysville, and is known as the South Muskoka River from this point on. The river flows generally southwest, through the Town of Fraserburg and converges with the outflow from Wood Lake. From here the river flows west past Matthias Falls and turns slightly north to flow through Trethewey, Hanna Chute and South Falls generating stations prior to converging with the North Branch in Bracebridge.

Following convergence of the two branches, the Muskoka River flows a short distance before emptying into the southern edge of Lake Muskoka, the largest lake in the watershed. Lake Muskoka also receives inflow from lakes Rosseau and Joseph, with the three collectively known as the 'Muskoka Lakes'. Drainage from Rosseau and Joseph, respectively the second and third largest lakes in the watershed, flows into the Indian River, past the locks and dam at Port Carling and into the north end of Lake Muskoka. Outflow from Lake Muskoka passes through the dams at Bala and into the Moon Chutes and Bala Reach area of the Moon River. Approximately 5 km downstream from Bala, the river forks into the Moon and Musquash Rivers. The Moon flows northwest and receives input from Kapikog and Healey lakes before emptying into Woods Bay, and subsequently Georgian Bay. The Musquash flows west through Ragged Rapids GS and swings northwest before flowing past Big Eddy GS on its way to Go Home Lake. This lake has two outlets, both of which empty into Georgian Bay.

Floodplain Areas

In the Muskoka System, there are two basic types of flood events, spring freshet and major storm events. The impacts of spring freshets may be reduced through operational changes of the control structures, however because of the infrequent and unpredictable nature of major storms, there may be fewer opportunities to lessen their impacts. None of the dams regulating the 23 major lakes in the watershed were built for flood control purposes (MacLaren, 1985). The dams regulating these larger lakes were built originally for commercial navigation purposes and in some cases for storage for hydropower generation. Flood control benefits of the lakes were never large and were of most use in the spring when the lakes had been drawn down to their minimum levels. Although extensive flood damage has not occurred in the Muskoka River watershed, flood control remains an important element of water management and local problem areas do exist (A&A, 2003a).

3.1.6 Streamflow Characteristics

Streamflow in the Muskoka River watershed has been measured since 1915. A total of seven streamflow measurement sites have been operated by the Water Survey of Canada (WSC) in the watershed over different periods. Details of the record lengths, drainage areas and average flows of the river flow gauging sites in the watershed are given in Table 3.1. Their locations are shown in Figure 2.2. In addition, details of the available natural streamflow data for adjacent rivers to the Muskoka River watershed are included in Table 3.1.

Based on a comparison of recorded peak flows, maximum annual flows vary proportionally to drainage area from upstream gauges to downstream gauges in the Bala reach and on the Moon and Musquash Rivers. This suggests that although the number of lakes in the watershed is great and storage volumes are considerable relative to the total drainage area of the basin, the amount of available storage is moderate. The distribution of the specific runoff is fairly uniform with a slight decrease in specific runoff from the North to South and Main branches. The watershed experiences the highest per unit of area flows on the Big East River. Several factors contribute to this phenomenon, including possible differences in soil and bedrock conditions, differences in forest cover in the upstream and downstream areas of the watershed, as well as differences in precipitation amounts due to orographic uplift.

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Project: Muskoka Basin Water Management Plan
Client: Ministry of Natural Resources (MNR)

ARSP Reservoir Name	Rating Curve	Historic Water Level			Historic Daily Flow	
		Hard Copy*	Processed** Daily	Processed Hourly	Theoretical ***	Recorded - WSC
Go-Home	Oper. Manual	1968 - 1979	1980 - 1999	Aug 26/98 - Jul 2/02	1980 - 1999	
Lake Muskoka	Oper. Manual	1968 - 1979	1980 - 1999	Oct 31/99 - Mar 7/02 Bala Bay Nov 1/00-Jul 1/01	1981 - 1999	02EB011 Moon R. Sep. 1965-1999 02EB012 Musquash R. Aug. 1965-1999 02EB006 Muskoka R. Bala Reach Jun 1937-1999
Lake Rosseau & Joseph	D. S.	1968 - 1979	1980 - 1999	Aug 25/98 - Mar 7/02		
Skeleton	Oper. Manual	1968 - 1979				
Wood Lake	Oper. Manual					
Lake of Bays	D. S.	1968 - 1979	1980 - 1999	Aug 18/98 - Mar 1/02	1980 - 1999	02EB008 South Muskoka R. Aug. 1941-May 1995
Kawagama	D. S.	1968 - 1979	1980 - 1999	Feb 10/99 - Mar 5/02	1980 - 1999	
Fletcher	Oper. Manual					
Livingstone	Oper. Manual					
Canoe/Smoke/Tea	D. S.	1968-1979 sparse		Oct 25/99 - Feb 28/02		02EB014 Oxtongue R. Sep. 1981-1999
Joe	D. S.	1968-1979 sparse				
Burnt Island	D. S.	1968-1979 sparse				
Ragged Lake	D. S.	1968-1979 sparse				
Divine	Oper. Manual					
Clearwater	Oper. Manual					
Mary Lake	D. S.	1968 - 1979	1980 - 1999 Jan 1/00 - Jan 22/02	Aug 20/98 - Jul 1/02	1980 - 1999	02EB004 North Muskoka R. June 1915-1999
Huntsville	D. S.	1968 - 1979	1980 - 1999 Jan 1/00 - Jan 30/02	Jun 1/98 - Jan 1/00	1980 - 1999	
Fox	D. S.	1968-1979 sparse				
Buck	D. S.	1968-1979 sparse				
Axe	Oper. Manual	1968-1979 sparse				
McCraney	D. S.					
West Harry	Oper. Manual					
Tasso	D. S.	1968-1979 sparse				
Camp	D. S.	1968-1979 sparse				

D. S. - Rating Curve from Dam Operation Manual was updated in recent Dam Safety Report.
S/S - Water Level or Reservoir Outflow process in gate design study.

* MNR hard copy records need to be entered manually into spreadsheet to be used in electronic form.
** Last processed year of daily water level data ends at October 31, 1999, need December data.
*** Discharge values obtained using theoretical discharge equations and processed historic water level data.

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Reservoir Name	Local* Drainage Area km^2	Total* Drainage Area km^2	Lake* Surface Area km^2	Ratio Lake Area to Total DA	Reference** Hydrology m^3/s per km^2	ARSP Proration Factor	ARSP PF Calibration	ARSP Hydrology File
Go-Home	84*****	4808	7	0.1%	Black	0.084		blk_unit.hst
Moon	24***	4707			Black	0.024		blk_unit.hst
Lake Muskoka	596	4683	120	2.6%	Black	0.596		blk_unit.hst
Wood Lake	35	35	4	10.8%	Black	0.035		blk_unit.hst
Lake of Bays	756	1481	68	4.6%	Black	0.756		blk_unit.hst
Kawagama	308	380	32	8.4%	Black	0.308		blk_unit.hst
Fletcher	24	24		0.0%	Black	0.024		blk_unit.hst
Livingstone	48	48	2	3.8%	Black	0.048		blk_unit.hst
Canoe/Smoke/Tea	155	344	13	3.6%	Black	0.155		blk_unit.hst
Joe	59	118	6	4.9%	Black	0.059		blk_unit.hst
Burnt Island	59	59	9	14.9%	Black	0.059		blk_unit.hst
Ragged Lake	70	70	4	5.9%	Black	0.070		blk_unit.hst
Lake Rosseau & Joseph	728	798	116	14.6%	Magnetawan	0.728		mag_unit.hst
Skeleton	71	71	20	28.9%	Magnetawan	0.071		mag_unit.hst
Divine	9	12	0	3.1%	Magnetawan	0.009		mag_unit.hst
Clearwater	3	3	1	25.1%	Magnetawan	0.003		mag_unit.hst
Mary Lake	182	1391	10	0.7%	Magnetawan	0.182		mag_unit.hst
Huntsville	321	1160	31	2.7%	Magnetawan	0.321		mag_unit.hst
Fox	14	219	1	0.6%	Magnetawan	0.014	0.018	mag_unit.hst
Buck	157	205	3	1.3%	Magnetawan	0.157	0.199	mag_unit.hst
Axe	48	48		0.0%	Magnetawan	0.048	0.061	mag_unit.hst
McCraney	44	44	4	9.9%	Magnetawan	0.044	0.060	mag_unit.hst
West Harry	39	39	2	3.9%	Magnetawan	0.039	0.053	mag_unit.hst
Tasso	24	42	2	4.5%	Magnetawan	0.024	0.033	mag_unit.hst
Camp	18	18	2	12.4%	Magnetawan	0.018	0.025	mag_unit.hst
Distress	329****	455	1	0.2%	Magnetawan	0.329	0.451	mag_unit.hst
Georgian Bay		5158						

* Drainage and Surface Areas taken from Muskoka River Dam Operational Manual, Local areas are stated with respect to next upstream regulating dam

** Two WSC gauges outside of the Muskoka River Basin selected for development of the reference hydrology are:
02EC002 - Black River Near Washago (1915 - 1997), Unregulated, Drainage Area 1520 km^2
02EB005 - Magnetawan River Near Burk's Falls (1915 - 1997), Unregulated, Drainage Area 321 km^2

*** Local drainage area represents that between the outlet of Lake Muskoka and Moon AND Ragged Rapids Dams, Digitized from 1:50000 scale mapping

**** Distress Dam Local Area represents the drainage area below Tasso, McCraney, and West Harry. Finlayson Dam was removed in recent years.

***** Digitized from 1:50000 scale mapping

Notes: ARSP Proration Factors adjusted as necessary in model calibration

Table 3.1 Summary of Water Survey of Canada (WSC) Gauges within and near Muskoka River System							
WSC River Flow Gauge	**Total Drainage Area**	**Mean Daily Flow[1]**	**Regulation**	**Period of Daily Record**	**Specific Runoff[2]**	**Mean Annual[3] Maximum**	**Minimum**
	(km^2)	(m^3/s)			($L/s/km^2$)	(m^3/s)	(m^3/s)
Within Muskoka River Watershed							
02EB013 - East River near Huntsville	593	11.3	Regulated	1973-1999	19.1	15.9	7.0
02EB004 - N. Muskoka River at Port Sydney	1390	24.1	Regulated	1915-1999	17.3	40.3	13.6
02EB014 - Oxtongue River near Dwight	601	10.6	Regulated	1981-1999	17.6	13.1	6.4
02EB008 - S. Muskoka River at Baysville	1390	24.8	Regulated	1941-1995	17.8	31.8	12.7
02EB011 - Moon River at Hwy 69	4707	22.1	Regulated	1965-1999	4.7	41.3	4.3
02EB012 - Muskoka River (Musquash) at Hwy 69	4724	53.8	Regulated	1965-1999	11.4	77.7	39.2
Adjacent to Muskoka River Watershed							
02EC002 - Black River near Washago	1520	21.9	Natural	1915-1997	14.4	32.9	13.1
02EA005 - Magnetawan River near Burk's Falls	321	5.6	Natural	1915-1997	17.4	10.4	3.2

[1] Based on long-term WSC flood records

[2] Calculated from mean daily flows divided by drainage area

[3] Calculated from monthly historic records

Source: Environment Canada, 2001

Based on the flows at station 02EB006 (Bala Reach), the long-term average stream flow of the watershed is approximately 76.7 m^3/s (see Table 3.5). Relative to the 4670 km^2 watershed drainage area, this flow is equivalent to a specific runoff (i.e., streamflow per unit drainage area) of 16.4 $L/s/km^2$. The sum of mean daily flows below the Bala reach (stations 02EB011 and 02EB012) is also approximately 76 m^3/s indicating the local drainage area between the location of the latter two gauges and the Bala reach is small. However, the incremental drainage area below stations 02EB011 and 02EB012 and Georgian Bay is significant and was digitized from 1:50,000-scale mapping to be approximately 430 km^2. This would imply a total drainage area and mean flow for the entire Muskoka River basin as 5100 km^2 and 85 m^3/s respectively. Flow in the Bala reach is split between the Moon and Musquash Rivers such that the Musquash River has a maximum flow capacity of 113 m^3/s. Flows in the Bala reach in excess of this magnitude are diverted into the Moon River using the Moon Dam log sluices. The temporal variability of streamflow is summarized in Table 3.2 and this pattern is typical of the flows at the other locations in the watershed.

Data on river channel slopes on the North, South, and Main river channels is available in the Muskoka River Dam Operation Manual (MNR, 1997). Travel times for river flow between main points in the river are also provided in the manual.

3.1.7 Water Balance Budget

A hydrologic model is not available for the Muskoka River watershed. In order to provide a review of the historic rainfall-runoff relationship for the Muskoka basin, precipitation and flow data from available gauges within the basin were used to derive mean annual precipitation and runoff depth estimates and thus to establish a runoff coefficient for the basin. The calculations indicated that on average 51% of all precipitation falling on the watershed runs off and becomes streamflow in the river. The evapotranspiration amount is 49%. This relatively high value may be due to the presence of numerous lakes in the Muskoka River watershed.

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**** Distress Dam Local Area represents the drainage area below Tasso, McCraney, and West Harry. Finlayson Dam was removed in recent years.

***** Digitized from 1:50000 scale mapping

Notes: ARSP Proration Factors adjusted as necessary in model calibration

Table 3.2
Muskoka River Below Bala Dams, Station 02EB006
Monthly and Annual Discharges (m^3/s) for 1937 to 1997

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1937							19.8	25	24.1	38.1	112	84.3	
1938	44	48.9	140	272	95.1	71.3	20.9	18.1	34.4	44.7	53.5	61.8	75.2
1939	48.5	54	89.3	155	241	30.9	26.5	30.1	36	35.2	42.7	34.4	68.8
1940	37.3	35.7	36	67.4	130	73.1	28.7	32.2	57.3	54.2	88.6	93.2	61.2
1941	84.3	62.8	61.8	163	86.2	21.9	21.4	19.6	16.4	26.8	101	88.9	62.7
1942	86	58.6	92.4	189	135	80.5	28.2	23.6	14.9	46.3	103	87.2	78.6
1943	67.2	75.4	104	163	290	74	43.3	40.1	29.1	25.7	39.6	49.8	83.6
1944	40.5	48.3	47.1	88.5	95.9	41.2	38.5	34.2	27.7	40.2	57.4	64.8	52
1945	48.5	41.3	138	149	113	95.1	42.3	27.9	26.9	35.1	61.5	67.5	70.6
1946	81	102	166	103	69.9	54.1	25.4	14	16.1	23.5	22.1	55.7	60.8
1947	70.6	78.5	115	232	263	128	37.7	40	22.4	24.4	22.5	37.6	89.3
1948	42	57.7	116	253	92.6	54.8	27.6	21.4	16.9	18.7	61.3	79.1	69.8
1949	82.7	109	121	259	73.7	43.2	39.9	19.4	11.1	19	19.7	60.3	71.1
1950	182	137	72.2	138	83.2	36.4	22.6	17.5	16.9	19.2	41.7	95.1	71.4
1951	85.2	60.2	112	317	187	25.8	28.7	25.8	22.8	53.6	153	123	99.5
1952	112	78.5	67.9	211	99	46.5	26.9	24.1	46.2	26	45.1	101	73.5
1953	69.4	64.3	132	156	77.6	38	28.6	18.8	17.4	20.1	19.4	57.9	58.3
1954	52.1	55.8	133	170	94.7	68.9	23.6	20.1	43.9	176	118	73	85.9
1955	54.1	71.7	74.4	192	60.1	18.6	14.8	12.8	11.5	23.3	86.6	43	54.9
1956	42.4	46	69.7	78.3	164	82.4	68.2	21.7	57.3	51.6	45.7	78.4	67.3
1957	74.8	88.1	101	99.9	32.1	56.1	171	15.4	65.5	48.9	132	150	86.1
1958	133	79.1	85.7	65.5	8.06	15.3	27.8	17.3	34.5	45.4	58.9	61	52.5
1959	45	81.6	91	196	170	43.5	18.4	26.3	37.3	48	117	108	81.7
1960	85.2	70.6	77.1	260	200	61.6	57	29.2	28.2	28.3	54.3	42.5	82.7
1961	44.4	35.4	81.9	129	92.4	36.9	35.7	27.3	28.7	20.8	24	45.4	50.2
1962	52.2	80.8	64.6	108	69.7	16.6	6.79	10.6	15.2	36.3	26.5	42.6	43.9
1963	53.7	46.5	51.7	132	110	33.3	11.1	20	35.3	29	34.3	63.6	51.7
1964	56.3	79.9	83	53.6	76.7	15.2	8.58	10.9	25.8	32	21.8	58.8	43.5
1965	89.9	90.7	83.6	139	129	12.8	11.9	24.5	60.3	161	89.8	162	88.1
1966	111	78.8	105	81.7	55.8	44.3	12.2	8.86	20.1	28.6	117	240	75.3
1967	96.3	99.5	91.3	202	52.8	95.8	51.9	29.9	58.7	96.7	222	125	101
1968	101	121	115	111	26.3	18.8	26.7	30.3	51.6	33.7	35	77.6	62.1
1969	71.6	85.8	91.4	164	153	70.2	39.1	16.4	28.4	42.9	118	82.5	80.1
1970	71.1	68.4	70	135	136	34.9	106	50.6	37.9	86.3	89.7	88.7	81.5
1971	73.3	81.6	130	189	132	29.8	20.5	16.9	27	20.1	32	70.6	68.5
1972	81.5	85.3	94.6	176	170	47.5	58.3	72.8	46.4	57.5	103	88.5	90.1

Table 3.2
Muskoka River Below Bala Dams, Station 02EB006
Monthly and Annual Discharges (m^3/s) for 1937 to 1997

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1973	106	134	210	198	120	98.7	47.7	45.1	28	47.2	67.8	100	99.9
1974	85.3	105	150	203	203	52.5	25.6	16.5	42.5	97	117	95.6	99.4
1975	72.2	81.8	145	154	133	12.9	9.29	15.3	42.7	42.9	37.5	128	73
1976	87.5	93.3	168	233	88.3	32.3	42.3	17.5	22.5	22.2	34.4	79.8	76.6
1977	52.8	55.9	154	161	44.8	6.76	19.5	14	52.5	124	112	112	75.8
1978	97.6	74.6	70.2	113	142	50.3	14.3	16.7	49.4	69.3	60.9	84.7	70.2
1979	84.7	91.5	166	239	149	43.2	14.8	22	39.3	75.4	117	151	99.3
1980	112	82.2	88.7	258	77.5	68.1	59.8	58.2	72.9	118	117	92	100
1981	76	109	184	129	75.8	48.5	20.4	9.39	196	107	62.7	68.9	90.2
1982	68.5	79.7	96.6	199	92	65.4	24.3	15.2	41.4	63.9	121	205	89.2
1983	156	110	130	87.3	203	78.5	16.1	5.34	20.5	62.7	51.2	98.9	85
1984	83.6	136	154	161	84.8	92.6	40.2	11.6	35.7	44.2	77.8	103	85.1
1985	167	102	172	252	167	43	39.8	32.4	119	111	117	108	119
1986	90	96.9	111	192	83.8	73.5	29.2	29.2	57.9	134	48.5	75.1	84.9
1987	52.9	70.7	94.4	117	24.4	24.5	17.1	4.92	5.36	28.2	33.8	109	48.3
1988	95.1	116	115	200	92.6	23.7	4.17	8.92	34.8	71.4	140	77.6	81.2
1989	78.3	76.7	119	200	117	92	21.7	6.65	15.3	28.9	39.8	84.2	73.1
1990	78.4	112	149	165	94.3	48.3	12.3	10.6	8.24	83.1	90.1	156	83.7
1991	111	81	157	254	71.4	34.6	10	8.79	23.6	62.7	84.3	144	86.8
1992	86	73.9	127	150	75.3	13	28.6	29.9	111	123	231	149	99.7
1993	124	89.5	67.1	137	59.6	101	75.6	15.1	51.8	141	120	106	90.6
1994	72.6	60.5	80.7	71.1	103	73.8	76.7	34.2	49.8	44.4	119	124	75.9
1995	141	121	113	68.4	141	53.8	39.7	39.2	41.7	62.8	205	119	95.3
1996	96.3	138	124	160	151	71.4	61.1	43.7	50.6	62	134	100	99
1997	151	147	141	202	187	33.2	18.2	6.04	17.8	36	25.5	51.6	84.4
QMEAN	83.3	83.3	109.9	165.0	114.1	50.9	33.5	23.1	39.0	57.0	80.9	92.9	77.7
QMAX	182.0	147.0	210.0	317.0	290.0	128.0	171.0	72.8	196.0	176.0	231.0	240.0	119.0
QMIN	37.3	35.4	36.0	53.6	8.1	6.8	4.2	4.9	5.4	18.7	19.4	34.4	43.5
S.D.	32.2	26.7	37.0	60.6	57.7	27.1	26.4	13.2	29.6	37.9	49.3	39.6	16.3
NO.	60	60	60	60	60	60	61	61	61	61	61	61	60

3.1.8 Surface Water Quality

Water quality data from Ontario Ministry of the Environment (MOE) monitoring stations on the Muskoka River were examined to assess the general characteristics of river and tributary waters. The MOE collected data at 14 stations between 1984 and 1995 (last year data collected), with a variety of parameters measured at each site. Of these 14 stations, the results of 9 were selected as being representative of watershed conditions (A&A, 2003a) and the following summarizes this data:

- General physical/chemical parameters including alkalinity, conductivity, pH, chloride ion, and turbidity are not unusual, and are reflective of the watershed's location in Ontario and on the Canadian Shield (low alkalinity, conductivity and turbidity, good pH level given the low buffering capacity of the water).

- Concentrations of arsenic, nickel and zinc were generally at or below applicable guidelines, although individual samples were occasionally over the limit, as well as zinc levels in 1992/1993.

- Copper and lead were marginally over the guidelines at most sampling sites during most sampling years, although no clear trend can be deduced from the data.

- Iron values were generally below guidelines with the exception of mean values at Station 032 on the Big East River near Williamsport, and several yearly maxima in the Moon and Musquash Rivers.

- Mean phenol concentrations were below the applicable federal guideline (revised upward in 1999) and provincial guideline, but at most sampling stations, yearly maximums slightly exceeded provincial guidelines.

3.2 Biological Environment

Information on the biological environment is provided on a sub-watershed basis in Figures 3.1a to 3.1c.

3.2.1 Fisheries

General Description

A detailed description of the fisheries for each of the larger lakes with actively operated control structures is provided in the Background Information Report (A&A, 2003a). Table 3.3 identifies fish species, fishing pressure and fishing quality by lake and river reach for the Muskoka River watershed. The following provides a general description of the fish resources for the watershed.

The lakes and rivers located in Algonquin Park are popular with anglers for their excellent trout fisheries. The remoteness of the lakes, prohibitions on the use of mechanized travel in the interior of the park, and restrictive fishing season regulations (i.e., no winter fishing), have all resulted in a low intensity, high quality fishery for lake trout (*Salvelinus namaycush*) and brook trout (*Salvelinus fontinalis*). In the well-traveled Highway 60 corridor, fisheries for smallmouth bass (*Micropterus dolomieu*) (stocked along the railway early in the 20th Century) also comprise a substantial amount of the fishing in this area. Fish stocking, popular in Algonquin Park in the mid to late 1900's, has been curtailed, and is now only used to provide short-term angling opportunities along the Highway 60 corridor. Fisheries management in this area is strongly focused on fisheries for both lake trout and brook trout, and to a lesser degree, splake (a hybrid of brook trout and lake trout) and rainbow trout (*Oncorhynchus mykiss*). All four species are stocked to varying degrees but the main management tools are regulations (i.e., seasons, bag limits, and size limits). For the most part, the lakes provide lake trout and smallmouth bass fisheries, while brook trout and rainbow trout are found mainly in the connecting river reaches. Natural reproduction of rainbow trout is not known to occur in the Muskoka River system, and any local populations of this species are maintained solely by stocking of hatchery fish.

A much more complex fish community has developed in the lower parts of all the subwatersheds, although lake trout are still present in the large lakes. Northern pike, walleye and muskellunge (*Esox masquinongy*), as well as a variety of non-game species such as yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*) and rock bass (*Amblopites rupestris*) are all part of the fish community of the larger lakes. Walleye, northern pike and lake trout are

major species sought in lakes Muskoka and Rosseau. Lake trout is the primary species of interest in Lake Joseph. The walleye spawning areas of the South Branch of the Muskoka River are believed to be the major contributor of walleye to Lake Muskoka, with the Bracebridge Falls site being the major spawning area. Walleye also comprise an important part of the sport fishery in Bala Reach, Go Home Lake and the Moon and Musquash Rivers. The area below Moon Falls on the Moon River serves as an important spawning site for Georgian Bay walleye.

3.2.2 Wetlands

The Muskoka River watershed contains several provincially significant wetlands (i.e., Axe Lake Wetland, Novar Bog, Big East Delta Wetland, Siding Lake Wetland, Fawn Lake Wetland, Boyne River Wetland, and the Bruce Lake Wetland), as well as numerous small wetlands, many of which would have significance on a local scale (see Figures 3.1a to 3.1c). The Big East River Delta Wetland, a complex of 15 individual wetlands, is the only provincially significant wetland in the watershed that could be potentially affected by water level manipulation activity resulting from water management planning. This is because it is located on a regulated lake (Lake Vernon at the mouth of the Big East River). The Axe Lake wetland is located at the head of Axe Lake. The Axe Lake Dam is operated as an overflow weir with no other level or flow control upstream from it and therefore there will be no changes to the current water management practices.

However, most wetlands, even those not classified as provincially significant, serve important ecological and social functions. Many species of fish and wildlife (birds, amphibians, reptiles, mammals, insects) depend on wetlands for at least some, if not all, of their life. Wetlands also serve important water quality and flood storage and attenuation functions. As a result, potential manipulations of current water management practices need to take into consideration their effect on wetland areas throughout the watershed.

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
North Branch Subwatershed							
Rain	2EB15	168.4	23.5	5.5	LT, SMB	Unknown	Unknown
Islet	2EB15	137.2	7.3	3.6	SMB	Unknown	Unknown
West Harry	2EB15	118.9	13.7	3.0		Unknown	Unknown
McCraney	2EB15	361.0	61.3	14.2	BT, LT	Light	Good
Camp	2EB15	189.3	42.7	15.0	LT	Heavy	Medium
Tasso	2EB15	170.0	22.3	6.2	LT, SMB, BT	Heavy	Poor
Bella	2EB15	327.9	40.0	16.2	LT, LW, SMB	Medium	Medium
Rebecca	2EB15	210.5	29.0	7.9	LT, LW, SMB	Medium	Medium
Axe	2EB13	265.1	12.8	2.5	LMB, C	Light	Good
Round	2EB13	190.2	21.4	6.7	BT, LW, SMB, NP, LMB, C, YP	Unknown	Unknown
Buck	2EB13	265.5	23.5	9.9	SMB, NP, W, LMB, C	Heavy	Good
Fox	2EB13	136.6	12.2	5.7	SMB, NP, W	Heavy	Medium
Waseosa	2EB16	156.6	19.2	6.5	LT, BT, RT, SMB	Light	Medium
Vernon	2EB13	1505.1	37.2	12.7	LT, LW, SMB, NP, W, RT	Medium	Medium
Fairy	2EB13	711.5	69.5	22.1	LT, LW, SMB, NP, W, RT	Light	Poor
Peninsula	2EB13	864.8	34.1	9.7	LT, SMB, NP, W, RT	Medium	Medium
Mary	2EB13	1065.4	56.4	24.7	BT, LT, LW, SMB, NP	Medium	Medium
Cripple Creek					BT, SMB, NP	Light	Unknown
Big East River					SMB, NP, W	Light	Unknown
Little East River					BT	Light	Unknown
N. Muskoka River 1					SMB, NP	Unknown	Unknown
N. Muskoka River 2					SMB, NP	Unknown	Unknown
N. Muskoka River 3					SMB, NP	Unknown	Unknown

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
South Branch Subwatershed							
Burnt Island	2EB11	854.3	32.9	10.8	LT, LW	Unknown	Unknown
Little Joe	2EB11	47.8	11.9	3.0	LW, SMB	Light	Unknown
Joe	2EB11	137.6	24.2	6.1	LT	Light	Unknown
Potter	2EB11	83.0	12.2	2.9	BT, LT, SMB	Light	Good
Canoe	2EB11	344.5	36.6	12.8	BT, LT, LW, SMB	Light	Medium
Tea	2EB11	156.1	14.8	5.4	LT, LW, SMB	Light	Poor
Smoke	2EB11	607.1	54.9	16.2	BT, LT, SMB	Medium	Good
Big Porcupine	2EB11	235.3	31.7	7.5	LT	Light	Good
Ragged	2EB11	629.4	37.8	5.8	LT, LW	Light	Good
Oxtongue	2EB11	249.3	26.8	8.9	BT, LT, LW, RT, SMB	Heavy	Medium
Lake of Bays	2EB10	6904.1	70.1	22.2	BT, LT, LW, RT, SMB	Medium	Good
Livingstone	2EB12	189.1	36.6	12.7	BT, LT, SMB	Medium	Medium
Fletcher	2EB12	255.8	23.2	7.9	BT, LT	Medium	Medium
Kawagama	2EB12	2818.8	73.2	21.8	BT, LT, LW, SMB	Light	Good
Wood	2EB09	378.0	14.3	5	SMB, W, LMB	Unknown	Unknown
Oxtongue River					BT, RT	Light	Light
Hollow River					BT	Unknown	Unknown
S. Muskoka 1						Unknown	Unknown
S. Muskoka 2						Unknown	Unknown
S. Muskoka 3						Unknown	Unknown
S. Muskoka 4						Unknown	Unknown
Lower Subwatershed							
Muskoka	2EB04	12205.8	66.5	15	BT, LT, LW, NP, SMB, W, MU, RT	Light	Unknown
Rosseau	2EB05	6374.4	90.0	23.2	LT, LW, SMB, W, MU, RT	Light/Med	Good

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
Joseph	2EB05	5155.6	93.0	24.7	LT, LW, SMB, W, RT, LMB	Light/Med	Good
Skeleton	2EB07	2155.5	64.7	28.9	LT, LW, RT, SMB, BT	Light	Medium
Three Mile	2EB08	929.2	11	3.4	SMB, W, LMB	High	Medium
Bent River					BT	Unknown	Unknown
Lower Muskoka River					NP, W, SMB	Unknown	Unknown
Bala Reach					W, SMB, MU	Unknown	Unknown
Moon River					LMB, MU, NP, SMB, YP, W, CHS, LS	Light	Poor
Musquash River						Unknown	Unknown
Healey Lake	2EB02	762.8	22.9	5.7	NP, SMB, LMB	Unknown	Unknown
Kapikog Lake	2EB02	316.9	15.6	5.6	NP, SMB, LMB	Unknown	Unknown
Go Home Lake	2EB02	666.0	32.6	8.6	NP, SMB, W, LMB, C	Unknown	Unknown

* BT = Brook Trout
C = Cisco
CHS = Chinook Salmon
LMB= Largemouth Bass
LS = Lake Sturgeon
LT = Lake Trout
LW = Lake Whitefish
MU = Muskellunge
NP = Northern Pike
RT = Rainbow Trout
SMB= Smallmouth Bass
YP = Yellow Perch
W = Walleye

** Fishing Quality – is an assessment based on information from MNR historical files, and may not represent present conditions nor angler views pertaining to fishing quality for individual species in the respective lakes.

3.2.3 Vegetation

The entire Muskoka Watershed is part of the Great Lakes-St. Lawrence Forest Region. The precolonization forest was dominated by white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*), as well as assorted tolerant hardwoods such as sugar maple (*Acer saccharum*), yellow birch (*Betula allegheniensis*), beech (*Fagus grandifolia*) and red oak (*Quercus rubra*). The great pine forests attracted lumbermen who cut the pines for ships of the Royal Navy, and hemlocks for the tanbark (tanning) industry. The resultant forest is dominated by a mixture of hardwood species, most notably sugar maple, yellow birch and red maple (*Acer rubrum*), but stands of mature pine and hemlock continue to characterize the Muskoka skyline, and contribute greatly to the aesthetic appeal of the region.

Several areas in the Muskoka River watershed support remnants of Atlantic coastal plain flora, including Axe Lake, the Spence Lake area (a tributary of the South Branch), the northwest shore of Lake Joseph, Bala Reach, the Musquash River upstream from Go Home Lake and the Gibson Lake area. The Axe Lake wetland is the second most significant example of this habitat type in Ontario (NHIC, 2002). This shoreline vegetation type is sensitive to water level changes and, in fact, it benefits from fluctuating water levels, which help to prevent shrub growth (Environmental Protection Agency et al, 1996). Twenty-three species of plants, many of which are rare, threatened or endangered, have been identified as characteristic coastal plain flora in the Muskoka area (Keddy and Sharp, 1989). Virginia meadow beauty (*Rhexia virginica*), listed as rare to uncommon (possibly common) (NHIC, 2002) is a characteristic species of this habitat in the Muskoka watershed.

3.2.4 Wildlife

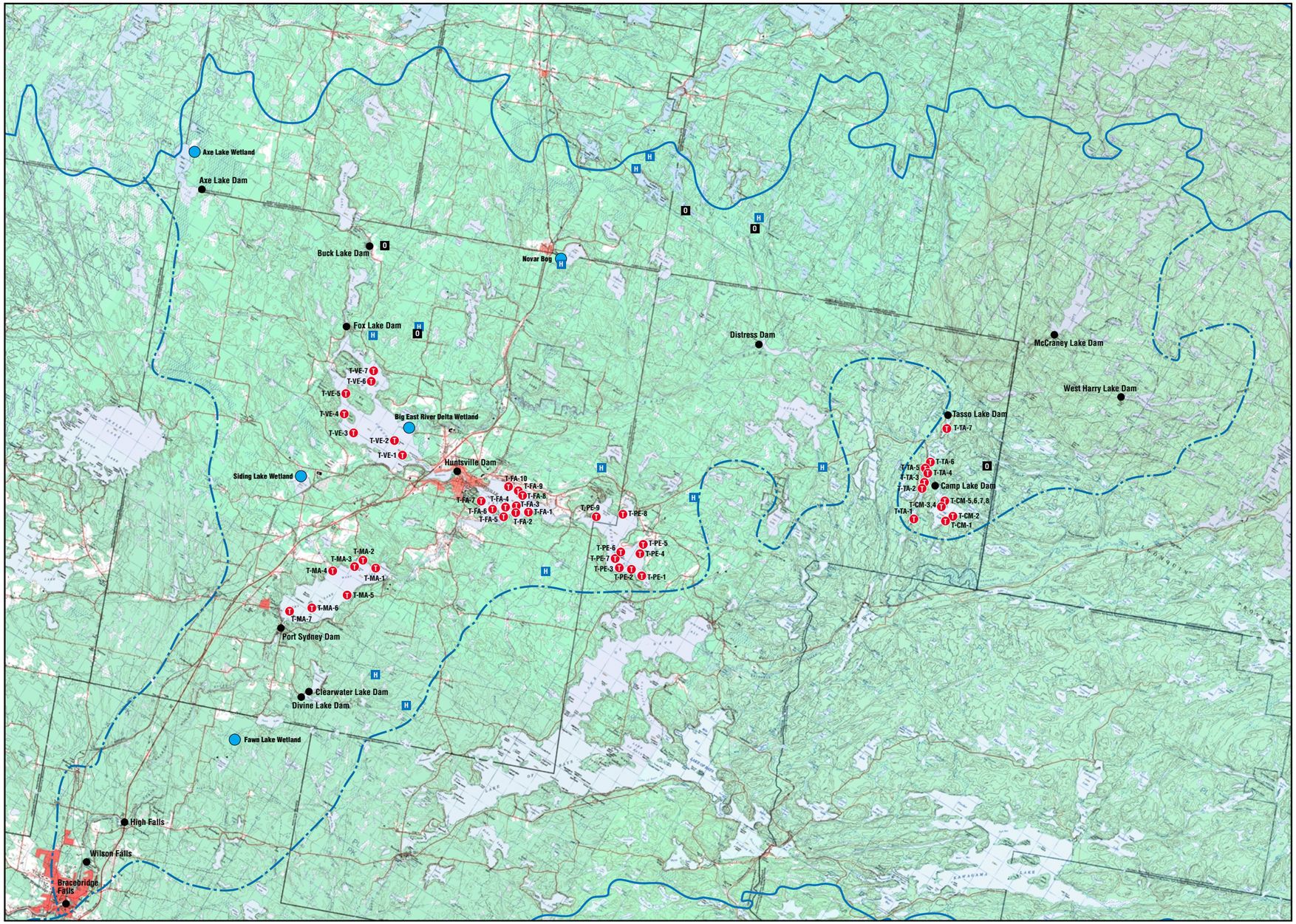
The Muskoka River watershed is home to a variety of wildlife species, both game and non-game. Big game species include moose (*Alces alces*), deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*). Recently introduced elk (*Cervus elaphus*) have found their way into the region from a release site in the Bancroft area though they are currently not permitted to be hunted.

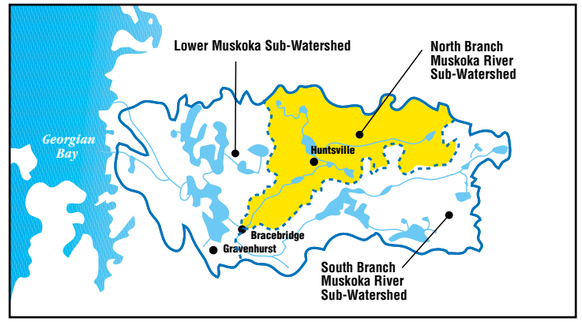
Although the Muskoka region does not lie on one of the major flyways, many migratory waterfowl species are found in the watershed. Some of the more common species include: mallard duck (*Anas platyrhynchos*), black duck (*Anas rubripes*), great blue heron (*Ardea herodius*), Canada goose (*Branta canadensis*) and common loon (*Gavia immer*). Heronries are identified in the French-Severn Forest Management Plan and are protected by sustainable forestry practices.

Loons are relatively common in the lakes of the Muskoka watershed, but detailed, long-term records are available for only one lake (Smoke Lake) where four pairs of loons persisted on the lake and did not appear to be adversely affected by water management activities on that lake. The main causes of reproductive mortality over the 20+ year observation period has been predation (raccoons, bears, gulls) and flooding during the nesting period. Loons are one of the wildlife species that could be most susceptible to shoreline development and human use of lakes.

Virtually no information is available on the abundance and/or distribution of other wildlife species (turtles, frogs and other amphibians) in the watershed.

Insert Figures 3.1a, b and c





Historic and/or Present Fish Spawning Areas

- T-SL-1 (T) Lake Trout
- W-SL-1 (W) Walleye
- P-SL-1 (P) Pike
- M-SL-1 (M) Muskellunge

Historic and/or Present Nesting Areas

- (H) Heron
- (O) Osprey

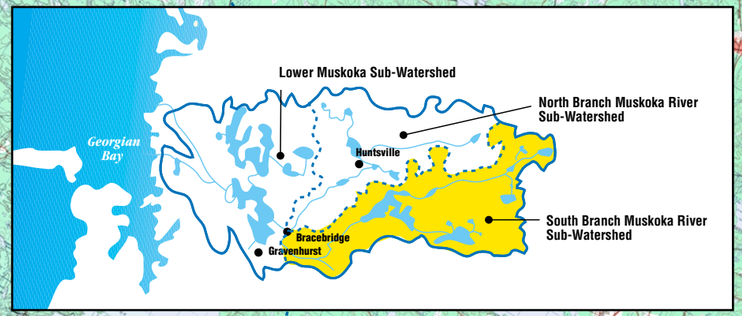
Wetlands

- Provincially Significant Wetland
- Life Science ANSI

0 2 4 6
kilometres

Figure 3.1a
Muskoka River Water Management Plan
Biological Features - North Muskoka Sub-Watershed

ACRES International



Historic and/or Present Fish Spawning Areas
- T-SL-1 (T) Lake Trout
- W-SL-1 (W) Walleye
- P-SL-1 (P) Pike
- M-SL-1 (M) Muskellunge

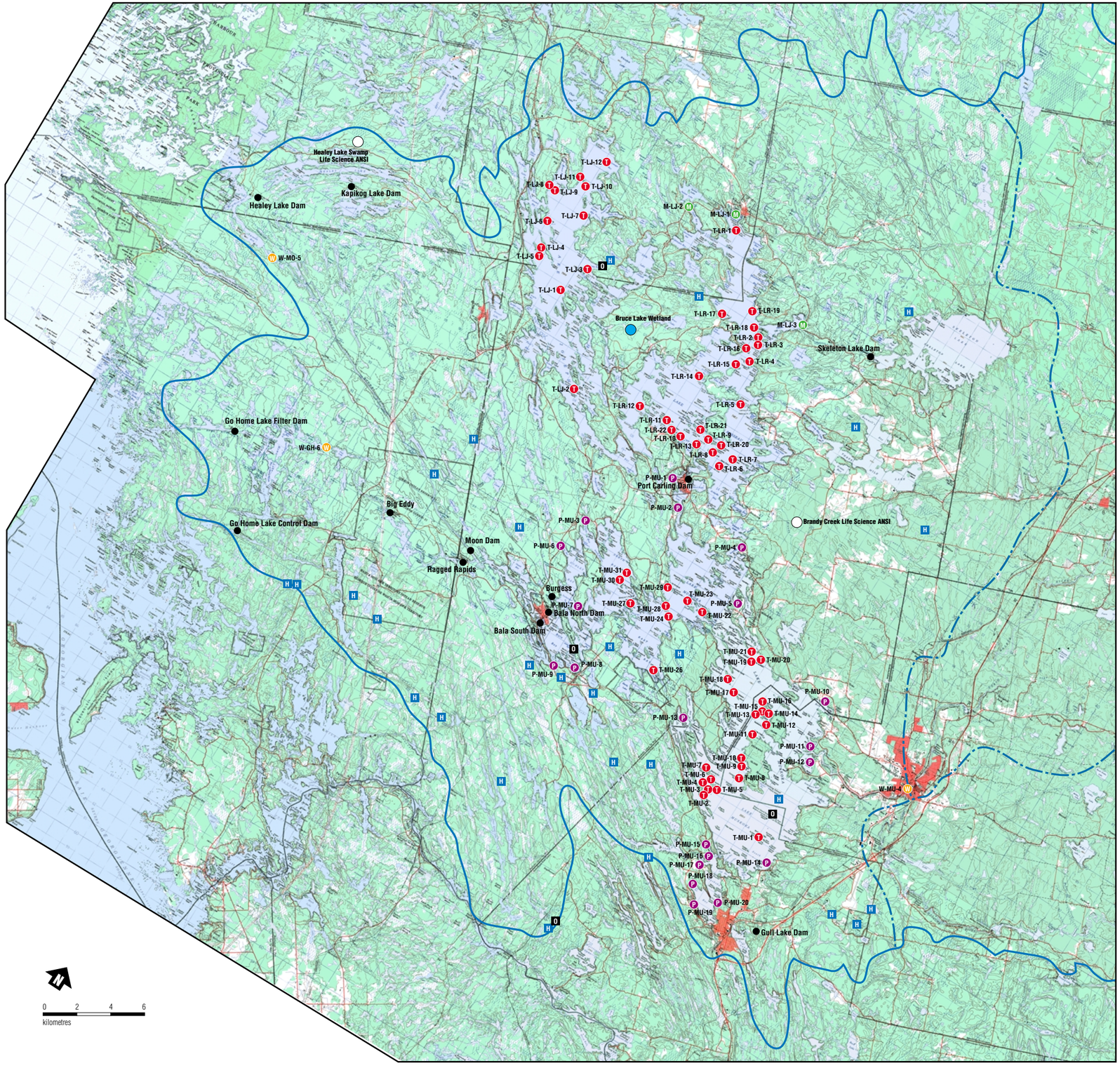
Historic and/or Present Nesting Areas
- H Heron
- O Osprey

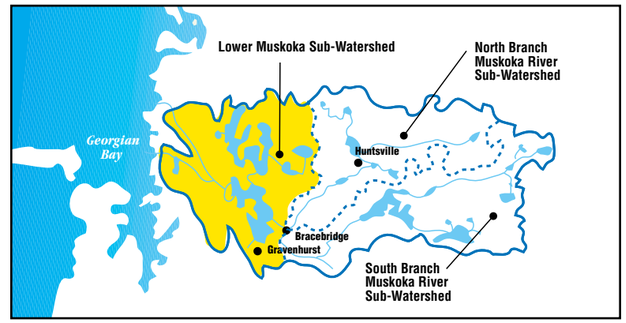
Wetlands
- Provincially Significant Wetland
- Life Science ANSI

0 2 4 6
kilometres

Figure 3.1b
Muskoka River Water Management Plan
Biological Features - South Muskoka Sub-Watershed

ACRES International





Historic and/or Present Fish Spawning Areas

- T-SL-1 (T) Lake Trout
- W-SL-1 (W) Walleye
- P-SL-1 (P) Pike
- M-SL-1 (M) Muskellunge

Historic and/or Present Nesting Areas

- H Heron
- O Osprey

Wetlands

- Provincially Significant Wetland
- Life Science ANSI

Figure 3.1c
Muskoka River Water Management Plan
Biological Features
- Lower Muskoka Sub-Watershed

ACRES International