

Appendix A
Climate Information

**Active Environment Canada climate stations in and around
Mississippi-Rideau Region**

No.	Watershed	Station	Name	Period of Record	Years of Data
1	Mississippi	6100285	Appleton	1992-present	14
2	Mississippi	6102J13	Drummond Ctr	1984-present	22
3	Mississippi	6105760	Ompah	1994-present	12
4	Mississippi	6105762	Ompah-Seitz	1994-present	12
5	Rideau	6104025	Kemptville	1928-1997	70
6	Rideau	6104027	Kemptville CS	2001-present	5
7	Rideau	6105978	Ottawa CDA	1889-present	117
8	Rideau	6106000	Ottawa Airport	1938-present	68
9	Outside	6100971	Brockville PCC	1965-present	41
10	Outside	6101820	Comberemere	1956-present	50
11	Outside	6102857	Godfrey	1981-present	25
12	Outside	6104725	Lyndhurst	1976-present	30
13	Outside	6103367	Hartington	1967-present	39
14	Outside	7030170	Angers*	1962-present	44
15	Outside	7034365	Luskville*	1981-present	25

* Quebec stations

Historic (Discontinued) Environment Canada Climate Stations in (and around) the Mississippi-Rideau Region

No.	Watershed	Station	Name	Period of Record	Years of Data
1	Mississippi	6100226	Almonte	1912-1980	69
2	Mississippi	6101250	Carleton Place	1984-1999	16
3	Mississippi	6101249	Carleton Place	1948-1976	29
4	Mississippi	6101260	Carp	1960-1975	16
5	Mississippi	6101955	Dalhousie L High Falls	1923-1983	61
6	Mississippi	6102150	Dunrobin	1990-1991	2
7	Mississippi	6105993	Ottawa Hazeldean	1969	1
8	Mississippi	6106003	Ottawa Kanata	1969	1
9	Mississippi	6106102	Ottawa South March	1969	1
10	Mississippi	6107699	Shirley Bay	1954-1956	3
11	Mississippi	6109590	Woodlawn	1975-1982	8
12	Mississippi	6100353	Ashton	1956	1
13	Rideau	6100363	Ashton Stn Sesia Farm	1959-1973	15
14	Rideau	6100722	Bells Corners	1991	1
15	Rideau	6101521	City View	1953-1960	8
16	Rideau	6101920	Crow Lake	1972-1991	20
17	Rideau	6101935	Cumberland	1973-1980	8
18	Rideau	6102840	Gloucester Kettles	1975-1982	8
19	Rideau	6104733	Maccue	1883-1918	36
20	Rideau	6104931	Manotick	1953-1956	4
21	Rideau	6104932	Manotick	1975-1986	12
22	Rideau	6105061	Merivale Cda	1972-1977	6
23	Rideau	610E061	Merivale TS	1983-1994	12
24	Rideau	6105262	Montague	1895-1915	21
25	Rideau	6105576	Navan	1973-1974	2
26	Rideau	6105678	North Augusta	1971-1972	2
27	Rideau	6105709	North Gower	1902-1925	24
28	Rideau	6105710	North Gower	2001-2004	4
29	Rideau	6105832	Orleans Veh. Prvg. Gnd.	1953-1958	6
30	Rideau	6105887	Ottawa	1872-1935	64
31	Rideau	6105910	Ottawa Albion Rd	1954	1
32	Rideau	6105913	Ottawa Alta Vista	1961-1963	3
33	Rideau	6105938	Ottawa Beckwith Rd	1955-1961	7
34	Rideau	6105950	Ottawa Billings Bridge	1953-1954	2
35	Rideau	6105960	Ottawa Britannia	1972-1984	13
36	Rideau	6105980	Ottawa City Hall	1966-1975	10
37	Rideau	6105995	Ottawa Hogs Back	1953-1954	2
38	Rideau	6106014	Ottawa La Salle Acad.	1954-1967	14
39	Rideau	6106080	Ottawa Nepean	1960-1962	3
40	Rideau	6106090	Ottawa NRC	1951-1984	34
41	Rideau	6106098	Ottawa Rideau Ward	1972-1975	4
42	Rideau	6106100	Ottawa Rockcliffe A.	1942-1964	23
43	Rideau	6106105	Ottawa U of O	1954-1955	2
44	Rideau	610F3Q0	Perth	1989	1
53	Rideau	610FLPR	Perth	1986-1987	2
54	Rideau	6106385	Perth Ontario Hydro	1982-1983	2
55	Rideau	6106660	Port Elmsley	1948-1968	21
56	Rideau	6106677	Portland	1953-1958	6

No.	Watershed	Station	Name	Period of Record	Years of Data
57	Rideau	6106874	Ramsayville Crf	1972-1976	5
58	Rideau	61070AA	Richmond	1981-1984	4
59	Rideau	6107011	Richmond	1971-1972	2
60	Rideau	6107010	Richmond	1973-1974	2
61	Rideau	6107031	Rideau C Burrits Rapids	1954-1969	16
62	Rideau	6107017	Rideau Canal Bobs L.	1954-1961	8
63	Rideau	6107059	Rideau C Kilmarnock	1954-1969	16
64	Rideau	6107073	Rideau Canal Long Isl.	1954-1969	16
65	Rideau	6107087	Rideau Canal Narrows	1954-1969	16
66	Rideau	6107096	Rideau Canal Perth	1954-1956	3
67	Rideau	6107133	Rideau Ferry	1948-1969	22
68	Rideau	6107834	Smiths Falls	1895-1922	28
69	Rideau	6107836	Smiths Falls TS	1982-1989	8
70	Rideau	6107835	Smiths Falls WPCP	1964-1983	20
71	Rideau	6109458	Westport	1895-1920	26
72	Outside	6100310	Arden	1895-1911	17
73	Outside	6100340	Arnprior	1959-1964	6
74	Outside	6100345	Arnprior Grandon	1959-1999	41
75	Outside	6100375	Athens	1969-1978	10
76	Outside	6100521	Barrett Chute	1950-1968	19
77	Outside	6100828	Bourget	1950-1951	2
78	Outside	6100969	Brockville	1871-1980	110
79	Outside	6101077	Calabogie	1950-1956	7
80	Outside	6101440	Chats Falls	1950-1992	43
81	Outside	6101555	Claybank	1961-1994	34
82	Outside	6161662	Cloyne Ont. Hydro	1967-1981	15
83	Outside	6101986	Delta	1969-1994	26
84	Outside	6161990	Denbigh	1883-1896	14
85	Outside	6102417	Fitzroy Harbour	1870-1906	37
86	Outside	6102839	Gloucester Desjardins	1975-1977	3
87	Outside	6102841	Gloucester Ren	1954	1
88	Outside	6102842	Gloucester Tinker	1975-1976	2
89	Outside	6102857	Godfrey	1981-2003	23
90	Outside	6103470	Hinchinbrooke	1961-1973	13
91	Outside	6104400	Leonard	1960-1962	3
92	Outside	6104723	Lyn	1960-1969	10
93	Outside	6104840	Maitland	1953-1954	2
94	Outside	6104880	Mallorytown Graham L.	1961-1989	29
95	Outside	6105010	Matawatchan	1983-1988	6
96	Outside	6105066	Metcalfe Osgoode	1968-1976	9
97	Outside	6105679	North Augusta Mahoney	1973-1980	8
98	Outside	6106052	Ottawa Lemieux Island	1953-1979	27
99	Outside	6107119	Rideau Canal Wolfe L.	1954-1961	8
100	Outside	6107533	Sarsfield	1985-1989	5
101	Outside	6107955	South Mountain	1960-1996	37
102	Outside	6107971	Spencerville	1953-1959	7
103	Outside	6108027	Stewartville	1950-1969	20

Detailed record of climate data availability for all climate stations in the region

Watershed	Station	Name	Period of Record	Data Recorded during Period of Record						
				Max Temp	Min Temp	Mean Temp	One Day Rainfall	One Day Snowfall	One Day Percipiation	Snow Depth
Mississippi	6100285	Appleton	1992-present	✓	✓	✓	✓	✓	✓	✓
Mississippi	6102J13	Drummond Centre	1984-present	✓	✓	✓	✓	✓	✓	✓
Mississippi	6105760	Ompah	1994-2005	✓	✓	✓	✓	✓	✓	✓
Mississippi	6105762	Ompah-Seitz	1994-2005	✓	✓	✓	✓	✓	✓	✓
Rideau	6104025	Kemptville	1928-1997	✓	✓	✓	✓	✓	✓	1971-1997
Rideau	6104027	Kemptville CS	2001-present	✓	✓	✓	1997-1999	1997-1999	✓	✓
Rideau	6106000	Ottawa Airport	1938-present	✓	✓	✓	✓	✓	✓	1947-present
Rideau	6105976	Ottawa CDA RS	2000-present	✓	✓	✓	X	X	✓	✓
Rideau	6105978	Ottawa CDA	1889-2005	✓	✓	✓	✓	✓	✓	1961-2005
Outside	6100969	Brockville	1871-1980	1972-1980	1972-1980	1972-1980	✓	✓	✓	1980
Outside	6100971	Brockville PCC	1965-present	✓	✓	✓	✓	✓	✓	1980-present
Outside	6102857	Godfrey	1981- May 2003	1984-2003	1984-2003	1984-2003	✓	✓	✓	✓
Outside	6103367	Hartington IHD	1967-present	✓	✓	✓	✓	✓	✓	1980-present
Outside	6107247	Russell	1954-present	✓	✓	✓	✓	✓	✓	1980-present
Québec	7030170	Angers	1962-2005	1966-2005	1966-2005	1966-2005	✓	✓	✓	1980-2005
Québec	7034365	Luskville	1980-2005	✓	✓	✓	✓	✓	✓	✓

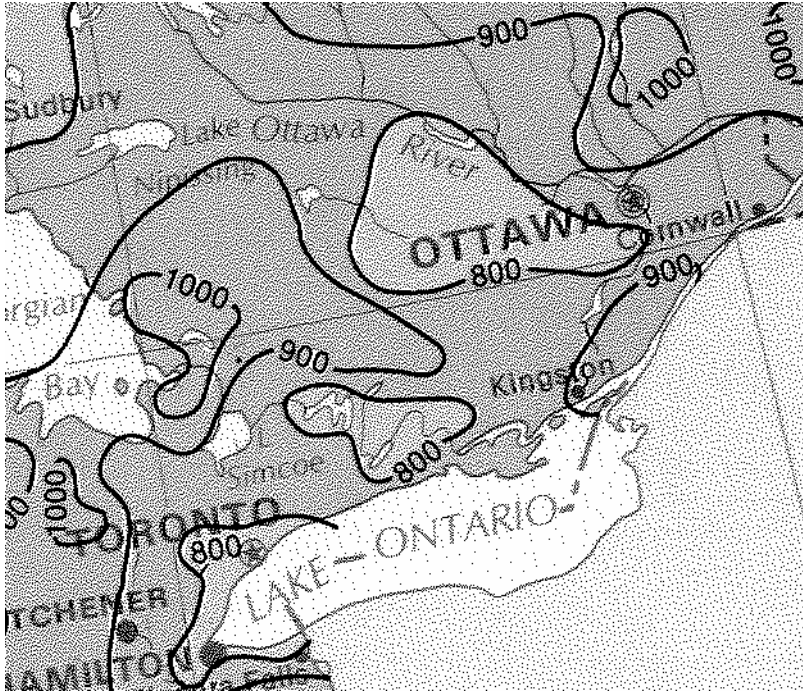
Rain Gauges in the Mississippi-Rideau Region

No.	Watershed	Name	Station	Data	Period of Record	Years of Data	Owner
1	Mississippi	Marble Lake	02KF016	Rain	1993 -present	11	MVC
2	Mississippi	Plevna	02KF017	Rain	1997- present	7	MVC
3	Mississippi	Gordon Rapids	02KF013	Rain	1993 -present	11	MVC
4	Mississippi	Lanark	02KF010	Rain	1993 -present	11	MVC
5	Mississippi	Fergusons Falls	02KF001	Rain	1993 -present	11	MVC
6	Mississippi	Appleton	02KF006	Rain	1993 -present	10	MVC
7	Mississippi	Blakeney	02KF012	Rain	1993 -present	10	MVC
8	Mississippi	Kinburn	02KF011	Rain	1993 -present	9	MVC
9	Rideau	OMYA Inc.	OMYA	Rain	2005-present	1	RVCA
10	Rideau	Irish Creek	Irish Ck	Rain	2004-present	2	RVCA

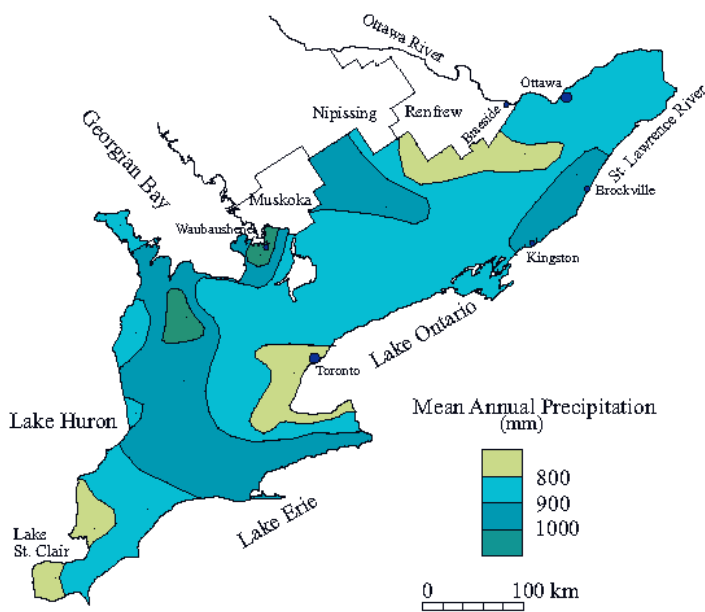
Snow Sites in the Mississippi-Rideau Region

No.	Watershed	Station	Period of Record	# yrs between 1974 - 2003	Operator
1	Mississippi	Mackavoy	1986-present	19	MVC
2	Mississippi	Bon Echo	1982-present	24	MVC
3	Mississippi	Buckshot	1985-present	20	MVC
4	Mississippi	Ardoch	1981-present	24	MVC
5	Mississippi	Canonto	1986-present	19	MVC
6	Mississippi	Snow Road	1981-present	24	MVC
7	Mississippi	Maberley	1979-present	26	MVC
8	Mississippi	Lavant Station	1986-present	19	MVC
9	Mississippi	Gordon Rapids	1985-present	20	MVC
10	Mississippi	Fallbrook	1986-present	19	MVC
11	Mississippi	Brightside	1981-present	26	MVC
12	Mississippi	Innisville	1979-present	26	MVC
13	Mississippi	Blakeney	1979-present	26	MVC
14	Mississippi	Kinburn	1979-present	26	MVC
1	Rideau	Westport	1989-present	15	Parks Canada
2	Rideau	Houghton	1989-present	15	Parks Canada
3	Rideau	Bolingbroke	1989-present	15	Parks Canada
4	Rideau	Bathurst	1989-present	15	Parks Canada
5	Rideau	Perth	1989-present	15	Parks Canada
6	Rideau	Portland	1989-present	15	Parks Canada
7	Rideau	Wolford Centre	1976-present	28	RVCA
8	Rideau	Pierces Corners	1974-present	30	RVCA
9	Rideau	Ashton	1974-present	30	RVCA
10	Rideau	Bells Corners	1978-present	26	RVCA
11	Rideau	Nolans Corners	1976-present	28	RVCA

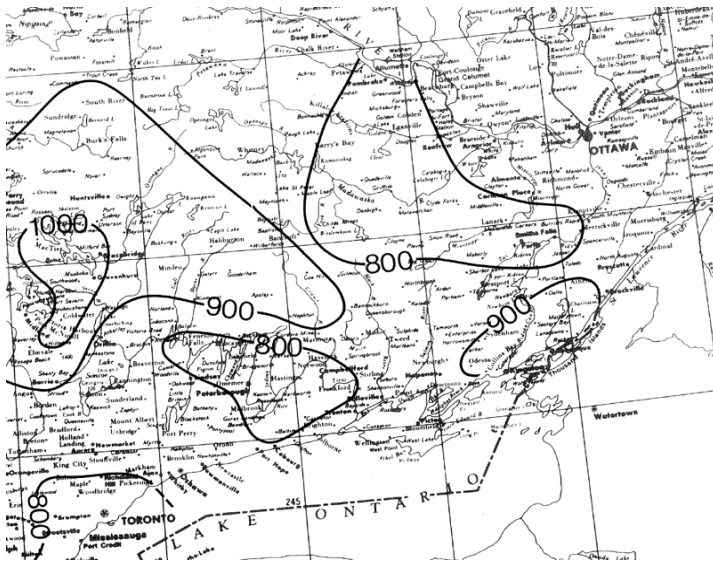
**Annual Precipitation Map from Hydrologic Atlas of Canada (1978)
(Not to Scale)**



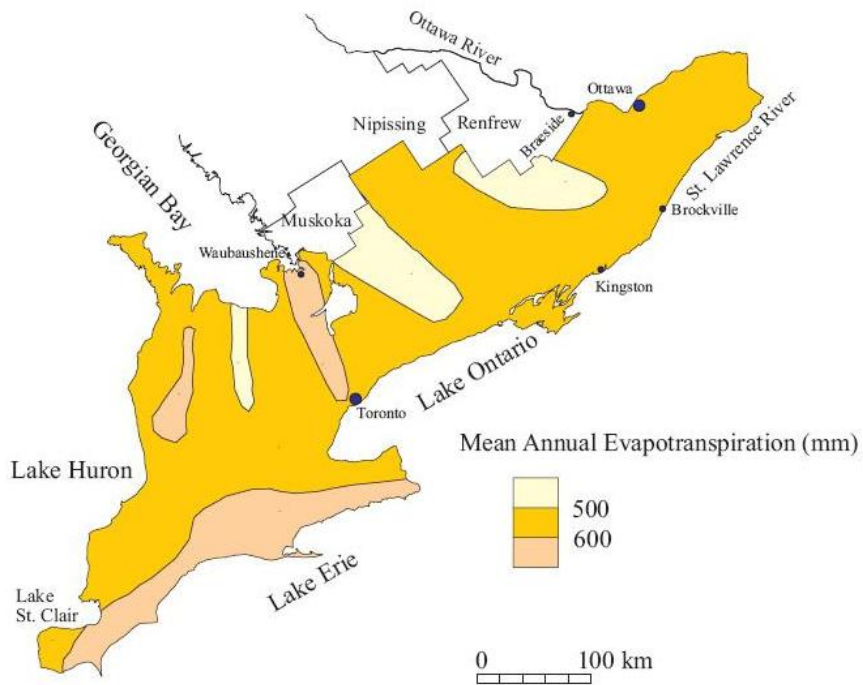
Annual Precipitation Map from MNR (1984)



Annual Precipitation Map from Moin & Shaw (1985)



Annual Evapotranspiration Map from MNR (1984)



Summary of missing precipitation data for selected climate stations in Mississippi-Rideau Region

No.	Watershed	Station	Name	Period of Record	Missing Months & Years
1	Mississippi	6100285	Appleton	1992-present	Jan-Mar-1992, Sept-1993
2	Mississippi	6102J13	Drummond Centre	1984-present	Jan-June-1984, Nov-1996, Mar-1997 & 1999
3	Mississippi	6105760	Ompah	1994-present	Jan-Jul-1994, Jul-1997
4	Mississippi	6105762	Ompah-Seitz	1994-present	Jan-Jul-1994
5	Rideau	6104025	Kemptville	1928-1997	Jan-Nov-1928, Feb-Dec-1937, Jan-Dec-1938, Jan-Aug-1939
6	Rideau	6104027	Kemptville CS	2001-present	Mar, Apr, & Sep-1998, Oct-1999, Jmar, Apr, Jun-Dec-2000, Jan, Mar, & Apr-2001
7	Rideau	6105978	Ottawa CDA	1889-present	Jan Oct-1838, May-1899, Apr-1951
8	Rideau	6106000	Ottawa Airport	1938-present	Jan-Oct-1938
9	Outside	6100971	Brockville PCC	1965-present	Jan-Oct, & Dec-1965, Jan, Feb, Mar, & Dec-1966, Oct-1970, Nov-1978 Mar-1997 & 1999
10	Outside	6101820	Comberemere	1956-present	Oct-1960, May-1961, May, Jun, Sep-1962, Jan-1964, Jun, Jul, & Sep-1965, Jan-1966, Sep, Oct-1968, Mar-May, Jul-Nov-1974, Feb-1975, Apr, Jul, & Oct-1976, Nov-1977, Jun-1978, Sep-1979, Feb-1984 & 1986, Jun-1992
11	Outside	6102857	Godfrey	1981-present	Jan-May-1981, Jan-Feb-2001, Jul-Sep-2002
12	Outside	6104725	Lyndhurst	1976-present	Jan-Jul-1976, Jan, Feb-1999, Feb 2001 and 2002
13	Outside	6103367	Hartington	1967-present	May-1970 & Jun-1985
14	Outside	7030170	Angers*	1962-present	Jan-Mar-1962, May-1965, Jan, Mar, Sep, & Nov-1968, May-Oct-1969, Sep-1977, Jan, Mar, & Dec-1989, Dec-1990, Jan-Mar, Dec-1991 & 1992, Jan, Mar, & Dec-1993, Jan-Mar, Nov, Dec-1994, Feb, Nov, & Dec-1995, Jan-Mar, Dec-1996, Jan, Feb-1997, Sep-1999
15	Outside	7034365	Luskville*	1981-present	Jan-Apr-1981, Sep-1999, Aug-2002, Jul, Oct-2003

* Quebec stations

Summary of missing temperature data for selected climate stations in Mississippi-Rideau Region

No.	Watershed	Station ID	Name	Period of	Missing Months & Years
1	Mississippi	6100285	Appleton	1992-present	Jan~Sept-1992, Sept-1993, Aug-1996, Jul-1997, Sept-1998&2000
2	Mississippi	6102J13	Drummond	1984-present	Jan~Jun-1984, Nov-1995, Feb~Mar-1997, Mar-1998
3	Mississippi	6105760	Centre Ompah	1994-present	Jan~Jul-1994
4	Mississippi	6105762	Ompah-Seitz	1994-present	Jan~Jul-1994
5	Rideau	6104025	Kemptville	1928-1997	Jan~Nov-1928, Feb~Dec-1937, Jan~Dec-1938, Jan~Apr-1939
6	Rideau	6104027	Kemptville CS	2001-present	Jan, Feb, & Sep-1998, Sep-1999, Jan, Feb, Apr~Dec-2000, Jan, Mar, & Apr-2001
7	Rideau	6105978	Ottawa CDA	1889-present	Jan Oct-1838, May-1899, Sep-1945, Apr~Jun-2003
8	Rideau	6106000	Ottawa Airport	1938-present	Jan~Oct-1938
9	Outside	6100971	Brockville PCC	1965-present	Jan~Aug-1965, Oct-1970, Sep~Dec-1978, Jan~Mar, Jun, Jul, & Dec-1979, Mar, Apr, Jun-1980, Jan, Feb, Mar, & Dec-1966, Oct-1970, Nov-1978 Mar-1997&1999
10	Outside	6101820	Comberemere	1956-present	Jan~May-1957, Dec-1959, Jun, Oct, & Nov-1961, Jun, Jul-1962, May~Aug-1963, Jan-1964, Jan-1966, Nov-1968, Apr~Jun, Aug~Nov-1974, Jan, Mar, & Aug-1975, Aug, Nov-1976, Jan-1978, Sep-1979, Feb-1984, Feb-1986, Jun-1992
11	Outside	6102857	Godfrey	1981-present	Jan~May-1981, Jan, Feb-2001, Jul~Sep-2002
12	Outside	6104725	Lyndhurst	1976-present	Jan~Jul-1976, Jan, Feb-1999, Oct~Dec-2000, Jan, Feb-2001, Feb-2002
13	Outside	6103367	Hartington	1967-present	May--1970
14	Outside	7030170	Angers*	1962-present	Sep, Oct-1967, Jan~Mar, Jun, Sep~Dec-1968, Apr, Jun~Oct-1969, Jan, May, & Jun-1970, Apr-1988
15	Outside	7034365	Luskville*	1981-present	Jan~Ap-1981

* Quebec stations

Water holding capacities (in mm) used for evapotranspiration calculations in the Mississippi-Rideau Region

Land Cover	Root Depth	Soil Texture Value						Eroded ³
		Heavy Clay	Loamy Sand	Loam ²	Sandy Loam	Silty Loam	Silty Clay Loam	
Alvar	Shallow	-	58	125	66	125	-	-
Cropland	Moderate	150	100	200	125	200	200	150
Unclassified (Cloud & Shadow)	Moderate ¹	-	100	-	-	-	-	-
Pasture and Abandoned Fields	Moderate-Deep	200	117	250	134	250	300	200
Forest, Plantation, Recent Cutovers	Deep	350	267	400	300	400	400	350
Water/marsh/Swamp/fen	None	Null ⁴						
Mine Tailings/Quarries/Bedrock Outcrop	None	Null ⁴						

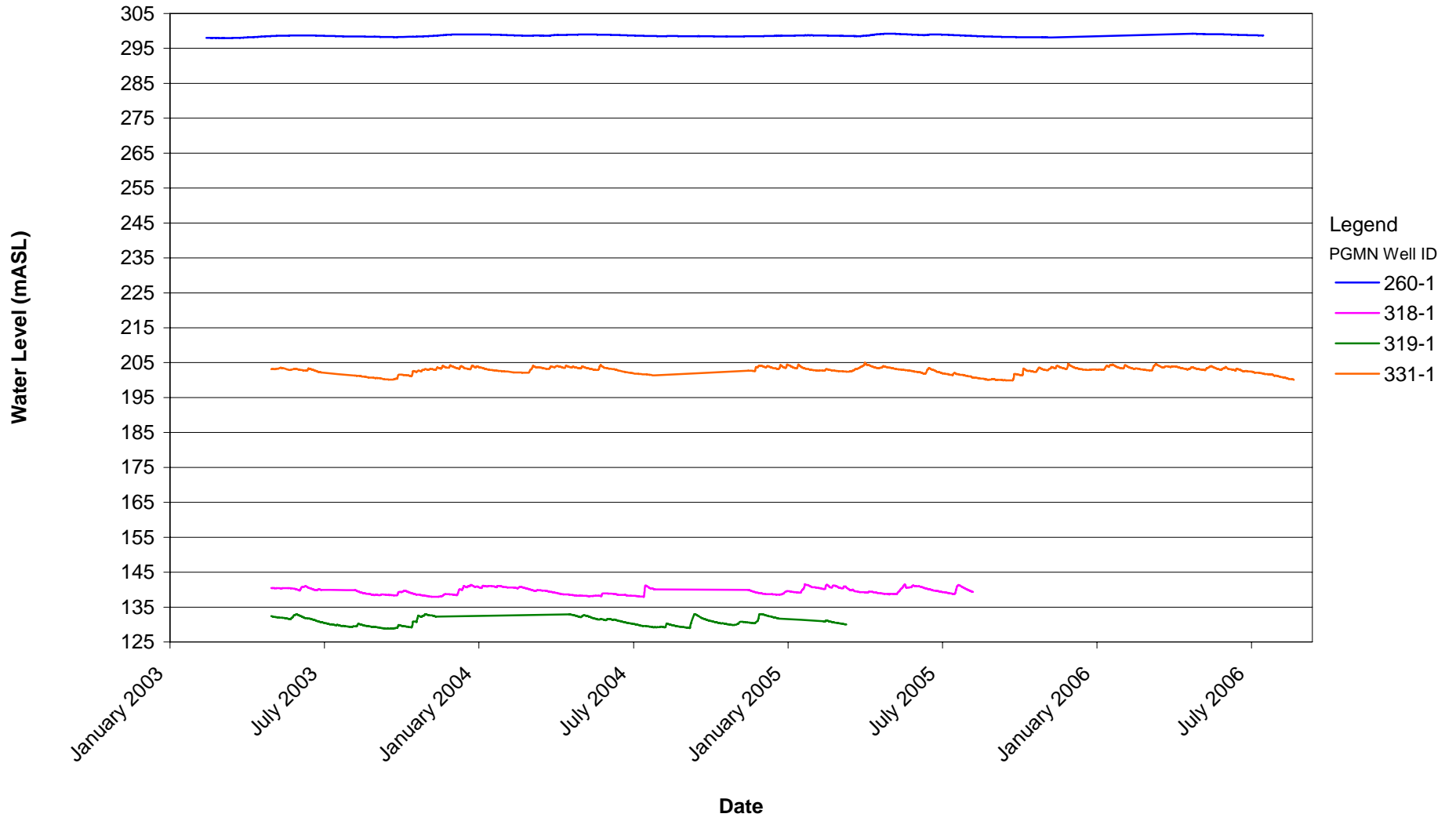
1. Assumed a moderate root depth for Unclassified (Cloud & Shadow) areas.
2. A water holding capacity for loam was not found in the MOE Stormwater Management Planning Manual (MOE, 2003) or in the Regional Groundwater Study (Golder et. al, 2003). Water holding capacities for loam were made equivalent to those of silt/loam.
3. These areas are classified as Eroded by the Soils Landscape of Canada and are located just outside of the Development/Settlement Lands within the MNR land cover data. No soil texture values were available so water holding capacity has been assigned assuming a soil texture value of heavy clay as most areas are in the City of Ottawa where clays are dominant.
4. Water holding capacities of water/marsh/swamp/fen and mine tailings/quarries/bedrock outcrop were not available (or assigned a value of zero "null").

Mean Temperature, Precipitation and Evapotranspiration in the Mississippi-Rideau Region

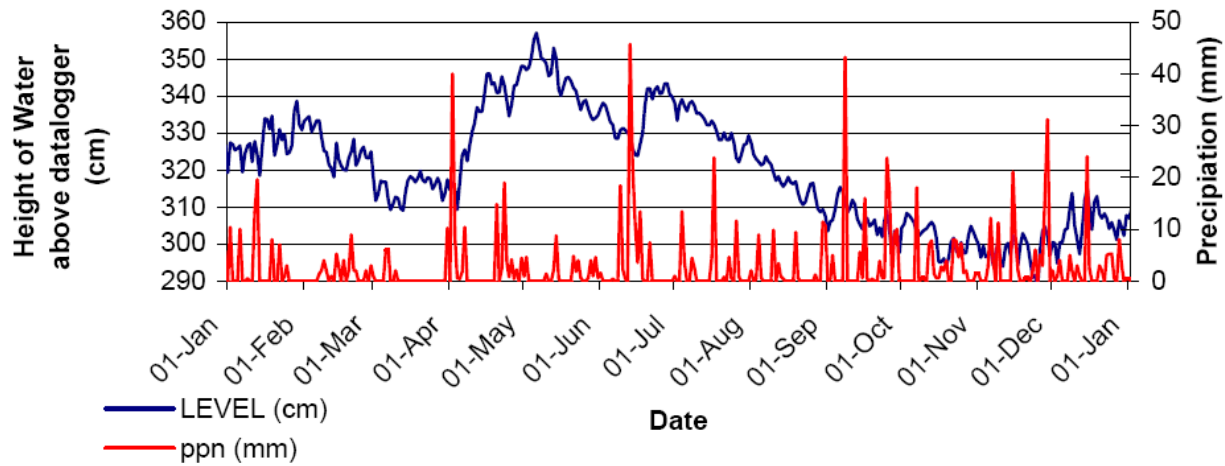
Month	Average Temperature (°C)	Average Precipitation (mm)	Average Actual Evapotranspiration (mm)
January	-10.2	72.8	0
February	-8.7	56.0	0
March	-2.6	71.3	0
April	5.3	70.1	28.4
May	12.6	76.3	80.3
June	17.5	79.5	114.5
July	20.1	79.9	130.2
August	18.8	81.6	110.3
September	14.0	88.6	72.8
October	7.6	76.7	34.7
November	1.1	79.3	4.2
December	-6.4	79.7	0
ANNUAL	5.8	912	575
<p>1. Climate data (1971-2000) from Great Lakes Forestry Canada Study (McKenney et al., 2006).</p> <p>2. Evapotranspiration calculated using climate data with procedure from Thornthwaite and Mather (1955, 1957).</p>			

Appendix B
PGMN Groundwater Levels

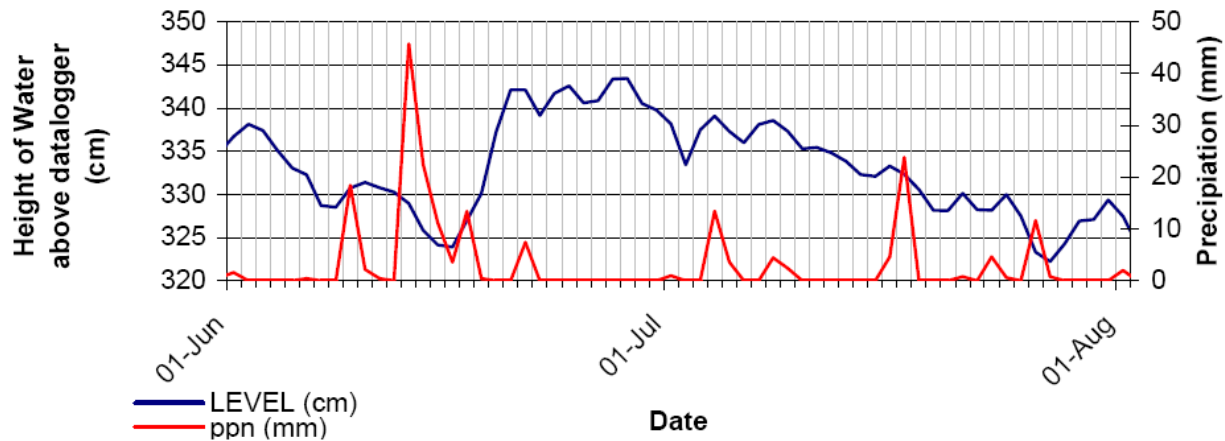
PGMN Well Water Levels for MVC Region



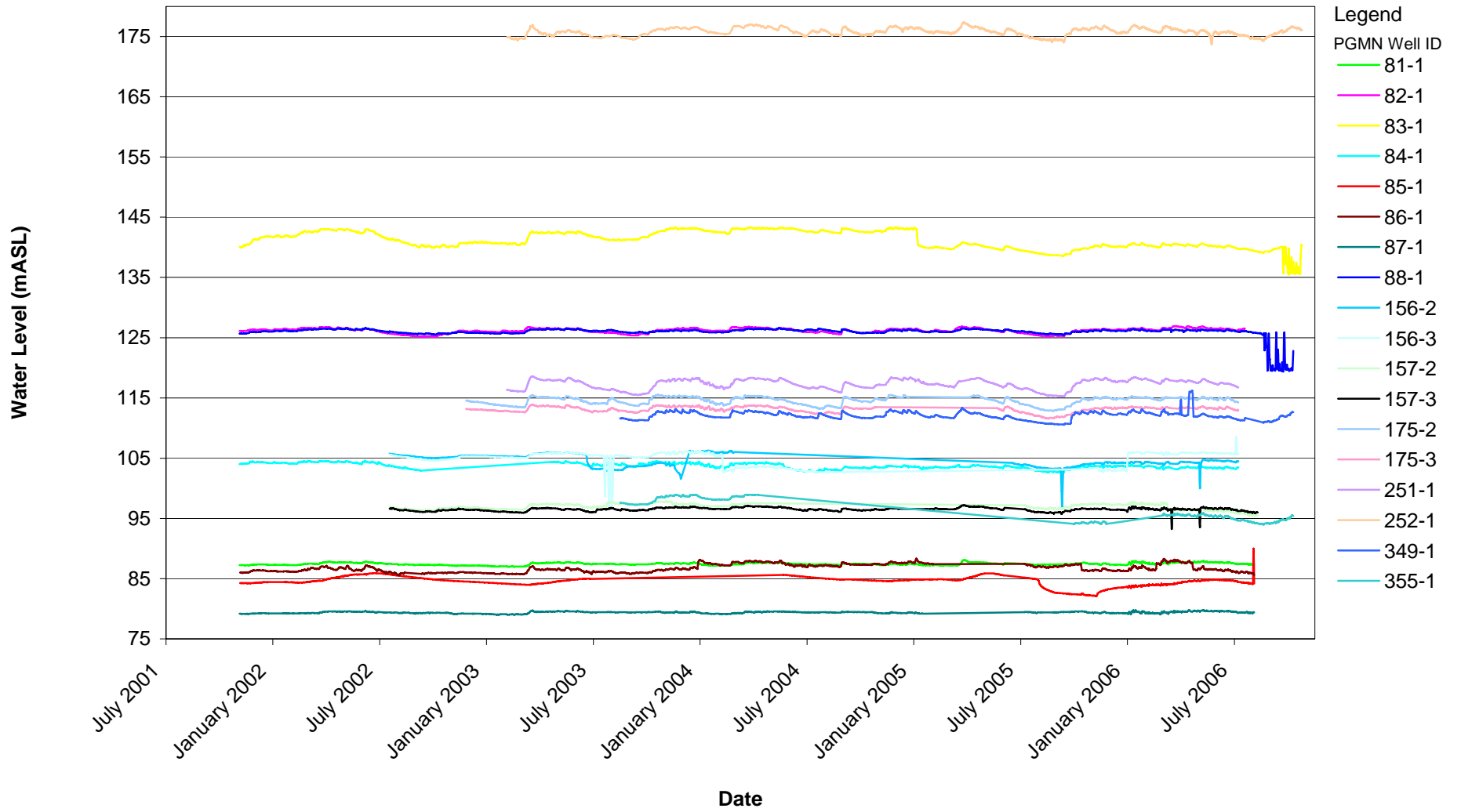
**Water Level Response with Precipitation
PGMN ID#260 during 2005**



**Water Level Response with Precipitation
PGMN ID#260 during June-July 2005**



PGMN Well Water Levels for RVCA Region



Appendix C
Surface Water Information

Watersheds and Subwatersheds in the Mississippi-Rideau Region

Jurisdiction	Watershed	Subwatershed	Drainage Area (km ²)		
Mississippi Valley Conservation Authority (MVCA)	Mississippi River	Big Gull	148	3,747	4,335
		Buckshot Creek	292		
		Clyde River	661		
		CP Dam	488		
		Fall River	490		
		High Falls	203		
		Indian River	211		
		Lower Mississippi	664		
		Mazinaw	358		
		Upper Mississippi	233		
	Carp River	Carp River	300	300	
	Ottawa River (MVCA)	Ottawa River	287	287	
Rideau Valley Conservation Authority (RVCA)	Rideau River	Jock River	578	3,872	4,256
		Kemptville Creek	460		
		Lower Rideau	759		
		Middle Rideau	828		
		Tay River	797		
		Rideau Lakes	450		
	Ottawa River (RVCA)	Ottawa River - East	263	263	
		Ottawa River - West	121	121	
TOTAL AREA for MISSISSIPPI-RIDEAU REGION					8,591

Major Reservoirs and Control Structures in the Mississippi-Rideau Region

Watershed	Major Reservoir	Control Structure	Surface Area (ha)	Live Storage Volume ⁴ (1,000 m ³)
Mississippi ¹	Mazinaw Lake	Dam	1,630	17,930
	Big Gull Lake	Dam	2,540	15,240
	Kashwakamak Lake	Dam	1,274	19,110
	Mississagagon Lake	Dam	545	3,820
	Shabomeka Lake	Dam	268	4,020
	Crotch (Cross) Lake	Dam	1,953	58,590
Rideau ²	Big /Lower Rideau Lake	Poonamalie Locks	5,910	47,280
	Upper Rideau Lake	Narrows Locks	1,380	10,488
	Wolfe Lake	Dam	970	6,984
	Bob's Lake/Crow Lake	Dam	3,340	47,011
	Eagle Lake ³	Dam	653	n/a

1. Mississippi data from the Draft Mississippi River Water Management Plan (August, 2005)

2. Rideau data from the Rideau Canal Water Management Study (Acres, 1994)

3. From the Eagle Lake Dam Operation Plan (MNR, November 1980)

4. Live storage volume for Mississippi reservoirs refers to the actual operating range currently in place (to maximum of summer target range to minimum fall level, does not include maximum spring level). The live storage volume for Rideau is assumed to be over the full operating range.

Inventory of available streamflow data and data infilling approaches for selected hydrometric stations

Station Name	Available Streamflow Data			# of Years of Data (1974-2003)	Data Gaps (1974-2003)	Data Infilling Approach
	HYDAT	Parks Canada	MVCA/RVCA			
Mississippi River at Fergusons Falls	1915-1919, 1983-2003			21	1974-1982	Correlated with Appleton
Mississippi River at Appleton	1918-2003			30	None	
Clyde River near Lanark	1970-2003			30	June-Dec 1984, Jan 1985	Correlated with Gordon Rapids
Carp River Kinburn	1971-2003			30	None	
Indian River near Blakeney	1971-1998, 2002-2003			27	Apr-Dec 1998, 1999-2001	Filled with Indian River Mill data
Mississippi River below Marble Lake	1988-2003			16	1974-1987	Correlated with Gordon Rapids
Fall River near Fallbrook	1974-1992			19	Jan-Sep 1974, April 1992-Dec 2003	Correlated with Appleton
Rideau River at Ottawa	May-Nov 1933-1945, Apr-Dec 1946, Jan-Nov 1947, Apr-Dec 1948, 1949-2003			30	None	
Jock River near Richmond	1970-2003			30	None	
Kemptville Creek	1970-2003, Jan-Mar, Jun-Sept, Dec 2000			29	Apr. & Nov 2000	Correlated with Jock River
Rideau River below Manotick	Sept-Dec 1980, 1981-1990, Jan-Apr, Nov-Dec 1991-1995	1996-2003	Jan-Aug 1980, 1991-1995 (May-Oct), Aug 1998, Nov 1999, Oct 2000, Aug 2001	21	1974-1979 ^A , Oct 1992, Oct 1993, Oct 1995	Correlated with Rideau at Ottawa

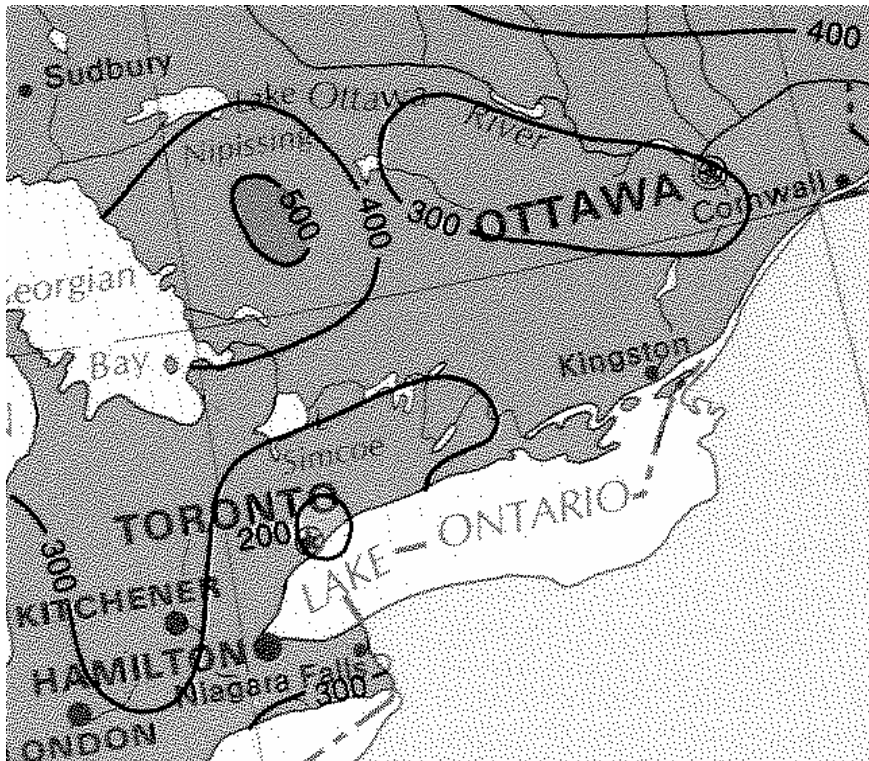
Rideau River at Merrickville	Dec 1979, 1980-1990, Jan-Apr, Nov-Dec 1991-1995	May-Oct 1991-1994, Nov 1999, 1996-2003	May-Oct 1995, Aug 1998, May & Oct 2000, Aug 2001	24	1974-1979 ^A	Correlated with Rideau at Ottawa
Rideau River above Smiths Falls	Nov-Dec 1970, Jun-Dec 1971, 1972-1977, Jan-Apr, Nov-Dec 1978-1995	May-Oct 1978-1995 ¹ , 1996-2003	May & Oct 1978, May 1979, Sept & Oct 1979, May & June 1980, May & Sept 1981, Jul & Sept 1984, Oct 2000, Aug 2001	21	Aug 1980, May & June 1984, May 1985, Jul 1988, Jul 1990, Sept 1994, Jul & Sept 1995, Dec 1997, Aug 1998	Correlated with Rideau at Merrickville
Tay River in Perth	Oct-Dec 1994, 1995	1996-2003		7	1974-1993, Jan-Sept 1994, Sept 1998, Oct 2000	N/A ²

^A Data is not readily available. It is located on microfiche and on loose hard copy sheets at Parks Canada.

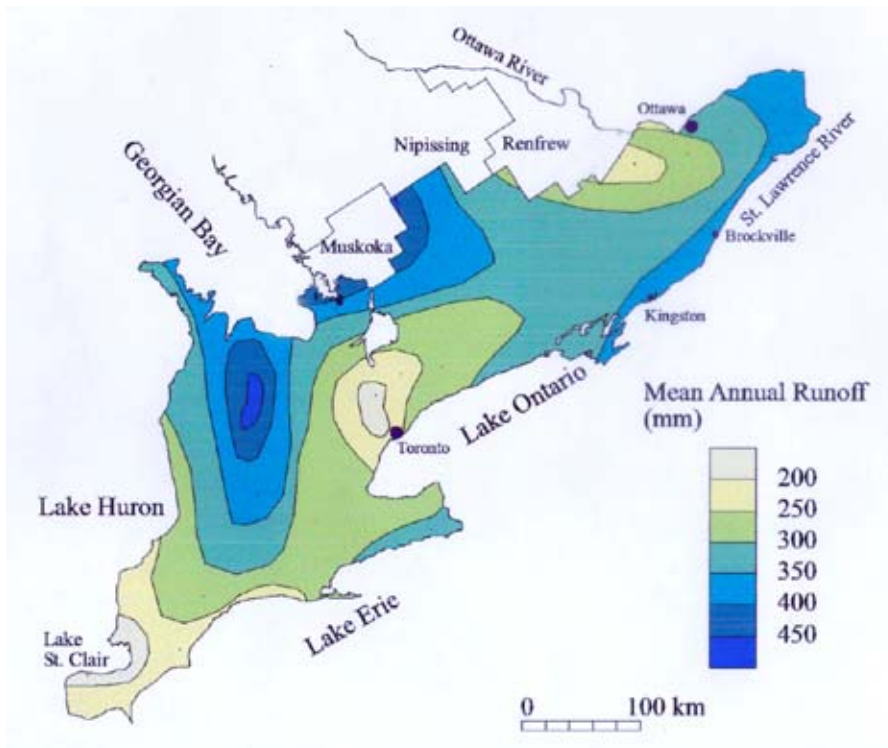
¹ Flows were estimated from a rating curve.

² Data infilling method TBD. Additional data on Tay River: 1. Port Elmsley (1982 (Jul-Dec), 1983-1986, 1987 (Jan-May), 1988 (Mar-Jun) 2. Bob's Lake (1984, 1985 (Jan-Jun), 1990 (Jan-Sept), 1992 (Aug-Nov), 1994 (Oct-Dec (hard copy)), 1995 (Jan-May (hard copy), July-Oct, (Nov-Dec (hard copy))).

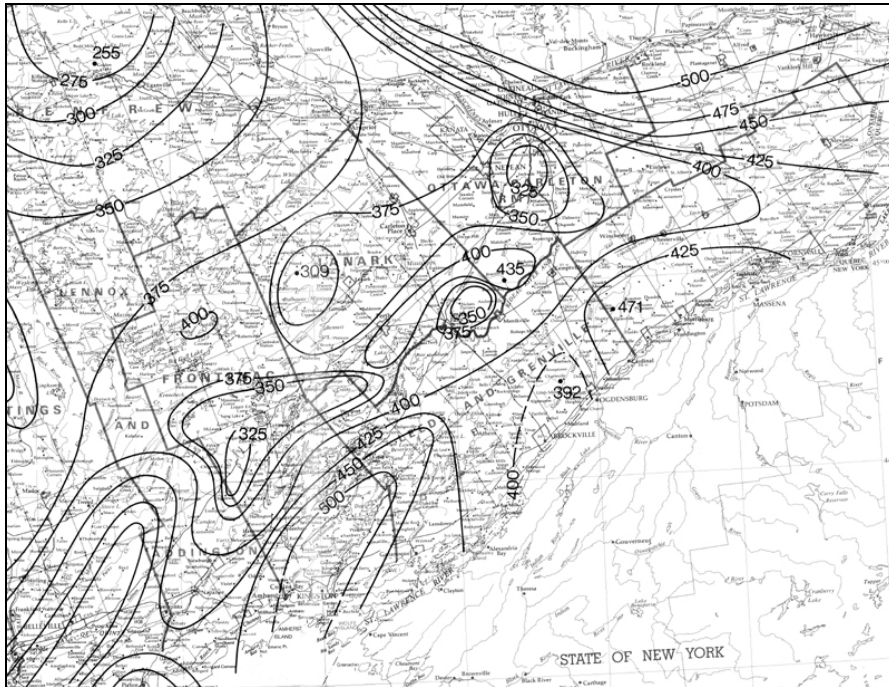
Hydrologic Atlas (1978) Mean Annual Flow (Not to Scale)



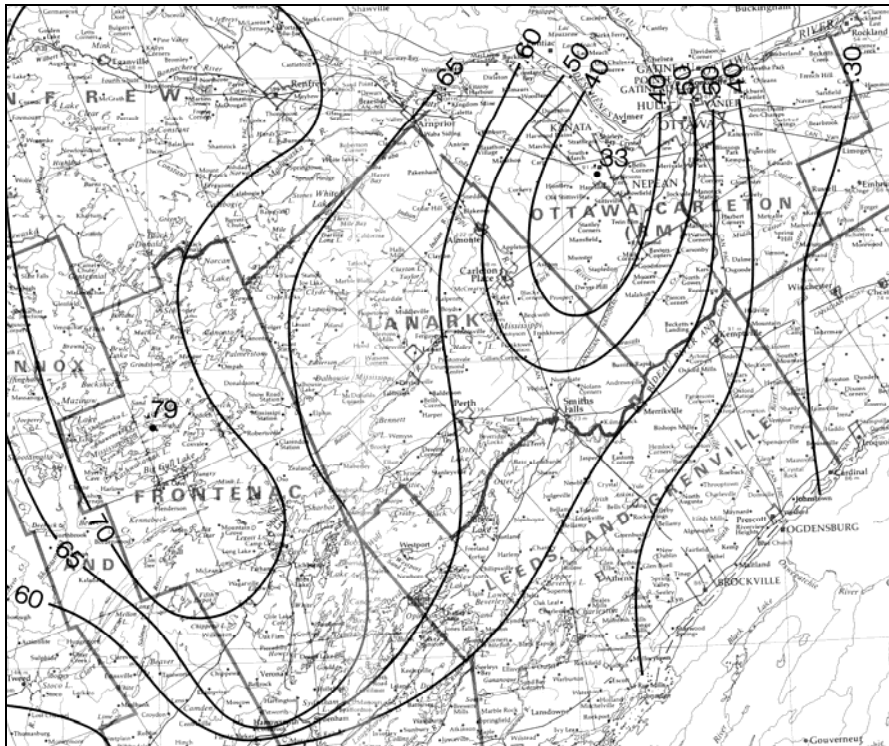
Mean Annual Runoff Map from MNR (1984) (Not to Scale)



Mean Annual Runoff Map from Moin & Shaw (1985) (Not to Scale)



Mean Baseflow Index (dimensionless) (Moin & Shaw, 1985)



Inventory of water level data at major reservoirs in the Mississippi-Rideau Region

Reservoir	Gauge Name (ID)	MVCA Data	HYDAT Data	Parks Canada Data	# yrs 1974-2003	Missing Data	Proposed Data Infilling Approach
Mississippi:							
Mazinaw Lake	(same)	1993-2005	-	-	11	1974-1992	Using the average of the available data (monthly average) for reservoirs
Big Gull Lake	(same)	1993-2005	-	-	11	1974-1992	
Kashwakamak Lake	(same)	1993-2005	-	-	11	1974-1992	
Shabomeka Lake	(same)	1993-2005	-	-	11	1974-1992	
Crotch (Cross) Lake	(same)	1993-2005	-	-	11	1974-1992	
Mississagagon Lake	(same)	1950-2003	-	-	30	none	n/a
Rideau:							
Big/Lower Rideau Lake	Poonamalie (02LA009)	-	1974-1977	1978-2003	30	none	Reservoir Rule Curve
	Rideau Ferry (02LA014)	-	1980-1982	1988-2003			
Upper Rideau Lake	Narrows (02LA025)	-	-	1980-2003	24	1974 - 1979	Reservoir Rule Curve
Wolfe Lake	(same)	-	-	1979-2003	25	1974 - 1978	Reservoir Rule Curve
Bob's Lake/Crow Lake	Bolingbroke (02LA017)	-	-	1978-2003	26	1974 - 1977	Reservoir Rule Curve
Eagle Lake	No gauge	-	-	-	0	1974-2003	No data or rule curve available. Possibly use Eagle Lake Operating Plan (MNR 1980).

Appendix D
Inventory of Hydrometric Stations

Inventory of Hydrometric Stations

Hydrometric stations collect data on rivers, creeks, and lakes. There are two types of measurements: streamflow and water levels. Streamflow data is collected where rating curves have been established on rivers and creeks. Water level data is collected on lakes and reservoirs. Historic sites are discontinued sites where some data may be available but is no longer being collected.

Mississippi River Stations

Within Mississippi River watershed, hydrometric stations are owned and operated by a division of Environment Canada called “Water Survey of Canada (WSC)” and by Mississippi Valley Conservation (MVC). There is also a stations operated by a power generator at the dam at High Falls on the Mississippi River. WSC has eight active flow stations in the Mississippi River watershed. MVC operates eleven stations. Stations in the Mississippi are listed in the table below.

Hydrometric stations in the Mississippi River Watershed

Station ID	Name	Data	Period of Record	# Years of Data	Operator	Status
02KF016	Mississippi River below Marble Lake (Myers Cave)	Flow	1988-2003	16	WSC	Active
02KF017	Buckshot Creek near Plevna	Flow	1993-2003	11	WSC	Active
02KF013	Clyde River at Gordon Rapids	Flow	1971-2003	33	WSC	Active
02KF010	Clyde River near Lanark	Flow	1970-2003	34	WSC	Active
02KF001	Mississippi River at Fergusons Falls	Flow	1915-2003	89	WSC	Active
02KF006	Mississippi River at Appleton	Flow	1918-2003	86	WSC	Active
02KF012	Indian River near Blakeney (Mill of Kintail)	Flow	1971-2003	33	WSC	Active
02KF011	Carp River near Kinburn	Flow	1971-2003	33	WSC	Active
02KF002	Mississippi River at Galetta	Flow	1915-1919	5	WSC	Historic
02KF003	Mississippi River near Snow Road Station	Flow	1915-1919	5	WSC	Historic
02KF007	Mississippi River at Ragged Chute	Flow	1919-1957	39	WSC	Historic
02KF014	Fall River near Fall Brook	Flow	1974-1992	19	WSC	Historic
-	Shabomeka Lake	Level	1993-2005	13	MVC	Active
-	Mazinaw Lake	Level	1993-2005	13	MVC	Active
-	Kashwakamak Lake	Level	1993-2005	13	MVC	Active
-	Big Gull (Clarendon Lake)	Level	1993-2005	13	MVC	Active
-	Cross Lake	Level	1993-2005	13	MVC	Active
-	Dalhousie Lake	Level	2004 -2005	2	MVC	Active
-	Palmerston Lake (upstream of S. Clyde River)	Level	*		MVC	Active
-	Clyde River at Lanark Village	Level	2005	1	MVC	Active
-	Sharbot Lake	Level	2004-2005	2	MVC	Active
-	Bennett Lake	Level	2004-2005	2	MVC	Active
-	Mississippi Lake	Level	2003-2005 ¹	3	MVC	Active
1993-2002 ²			10			
1981-1992 ³			12			
1950-1980 ⁴			31			

¹ Telemarks – automated but no data storage

² Telemetric staff gauge – instantaneous daily water level data

³ Weekly staff gauge

⁴ Some data, not sure where taken

Rideau River Stations

In the Rideau River watershed, hydrometric stations are owned and operated by WSC, Rideau Valley Conservation Authority (RVCA), Parks Canada (Parks), City of Ottawa, and OMYA Inc. of Perth, a private industry on the Tay River. WSC has four active stations in the Rideau River watershed including one on the Rideau River at Ottawa, Jock River near Richmond, Tay River at Perth, and Kemptville Creek. RVCA has one station located on the Jock River at Franktown. OMYA owns and operates their own station (installed in 2003 to monitor its water takings from the Tay River). Flow data is collected at the OMYA station on the Tay River by OMYA and RVCA. Parks Canada operates nine stations on parts of the Rideau River operated as the Rideau Canal and on lakes within the Rideau River watershed to assist with controlling levels and storage on the Canal. Some of the historic data from these sites is available from HY-DAT as many of these sites were formerly owned and operated by WSC. There are three historic stations in the Rideau Watershed. Active and historic stations in the Rideau River watershed (excluding Ottawa River subwatersheds) are listed in the table below.

Hydrometric stations in the Rideau River Watershed

Station ID	Name	Data	Period of Record	Years of Data	Operator	Status
02LA004	Rideau River at Ottawa	Flow	1933-present	73	WSC	Active
02LA007	Jock River near Richmond	Flow	1970-present	36	WSC	Active
02LA006	Kemptville Creek near Kemptville	Flow	1970-present	36	WSC	Active
02LA024	Tay River in Perth	Flow	1994-present	12	WSC	Active
OMYA	Tay River at OMYA	Flow	2003-present	3	OMYA	Active
JKFRK	Jock River at Franktown	Flow	2003-present	3	RVCA	Active
02LA012	Rideau River below Manotick	Flow	1980-1996	17	WSC	Active
			1996-present	10	Parks	
02LA011	Rideau River below Merrickville	Flow	1979-1996	18	WSC	Active
			1996-present	10	Parks	
02LA005	Rideau River above Smiths Falls	Flow	1970-1996	27	WSC	Active
			1996-present	10	Parks	
02LA016	Tay River at Port Elmsley	Flow	1982-1988	7	WSC	Historic
02LA001	Tay River near Glen Tay	Flow	1915-1926	12	WSC	Historic
-	Wolfe Lake	Level	1979-2004	25	Parks	Active
02LA025	Upper Rideau (Narrows) ¹	Level	1980-2004	25	Parks	Active
02LA014	Rideau River at Rideau Ferry (Big Rideau Lake)	Level	1980-1982	3	WSC	Active
			1988-present	18	Parks	
02LA017	Tay River below Bob's Lake (Bolingbroke)	Flow/ Level	1978-2003	26	Parks	Active
02LA018	Rideau River at Merrickville	Level	1988-1988	1	WSC	Active
			1988-1988	1	Parks	
02LA010	Rideau River near Becketts Landing	Level	1978-1979	2	WSC	Active
			1988-2003	16	Parks	
02LA009	Rideau River at Poonamalie Locks	Level	1972-1977	6	WSC	Historic
			1976-2003	28	Parks	
"Parks" is "Parks Canada".						

Ottawa River Stations

Water Survey of Canada (WSC) operates one hydrometric station on the Ottawa River within the Mississippi-Rideau Region. There are also six historic stations on the Ottawa River and its smaller tributaries. These stations are listed in the table below.

Hydrometric stations on the Ottawa River and its tributaries within the Mississippi-Rideau Region

Station ID	Name	Data	Period of Record	Years of Data	Operator	Status
02KF005	Ottawa R. at Britannia	Flows	1960-present	46	WSC	Active
		Levels	1915-present	91	WSC	Active
02LA003	Ottawa R. at Rideau Locks	Levels	1850-1977	128	WSC	Historic
02KF009	Ottawa R. at Chats Falls	Flows	1915-1994	80	WSC	Historic
02LA008	Black Rapids Ck. Tributary at Ottawa	Flows	1972-1979	8	WSC	Historic
02LA013	Sawmill Ck. at Ottawa ¹	Flow	1981-1983	2	WSC	Historic
02KF015	Graham Ck. at Nepean	Flows	1987-1995	8	WSC	Historic
02LB010	Ottawa R. at Cumberland	Levels	1918-1996	79	WSC	Historic

¹ Sawmill Creek site recently reinstated by City of Ottawa.

Pending/Proposed Stations

There are four hydrometric stations that are “pending”, meaning that they are in progress, or are “proposed”, meaning they are on the “wish-list”. The following stations are pending or proposed:

- Graham’s Creek at Nepean (former WSC Station ID #02KF015) - pending
- Becketts Creek- pending
- Stevens Creek – proposed
- Rosedale - Rideau at Black Creek – proposed

Appendix E
Water Use Information

**Average Annual Water Use in the Mississippi-Rideau Region
(excluding Britannia and Lemieux drinking water plants on the Ottawa River)**

Source	Location and Water Taking		Water Use (m³/year)
Surface Water (SW)	Municipal Drinking Water Plants:		
	Mississippi	Carleton Place	2,306,182
		Perth	1,764,147
	Rideau	Smiths Falls	3,465,128
		Subtotal – Municipal D.W. Plants	
Ground Water (GW)	Municipal Wells:		
	Mississippi	Almonte	668,462
		Carp	113,633
	Rideau	Kemptville-North Grenville	544,705
		Merrickville	187,831
		Munster Hamlet	157,885
		Westport	133,221
		Kings Park-Richmond	67,917
	Subtotal – Municipal Wells		1,873,654
	Private Wells:		
	Mississippi	Private Wells	3,055,422
		Rideau	Private Wells
	Subtotal – Private Wells		9,200,179
Sub-Total SW Takings			7,535,457
Sub-Total GW Takings			11,073,833
Total Takings (GW + SW)			18,609,290
% SW Takings			40%
% GW Takings			60%
% Private Wells			49%
% Municipal (D.W. Plants + Wells)			51%
Total Municipal Takings (excludes Private Wells)			9,409,111
Municipal Takings – SW			80%
Municipal Takings – GW			20%
Total Takings – GW only			11,073,833
% Private Wells			83%
% Municipal Wells			17%

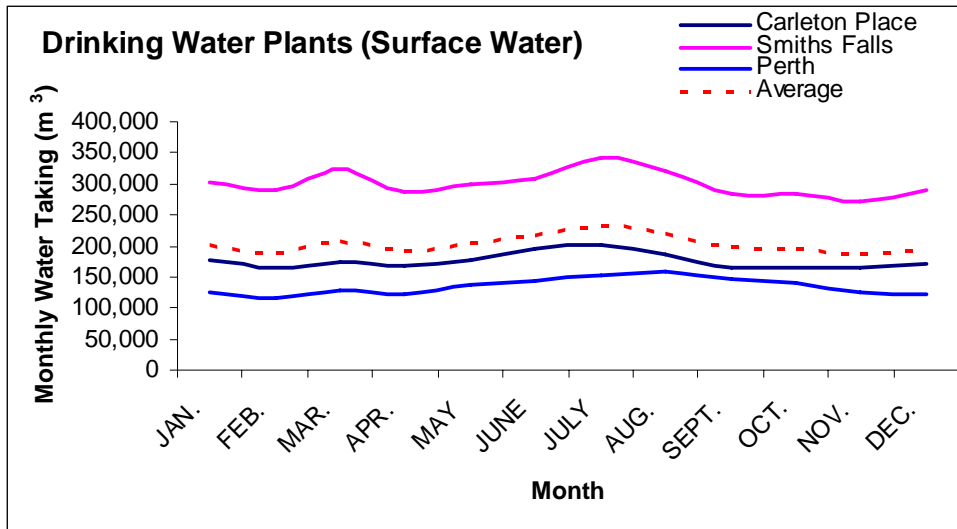
Summary of PTTW Database (October 2006)

PTTW summary - # of permits

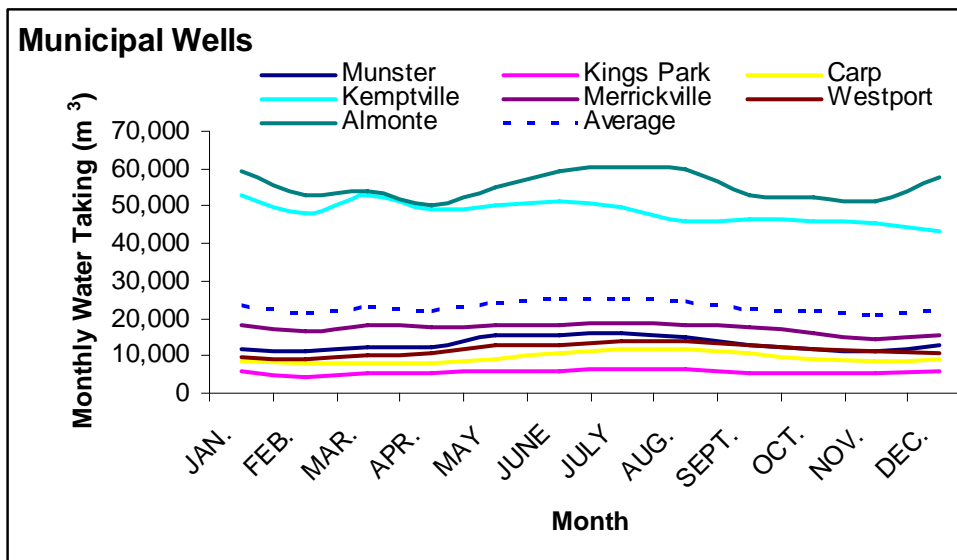
Sector	Surface Water		Ground Water		Both		Unknown		All		Region
	RVCA	MVC	RVCA	MVC	RVCA	MVC	RVCA	MVC	RVCA	MVC	
Commercial	13	5	11	4	5	3	0	1	29	13	42
Construction	7	7	3	6	1	1	0	0	11	14	25
Dewatering	6	7	17	7	1	1	0	0	24	15	39
Industrial	7	4	13	2	1	0	0	0	21	6	27
Miscellaneous	52	15	16	5	1	0	0	1	69	21	90
Agricultural	4	2	3	0	0	0	0	0	7	2	9
Institutional	0	0	2	0	0	0	0	0	2	0	2
Recreational	3	3	1	0	0	0	0	0	4	3	7
Remediation	7	6	13	1	0	0	0	0	20	7	27
Water Supply	7	5	25	25	0	0	0	1	32	31	63
Totals	106	54	104	50	9	5	0	3	219	112	331

PTTW summary - Permitted takings (m³/d)

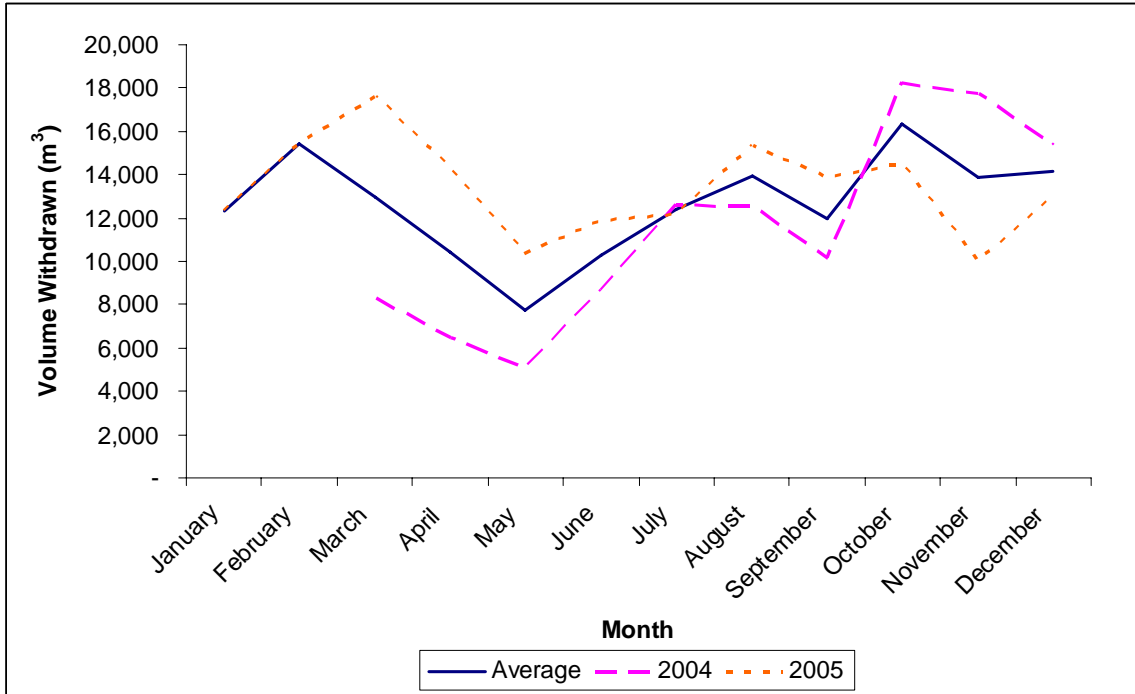
Sector	Surface Water		Ground Water		Both		Unknown		All		Region
	RVCA	MVC	RVCA	MVC	RVCA	MVC	RVCA	MVC	RVCA	MVC	
Commercial	459,857	14,490	13,061	29,448	140,877	10,453	0	5,891	613,796	60,283	674,078
Construction	1,040	2,900	2,420	28,272	151,548	70	0	0	155,008	31,243	186,251
Dewatering	3,449,948	28,783	52,507	40,815	177,000	5,433	0	0	3,679,455	75,031	3,754,486
Industrial	38,217	6,446,030	23,941	545	46,900	0	0	0	109,058	6,446,574	6,555,632
Miscellaneous	170,099	1,312,239	22,418	7,342	210	0	0	655	192,726	1,320,237	1,512,963
Agricultural	209,829	1,121	18,077	0	0	0	0	0	227,906	1,121	229,027
Institutional	0	0	22,205	0	0	0	0	0	22,205	0	22,205
Recreational	1,582	63,000	64	0	0	0	0	0	1,646	63,000	64,646
Remediation	55,353	137,705	16,634,213	1,555	0	0	0	0	16,689,566	139,260	16,828,827
Water Supply	27,088	19,047	1,942,581	53,670	0	0	0	2,300	1,969,669	75,017	2,044,686
Totals	4,413,013	8,025,315	18,731,486	161,649	516,534	15,956	0	8,846	23,661,034	8,211,766	31,872,800



Average monthly takings from surface water plants (2000-2005)



Average monthly takings from municipal wells (2000-2005)



Monthly water takings by OMYA on the Tay River (2004-2005)

Appendix F
Modified MOEE 1995 Groundwater Recharge
Methodology

Modified MOEE 1995 Groundwater Recharge Methodology

The MOEE published a methodology (MOEE, 1995) on estimating groundwater recharge for development sites based on infiltration factors multiplied by the water surplus (precipitation – evapotranspiration). The infiltration factors for slope, soil and land cover (see table on last page for MOEE published values) were used to customize a set of factors for the Mississippi-Rideau Region. The sum of these factors multiplied by the water surplus is the resulting groundwater recharge. The details for the M-R Region are given below.

Infiltration Factors for Slope

A 25m Digital Elevation Model updated in 2006 by the Province of Ontario was used to divide slope into three classes: flat, rolling and hilly, with different slope ranges, based on the amount of land area in each range. The slope classes were selected as follows:

- Flat Land: <1.5% slope range (35.5% of study area)
- Rolling Land: 1.5-3% slope range (21% of study area)
- Hilly Land: >3% slope range (43.4% of study area)

The infiltration factors for each slope class were interpolated from the MOEE published values. These factors were used by developing a relationship between slope and the infiltration factors (see figure on last page). The resulting relationship is charted above. Using the MOEE slope relationship, the infiltration factors were selected at the mid-point of the slope range except for Hilly Land (>3%), which exceeded the published slope range. The infiltration factor for Hilly Land was selected at approximately the middle of the land area distribution, which was at a slope of 10%, rather than the mid-point of the slope range, which would have been less representative of the land area and off the chart. The infiltration factors for each slope were determined to be:

- Flat Land = 0.172
- Rolling Land = 0.120
- Hilly Land = 0.073

Infiltration Factors for Soil

Infiltration factors for soil permeability were evaluated using the surficial geology data from the MNR. The surficial soils in the Region include clay, silt, till, sand, organic deposits, and bedrock. The permeability data has been classified categories into ten categories: low, medium, medium-high, high, variable (till, fill, sand and bedrock), and unknown. Infiltration factors were selected for each soils permeability category using the MOEE published values as a guide. The MOEE published values were only available for clay, clay-loam, and sandy loam so some new values were created for the remaining soil types. The final set of infiltration factors are:

- Low (clay, silt) = 0.1
- Low-Medium (till, sand-silt) = 0.15
- Medium (till, silty-sand) = 0.2
- Medium-High (sands) = 0.3
- High (gravel, sands, organic deposits) = 0.4
- Variable (till) = 0.2 (assumed Medium)
- Variable (fill) = 0.4 (assumed High)
- Variable (sand) = 0.35 (assumed between Medium-High and High)
- Variable (bedrock) = see below

- Unknown (no data available) = not included in evaluation

The MOEE published values did not include values for bedrock so a separate set of infiltration factors were created for this as well. The infiltration factors for Precambrian and Paleozoic bedrock were selected below the values for clay. Precambrian is the less porous than Paleozoic and was therefore assigned the lower infiltration value while Paleozoic tends to have more fractures and be more porous so it was assigned the higher infiltration value.

- Precambrian Bedrock = 0.02
- Paleozoic Bedrock = 0.05

Note: There was no soils data available for the western point in the Region so this area is not included in the evaluation.

Infiltration Factors for Land Cover

Using land cover data from the MNR, land cover was divided into infiltration categories based on the MOEE methodology. The infiltration factors for land cover from the MOEE did not cover areas such as urban and aggregate so a separate category for these areas was assigned. The following factors were assigned:

- Low infiltration - urban, aggregate = 0.05
- Medium infiltration - agriculture, pasture, abandoned fields, wetland = 0.1
- High infiltration - forest & plantation = 0.2

Determining the Combined Infiltration Coefficient

The above maps for slope, land cover, and soil permeability was overlaid to determine the combined infiltration coefficient by summing the infiltration factors for slope, land cover and soil permeability as follows:

$$\text{Combined Infiltration Coefficient} = \sum \text{Infiltration Factors (slope, land cover, soil)}$$

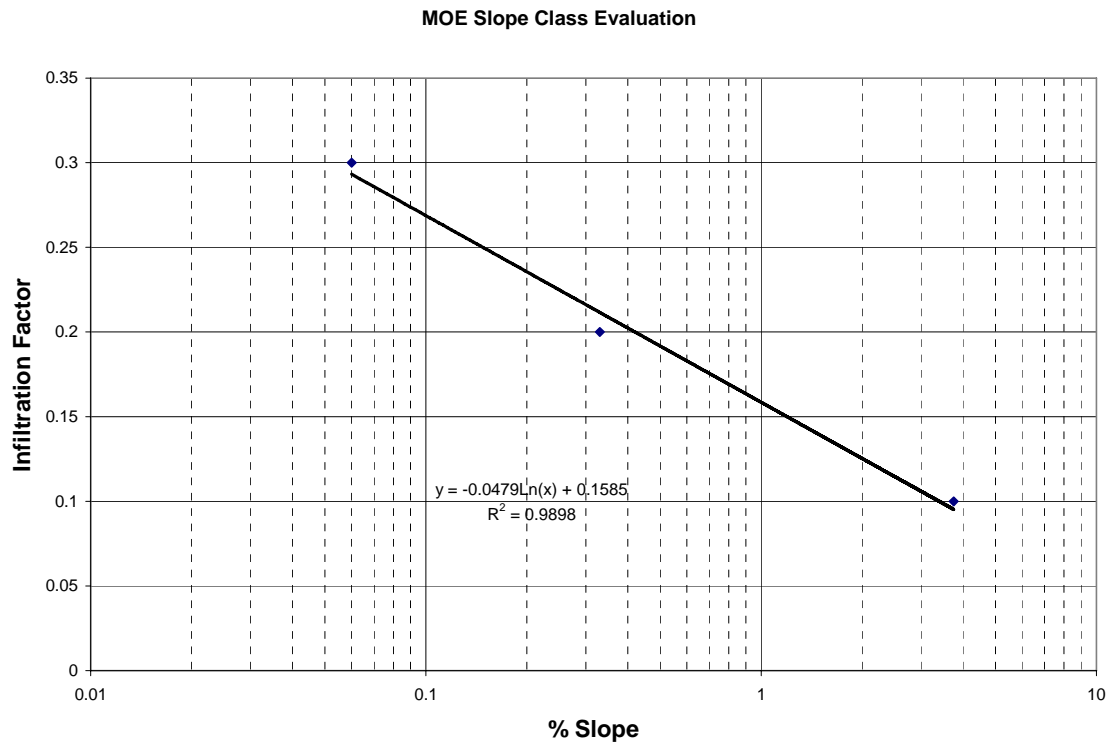
Determining the Groundwater Recharge Volume

The groundwater recharge volume was calculated by multiplying the water surplus (Precipitation – ET) by the Combined Infiltration Coefficient from above as follows:

$$(P - ET) \times \sum \text{Infiltration Factors (slope, land cover, soil)} = \text{Groundwater Recharge Volume}$$

MOEE Infiltration Factors (after Table 2 “MOEE Hydrogeological Technical Information Requirements”, from MOEE, 1995)

Description	Infiltration Factor
TOPOGRAPHY (SLOPE)	
Flat land, average slope not exceeding 0.6 m per km (0.06%)	0.30
Rolling land, average slope of 2.8 m to 3.8 m per km (0.3%-0.4%)	0.20
Hilly land, average slope of 28 m to 47 m per km (2.8%-4.7%)	0.10
SOIL PERMEABILITY	
Tight impervious clay	0.1
Medium combinations of clay and loam	0.2
Open sandy loam	0.4
LAND COVER	
Cultivated Land	0.1
Woodland	0.2



MOEE Slope Class Evaluation (courtesy of Quinte Source Protection Region)

Appendix G

Glossary

Glossary

Aquifer - an underground geologic unit that is capable of storing or yielding a significant quantity of groundwater by pumping or from a spring.

Aquitard - an underground geologic unit that is not permeable enough to supply significant quantities of groundwater, yet can store groundwater

Confined Aquifer - an aquifer that is bound on the top by an aquitard (confining layer) which results in the confined aquifer being under pressure (i.e. greater than atmospheric pressure)

Connectivity - the degree to which aquifers are hydraulically connected such that groundwater can flow between the connected units

Direct Runoff - the portion that goes direct to surface water

Esker - an elongated shape of sand and gravel deposited by the process of glaciers melting

Evapotranspiration – water lost to plant uptake by transpiration and to the atmosphere by evaporation

Graben - a geologic description of a depressed block of land between parallel faults

Groundwater Discharge - the portion of groundwater that flows from the subsurface and into a surface water body

Groundwater Recharge – the portion of precipitation that reaches the groundwater table

Hydraulic Gradient - a hydrogeologic term used to describe the change in hydraulic head per unit distance (i.e. the slope of the water table or potentiometric surface).

Hydraulic Head - the energy that causes groundwater to flow (combination of elevation head and pressure head)

Overburden - unconsolidated sediments that overly bedrock

Permeability - the ability of a geologic formation to transmit water

Physiography - the study of physical features on the earth's surface

Potentiometric Surface - the hydraulic head within a confined aquifer

Static Water Level - the elevation of groundwater at equilibrium with the atmosphere

Stratigraphy - the study of sediment deposition

Topographic Relief - the difference in elevation between high and low areas of land surface

Unconfined Aquifer - an aquifer that is not under pressure and without a confining layer above it, therefore the water surface elevation in an unconfined aquifer is the water table

Water Table - the upper surface of groundwater where subsurface material is fully saturated

Water Surplus – An MOEE term defining the portion of precipitation that is available after evapotranspiration, calculated by Precipitation minus Evapotranspiration.

Precipitation – rain and snow