ICELANDIC RIVER / WASHOW BAY CREEK INTEGRATED WATERSHED MANAGEMENT PLAN
STATE OF THE WATERSHED REPORT CONTRIBUTION

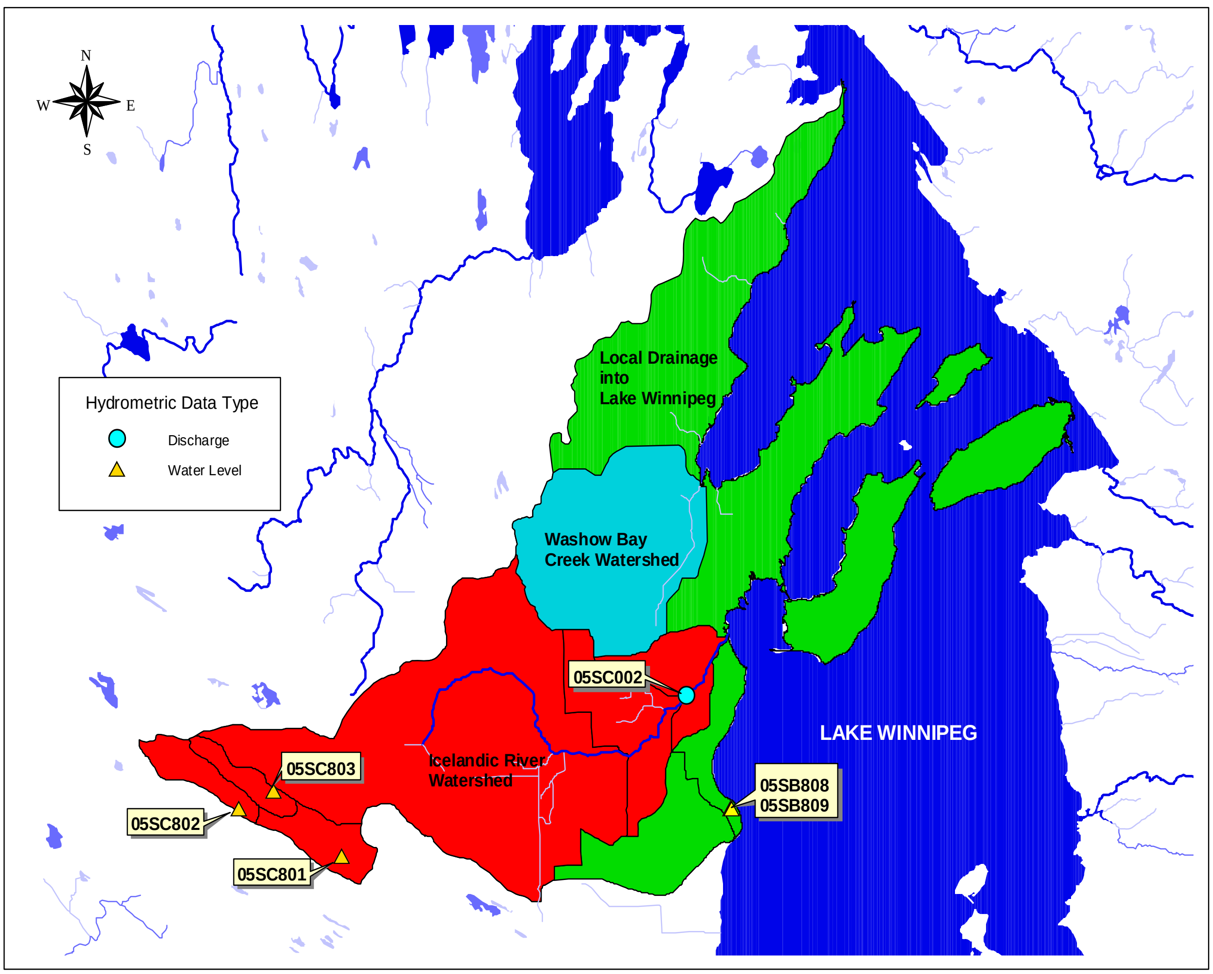
SURFACE WATER HYDROLOGY REPORT

Disclaimer: The hydrologic conditions presented in this report are estimates to indicate the health of the watersheds as of 2006. They should not be used for licensing or design purposes. The trends are based on historical records and are subject to change as more hydrological information becomes available. Factors such as climate change or land use changes could impact the values in the future. Utilization of this information on a specific case by case basis requires detailed analysis by trained professionals and is intended for demonstration purposes only.

Planning Area Boundary:

The Icelandic River/Washow Bay Creek (IRWBC) planning area is on the west side of the south basin of Lake Winnipeg in the Interlake Region. The area extends from north of Berlo, Manitoba to Big Bullhead Point and from east of Clearwater Lake, Manitoba to the shore of Lake Winnipeg. The IRWBC planning area is shown on Figure 1.

Figure 1: IRWBC Planning Area and Location of Hydrometric Gauging Stations



The planning area is made up of a number of individual watersheds. By definition, a watershed is the land area that contributes surface water runoff to a common point. It is separated from adjacent watersheds by a land ridge or divide. Watersheds can vary in size, from a few acres to thousands of square kilometers. A larger watershed can contain many smaller sub-watersheds. On a larger scale, a basin is defined as a collection of watersheds that feed into a common main tributary or large body of water (e.g. the Red River Basin). A sub-basin is a division of a basin and will be made up of multiple watersheds.

Watershed and basin boundaries form a prime ecological unit for:

- information and knowledge management and analysis, and
- water and land use planning and management.

Watershed and basin boundaries are defined through the application of the best available science and modified with documented and verifiable local input. Agriculture and Agri-Food Canada through the efforts of the Prairie Farm Rehabilitation Administration (AAFC-PFRA) and Manitoba Water Stewardship have delineated a system of watershed and basin boundaries for Manitoba. These boundaries have been designed to extend to the mouths of some rivers and streams and along large bodies of water. The IRWBC planning area boundaries were established using this system of watersheds.

Climate:

The IRWBC planning area is considered to be within the Interlake Plain ecoregion which is part of the Boreal Plains ecozone. The region is classified as having a sub-humid low boreal ecoclimate and is characterized by warm summers and cold winters. The mean annual temperature is approximately 1°C. The mean summer temperature is 15.4°C and the mean winter temperature is -14.8°C[1]. The mean annual precipitation is 500mm[2]. Approximately 400mm, or 80%, of this precipitation falls as rain, the rest falls as snow. Approximately 8.5% of the average annual precipitation results in streamflow. The potential mean annual gross evaporation is about 550mm[3], but is considered highly subjective.

Water Courses:

The IRWBC planning area has two main watercourses; the Icelandic River and the Washow Bay Creek. Numerous drains act as tributaries and empty into these two watercourses. The topography in this region is flat to rolling.

The Icelandic River watershed at the mouth at Lake Winnipeg has a gross drainage area of approximately 1336 km^2 and drains in an easterly direction from its headwaters in the Spruce Lake system to its outlet at Lake Winnipeg, northeast of Riverton, Manitoba. This watershed is shown in red on Figure 1.

The Washow Bay Creek watershed at the mouth at Lake Winnipeg has a gross drainage area of approximately 400 km^2 and drains in a north easterly direction from its headwaters around Otter Lake to its outlet at Lake Winnipeg, north of Washow Bay, Manitoba. This watershed is shown in light blue on Figure 1.

[1] Environment Canada, Canadian Climate Normals or Averages 1971-2000
[2] Agriculture and Agri-Food Canada, Mean Annual Precipitation in the Canadian Prairies for the Standard 30-Year Period 1971-2000
[3] Agriculture and Agri-Food Canada, Mean Annual Gross Evaporation in the Canadian Prairies for the Standard 30-Year Period 1971-2000

Drainage of the remainder of the IRWBC planning area is accommodated by local drains which do not empty into either one of the two main watercourses. Instead, the majority of these local drains empty directly into Lake Winnipeg. These areas are shown in green on Figure 1.

Hydrometric Data:

The collection of hydrometric data is critical to the understanding of the availability, variability and distribution of water resources and provides the basis for responsible decision making on the management of this resource. Historic hydrometric data provides the basis for understanding the potential extent and limitation of the resource. Water level and stream flow data collected under the Canada-Manitoba Hydrometric Agreement, which is part of a National Hydrometric Program, supports activities such as policy development, operation of water control works, flow forecasting, water rights licensing, water management investigations and hydrologic studies, ecosystem protection and scientific studies. Environment Canada, the Province of Manitoba and Manitoba Hydro operate 143 discharge and 133 water-level gauging stations under this Agreement.

Streamflow and lake level data has been recorded at six locations within the IRWBC for varying time periods since the 1950s. The locations of the six stations are shown on Figure 1. Table 1 provides information relating to the type of data collected, the years of operation and the operating periods for each station.

Streamflow (Discharge) Data:
Historic streamflow data is available on the Icelandic River. The respective gross drainage area for Icelandic River near Riverton (05SC002) is shown on Figure 1. The gauging station operated annually during the March to October period from the late 1950s to the mid 1990s. In 1997, the operating period of the gauge was reduced to the spring freshet period, March to May, due to program funding reductions.

Water Level Data:
Sporadic water level data is available on several of the lakes or swamps in the IRWBC planning area. Water level measurements are not recorded on a regular basis, but were taken by Regional staff about once a month.

Realtime water level data for Icelandic River near Riverton (05SC002) is available from Environment Canada's website: http://scitech.pyr.ec.gc.ca/waterweb/formNav.asp

Table 1: IRWBC Hydrometric Gauging Station Data

Station Number	Station Name	Years of Operation	Period of Operation	Type of Data	Gross Drainage Area in km^2
05SC002	Icelandic River near Riverton	1958 to 1996	March to October	Discharge	1236.7
		1997 to Present	March to May	Discharge	
05SB809	Einarson Swamp near Malo Lake	2003 to 2005	Sporadic	Water Level	Not Available
05SB808	Malo Lake near Lake Winnipeg	2003 to 2005	Sporadic	Water Level	Not Available
05SC801	Buffalo Lake near Poplarfield	1983 to 1993	Sporadic	Water Level	153.5
05SC803	Oak Lake near Poplarfield	1984 to 1993	Sporadic	Water Level	37.4
05SC802	Spruce Lake near Poplarfield	1984 to 1993	Sporadic	Water Level	51.3

Streamflow Characteristics:

A) *Icelandic River*

The daily discharge data for the gauging station on the Icelandic River was statistically analyzed to determine runoff characteristics of the IRWBC planning area. The results of the analysis are presented as follows:

The streamflow data for Icelandic River near Riverton (05SC002) is representative of streams in the IRWBC planning area. The gross drainage area of station 05SC002 is equal to 1236.7 km^2. The station has an effective to gross drainage area ratio equal to 0.84. The gross drainage area boundary is defined as the area at a specific location, enclosed by its drainage divide, which might be expected to entirely contribute runoff to that specific location under extremely wet conditions. The effective drainage area is that portion of a drainage area which might be expected to entirely contribute runoff to the main stem during a median (1:2 year event) runoff year under natural conditions. This area excludes marsh and slough areas and other natural storage areas which would prevent runoff from reaching the main stem in a year of average runoff. The effective to gross drainage area ratio is an indication of how well an area is drained. A perfectly drained area has a ratio of one.

The mean monthly discharge data for the Icelandic River is shown in Table 2. Based on available data, the average runoff during the period 1959 to 1996 is equal to 52,450 dam^3 or an equivalent depth of 42.4mm over the gross drainage area for station 05SC002. The annual runoff depths for the Icelandic River from 1958 to 2005 are shown on Figure 2. They range from a minimum of 6 mm in 1994 and 2003 to a maximum of 160 mm in 1974. This figure also illustrates the variability in runoff from year to year, as well as the years above and below average runoff.

Figure 2: Equivalent Annual Runoff Depths for the Icelandic River (05SC002)

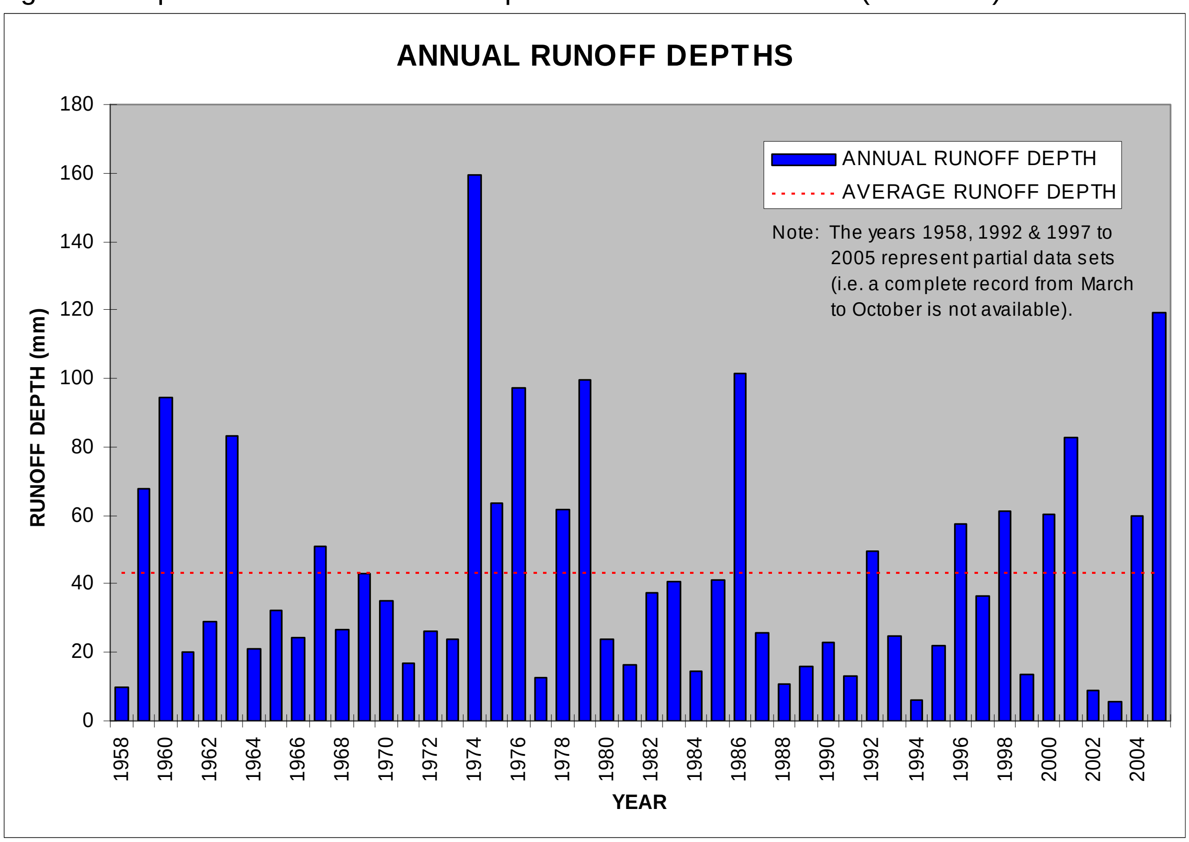


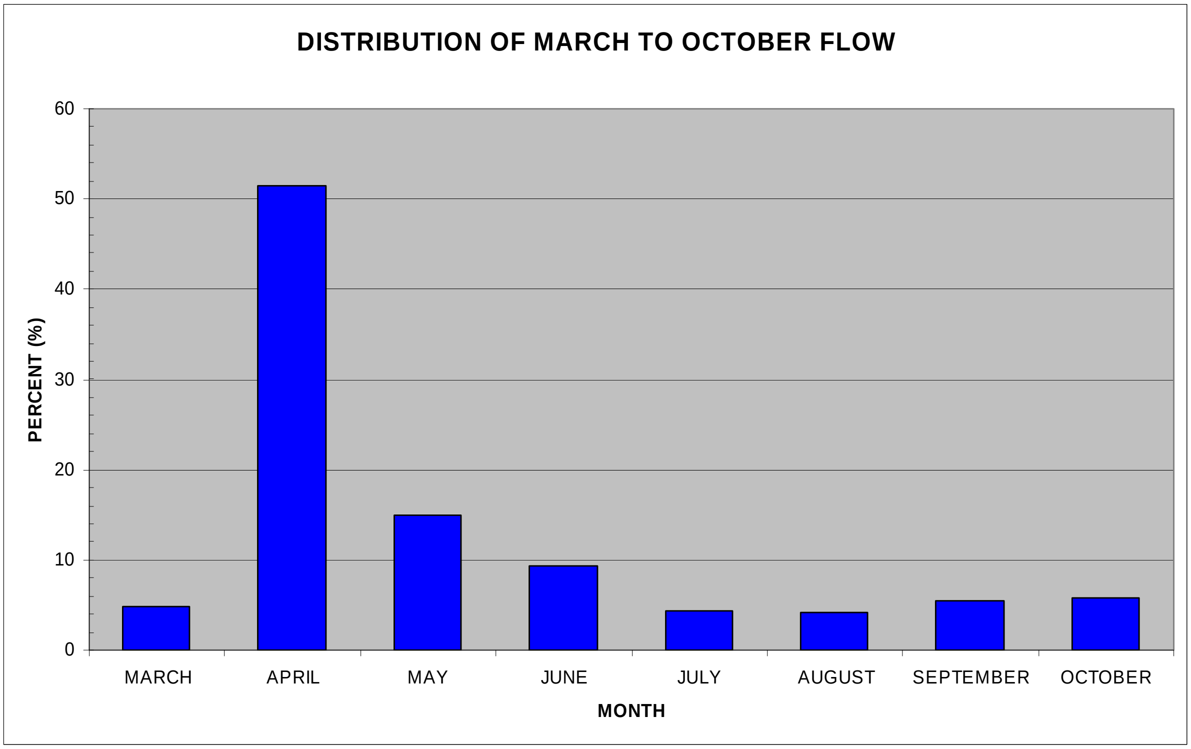
Table 2: Icelandic River near Riverton (05SC002)

	Mean Monthly Discharge (m^3/s)												Annual Volume
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**dam^3**
1958	-	-	-	-	-	0.24	3.20	0.29	0.29	0.46	-	-	11,950
1959	-	-	0.01	13.80	11.20	3.81	0.83	0.36	0.36	1.54	-	-	83,930
1960	-	-	0.20	34.30	7.20	1.49	0.40	0.35	0.35	0.41	-	-	116,560
1961	-	-	1.13	5.50	1.50	0.36	0.19	0.11	0.30	0.34	-	-	24,710
1962	-	-	0.07	7.74	2.30	1.88	0.29	0.54	0.30	0.53	-	-	35,710
1963	-	-	1.33	14.10	2.60	18.50	1.44	0.60	0.49	0.48	-	-	103,030
1964	-	-	0.21	4.74	2.03	1.04	0.38	0.50	0.48	0.52	-	-	25,980
1965	-	-	0.08	6.12	4.48	2.35	0.83	0.41	0.53	0.45	-	-	40,090
1966	-	-	0.27	4.51	4.47	0.71	0.60	0.25	0.27	0.27	-	-	29,950
1967	-	-	0.19	18.60	3.41	0.70	0.46	0.30	0.16	0.27	-	-	62,820
1968	-	-	0.50	5.50	1.32	0.62	1.22	0.87	1.61	1.01	-	-	33,210
1969	-	-	0.25	15.50	1.77	1.20	0.43	0.36	0.48	0.49	-	-	53,330
1970	-	-	0.16	10.10	4.28	0.87	0.38	0.24	0.22	0.25	-	-	43,220
1971	-	-	0.13	5.88	0.48	0.41	0.43	0.20	0.18	0.23	-	-	20,680
1972	-	-	0.13	10.20	0.74	0.33	0.34	0.26	0.22	0.24	-	-	32,440
1973	-	-	1.57	0.70	0.36	1.59	0.44	0.59	2.62	3.41	-	-	29,770
1974	-	-	0.30	49.80	21.50	2.40	0.35	0.37	0.31	0.35	-	-	197,350
1975	-	-	0.19	4.61	1.16	0.60	0.37	9.40	9.92	3.57	-	-	78,550
1976	-	-	0.27	41.70	2.32	1.01	0.49	0.21	0.17	0.19	-	-	120,490
1977	-	-	0.09	0.98	0.50	0.62	0.76	0.23	1.79	0.99	-	-	15,650
1978	-	-	0.22	24.70	1.99	0.94	0.56	0.31	0.33	0.33	-	-	76,460
1979	-	-	0.18	30.30	11.10	3.63	0.77	0.31	0.44	0.30	-	-	123,010
1980	-	-	0.21	7.41	0.49	0.26	0.23	0.55	1.02	1.02	-	-	29,220
1981	-	-	1.26	1.06	0.61	0.76	0.27	0.46	1.25	1.96	-	-	20,150
1982	-	-	0.54	9.83	1.67	1.59	1.82	1.18	0.38	0.72	-	-	46,470
1983	-	-	0.19	13.90	0.99	2.45	1.17	0.18	0.14	0.27	-	-	50,230
1984	-	-	0.41	2.67	1.08	1.26	0.31	0.20	0.23	0.60	-	-	17,750
1985	-	-	1.80	6.38	0.75	0.40	0.43	6.09	1.20	2.27	-	-	51,060
1986	-	-	3.98	30.20	11.00	1.02	0.68	0.32	0.28	0.31	-	-	125,260
1987	-	-	0.36	9.96	0.28	0.34	0.38	0.23	0.19	0.49	-	-	31,840
1988	-	-	0.38	2.76	1.05	0.22	0.24	0.11	0.13	0.19	-	-	13,320
1989	-	-	0.06	1.24	0.41	4.98	0.29	0.12	0.14	0.20	-	-	19,390
1990	-	-	0.57	7.01	1.20	1.15	0.51	0.07	0.11	0.22	-	-	28,290
1991	-	-	0.11	2.28	1.53	0.68	0.39	0.06	0.38	0.65	-	-	15,970
1992	-	-	0.25	19.10	2.19	0.37	1.10	0.41	-	-	-	-	61,050
1993	-	-	1.34	4.28	1.49	0.38	0.72	1.11	1.57	0.67	-	-	30,410
1994	-	-	0.11	0.82	0.50	0.20	0.52	0.10	0.22	0.34	-	-	7,400
1995	-	-	5.02	2.95	1.42	0.31	0.09	0.22	0.12	0.23	-	-	27,440
1996	-	-	0.06	12.60	10.90	1.79	0.86	0.26	0.23	0.24	-	-	70,920
1997	-	-	0.10	13.50	3.19	0.40	-	-	-	-	-	-	44,850
1998	-	-	1.75	23.90	2.66	0.82	-	-	-	-	-	-	75,880
1999	-	-	1.43	2.49	1.77	0.66	-	-	-	-	-	-	16,730
2000	-	-	15.60	4.66	1.34	6.55	-	-	-	-	-	-	74,430
2001	-	-	0.24	30.00	6.53	2.49	-	-	-	-	-	-	102,340
2002	-	-	0.06	3.30	0.79	-	-	-	-	-	-	-	10,830
2003	-	-	0.99	1.29	0.38	-	-	-	-	-	-	-	7,000
2004	-	-	1.90	23.50	1.10	2.01	-	-	-	-	-	-	74,160
2005	-	-	0.18	27.30	7.21	10.20	11.30	-	-	-	-	-	147,250
Minimum	-	-	0	1	0	0	0	0	0	0	-	-	7,000
Maximum	-	-	16	50	22	19	11	9	10	4	-	-	197,350
Mean	-	-	1	12	3	2	1	1	1	1	-	-	52,450

Note: Mean monthly discharges were calculated using the entire period of record.
Mean annual volume was calculated using the years 1959-1996.

The bar graph on Figure 3 illustrates the distribution of annual runoff for the Icelandic River in the March to October months. It can be seen that on average the majority of runoff, 52%, occurs in April as a result of snowmelt and early spring rains when the watershed is still saturated. The maximum daily discharge of each year, as well as the date it occurred, was reviewed. It revealed that in 32 of the 38 years (1959-1996), the annual peak flow occurred during the spring runoff, and in 6 out of the 38 years the peak flow occurred during the summer growing period.

Figure 3: Distribution of Annual Runoff for the Icelandic River (05SC002)



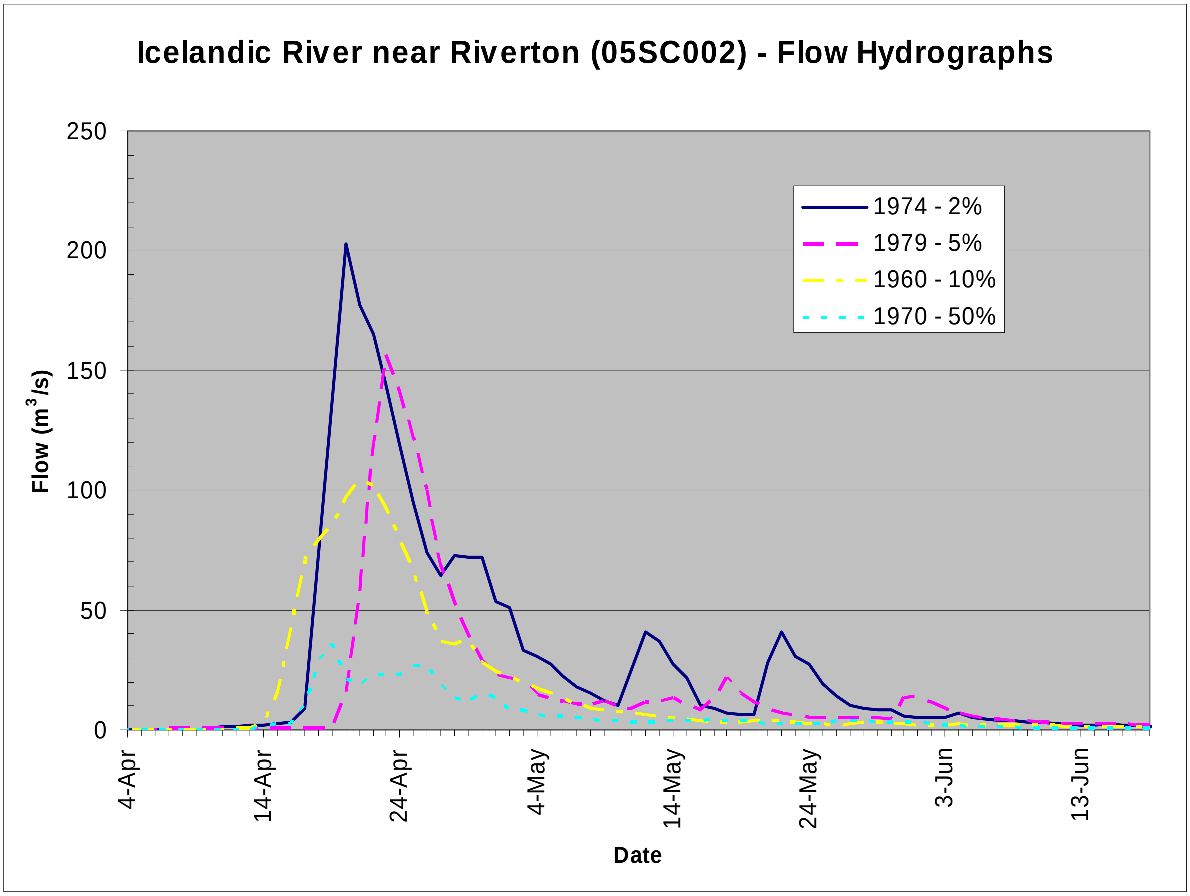
The results of a statistical analysis of the Icelandic River data are shown in Table 3. The expected annual peak discharge, runoff volume and corresponding unit depth for selected frequencies are given.

Table 3: Frequency of Flood Flows for the Icelandic River (05SC002)

Flood Frequency	Annual Peak Discharge (m^3/s)	Annual Runoff Volume (dam^3)	Unit Runoff (dam^3 / km^2)
1%	245.6	238,200	192.6
2%	201.2	195,300	157.9
5%	147.4	144,400	116.8
10%	110.3	109,800	88.8
50%	35.9	40,310	32.6
80%	15.7	20,220	16.3
90%	9.9	13,950	11.3

Icelandic River recorded flow hydrographs for years representative of the 2%, 5%, 10%, and 50% floods are plotted on Figure 4. The spring runoff hydrographs show minimal variability from the date the peak discharge occurs. In general, the peak occurs between April 1 and April 23 with some occurrences in late March.

Figure 4: Icelandic River near Riverton (05SC002) - Spring Runoff Hydrographs



B) Washow Bay Creek

No hydrometric data is available within the Washow Bay Creek drainage area and as such a statistical analysis is not available. Due to their close proximity and similarities in climate, soils and land use distribution, and topography, the Washow Bay Creek watershed should exhibit hydrologic characteristics similar to the Icelandic River watershed.

C) Summary of Findings

In summary, analysis of the available streamflow data in the IRWBC indicates the following:

- Streamflow varies considerably over the months and years.
- Annual streamflow usually peaks in April and May during the spring runoff period.
- On average, 70 to 75% of the annual runoff volume occurs in the period from the beginning of March to the end of May.
- The Icelandic River did not experience periods of zero flow and as a result is classified as a perennial stream.
- On the major watercourses, spring flooding is more significant than flooding from summer precipitation events. It is the smaller drainage areas (less than 30 km^2) that are sensitive to rainfall events. Localized flooding can occur in the smaller poorly drained areas from excessive rainfall events.
- Although different in size, the Icelandic River and Washow Bay Creek watersheds should exhibit similar general runoff characteristics.

Water Allocation:

The issuance of a Water Rights License requires the determination of the availability of water for human use allocation and the determination of instream flow needs (an estimate of a threshold flow above which a user may pump water from a stream). The allocation procedure depends on whether the stream is considered to be perennial or intermittent.

Intermittent:

The total spring volume (March to May) of water available for allocation on intermittent streams is based on the eight out of ten-year (80%) risk level. This would apply to smaller tributary streams.

On intermittent streams, one half of the spring volume of water is available for human use in eight out of ten years. The other half is allocated for maintainance of stream "health" or to maintain the ecological integrity of the stream system, referred to as an Instream Flow Need (IFN). The IFN is a specified minimum instantaneous flow that determines when a user may pump from the stream. Only when the flow in the stream is greater that the IFN can pumping occur. The IFN is computed based on daily stream flow records to ensure that at the 80% spring volume, one half of the total flow goes to protecting the stream's environmental needs with the other half being allocable.

Perennial:

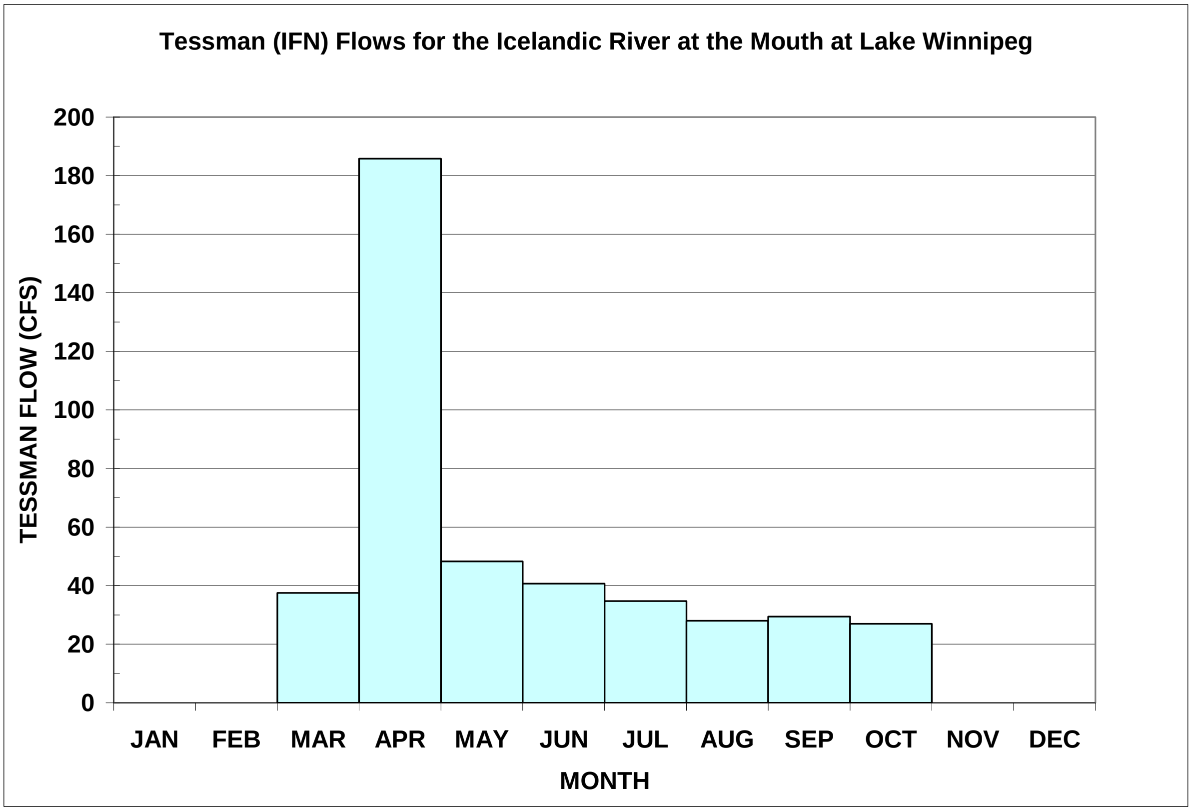
The Tessman Method has been adopted in Manitoba for determination of the IFN on perennial streams. This method establishes a range of instream flow recommendations for each month based on the following criteria:

1. For months where the average recorded flow for the period of record is less than 40% of the overall mean annual flow, the minimum instream flow is equal to that average monthly flow.
2. If the mean monthly flow is between 40% and 100% of the overall mean annual flow then the minimum instream flow is equal to 40% of the mean annual flow.
3. For months where the mean monthly flow is greater than the mean annual flow, then the minimum instream flow is equal to 40% of that month's overall mean flow.

Under the 80% risk level, the volume of water available for human use allocation is the 80th percentile value from a duration curve of available volumes after the IFN requirements have been satisfied.

The Icelandic River is considered to be a perennial stream. The Tessman method was applied in determining an allocable volume of water for the Icelandic River at the mouth. The Icelandic River near Riverton (05SC002) was used as the index station. Daily flows were transposed to the mouth of the river (where it empties into Lake Winnipeg) using a gross drainage area ratio. Application of the Tessman method indicates that the allocable volume of water for the Icelandic River watershed at the mouth is equal to 8125 dam^3. The instream flow recommendations on a monthly basis are shown in Figure 5. Again, these values were estimated based on data from the Icelandic River near Riverton (05SC002) station and adjusted based simply on a gross drainage area ratio.

Figure 5 – Plot of Tessman Flows for the Icelandic River at the Mouth at Lake Winnipeg



The allocable volume of water and instream flow need values are estimates only for the Icelandic River at the mouth to indicate the health of the watershed as of 2006. They should not be used for design or licensing purposes. These values should be reviewed as additional hydrologic data becomes available. The determination of the availability of water for allocation and instream flow needs for other locations in the Icelandic River Watershed require site specific analysis. Many variables, including hydrologic conditions, selection of index station and the corresponding period of record, watershed characteristics including landuse, soils and topography, location of the site, and other factors are considered in the analysis and can be very complex, especially in an ungauged watershed, or certain portions of a large gauged watershed.

Flood Risk Mapping Program:

Flooding is a serious concern to many residents of Manitoba. Although the public is probably more aware of flooding in the Red River Valley, flooding also occurs along numerous other rivers, streams and lakes. Damages and hardships resulting from flooding have resulted in large costs to the public. Controlling the use of areas prone to flooding is one effective way of reducing these damages, as are certain structural works such as dikes or diversions.

In an attempt to reduce flood damages, Canada and Manitoba signed a General Agreement Respecting Flood Damage Reduction on December 20, 1976. One aspect of the Agreement provided the formal delineation and mapping of a communities' flood risk area which are areas inundated by a design flood. The design flood for the flood risk mapping program was the greater of the 100-year flood (in other words, has a 1% chance of being equaled or exceeded in any given year) or the largest recorded flood. The flood risk area was divided into two zones for most of the mapped communities: the floodway and the floodway fringe. The floodway is not a manmade structure, but in this case refers to the portion of the flood risk area where the water is the deepest and most destructive. The floodway is the area into which the flow could be confined, while causing only a moderate rise in water levels upstream, and where the water is one metre or more deep. Floodway areas were designated to indicate where any type of new construction should not be permitted. The remaining portion of the flood risk area is called the floodway fringe. In this outer zone, floodwaters tend to move more slowly, and are shallower. The floodway fringe could be completely filled in or developed without causing any problems upstream. Each of the two zones is treated differently regarding development restrictions.

Under the terms of the General Agreement, Canada and Manitoba agreed to discourage any new development from occurring in any designated floodway area. Within a floodway area, the two governments agreed not to finance or engage in any further projects. They agreed to withhold flood assistance payments for flood damages to any structures constructed there after the official designation of the floodway area. At the same time, they agreed to encourage suitable land use, such as recreational and agricultural uses, and appropriate zoning aimed at restricting development in those areas. With respect to the floodway fringe area, it was agreed that restrictions concerning financial assistance or concerning development were not to be applied to undertakings that were adequately flood proofed. If the new development did not meet proper flood proofing requirements, financial support from government sources would not be available and assistance payments would not be made in the future.

Flood risk areas for seventeen communities within Manitoba were designated. Flood risk mapping was completed during the 1980s and was based on available hydrologic data at that time. A study was undertaken to determine the flood risk area of the Icelandic River at the community of Arborg.

Conversion Units:

Temperature: °C = 5/9 (°F – 32)

Length: 1 mm = 0.039370 inches

Area: 1 km^2 = 0.38610 mi^2

Volume: 1 dam^3 = 0.8107 acre-ft

Flow: 1 m^3/s = 35.315 ft^3/s