General Hydrometric Station Information Sheet

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General

Since 1968, there have been several changes in agency structure while the function for key working groups involved have remained the same. For simplicity throughout this discussion, the following acronyms have been used with no attempt to define the chronology of the name changes that occurred to agencies, affiliates or working groups.

IISD-ELA: International Institute for Sustainable Development - ELA

ELA: Experimental Lakes Area

ELA-Hyd: Experimental Lakes Area Hydrology Program or Personnel

DFO: Department of Fisheries and Oceans, Freshwater Institute, Winnipeg

ESD: DFO, Science, Environmental Science Division, FWI, Winnipeg

FRB: Fisheries Research Board

FWI: Freshwater Institute, Winnipeg

EC: Environment Canada

MSC: Environment Canada, Meteorological Service of Canada

WSC: Environment Canada, Atmospheric Monitoring and Water Survey Directorate, Water Survey Monitoring and Operations Branch

U of M: University of Manitoba, Department of Civil Engineering and Department of Geology and Earth Sciences

The Hydrometric Program

This discussion is intended to support hydrometric record found in the ELA database. Three previously published data reports provide similar information current to the end of 1987. Users of these data sets are encouraged to read this information sheet in order to gain the proper perspective for the hydrology of the ELA and the specifics of using the data.

Hydrological work began at ELA in the winter of 1968/69 with the planning of the first monitoring stations. It is important to note that at that time, ELA and DFO did not have "in-house" expertise in hydrology. To fill that gap, WSC and the U of M where invited to advise and participate in the ELA program. Early hydrological investigations were carried out jointly through an arrangement with the U of M and WSC. In 1975, DFO created positions for a Research Scientist and Hydrometeorological Technologist thereby moving the U of M contribution "in-house". WSC involvement continued, in all years, until March 31, 1985 with the exception of 1974. The WSC contribution included construction services, technical support, instrumentation and determination of mean daily discharge and mean daily lake level record as well as some financial support. The WSC continued to provide the loan of 22 water level recorders after 1985 which have since been decommissioned as obsolete.

From 1969 to end of 2018, 1,010 station years of hydrometric record have been collected from 48 hydrometric stations that have been operated in 28 different lake watersheds. A summary of stations and years of record during the 1969 to 2018 period is provided in this document.

Cross reference with Water Survey of Canada station numbers:

Hydrometric stations that are included in the Water Survey of Canada data base are identified in the following table. Data for these stations ceased to be included in the WSC data base a few years after the withdrawal of their services in 1985.

ELA Location	ELA Sub-location	ELA Station	WSC Name	WSC #
114	WW	HQ114	Lake 114 Outlet Near Kenora	05PD014

114	LA	HW114	Lake 114 Near Kenora	05PD027
120	WW	HQ120	Lake 120 Near Kenora	05PD016
223	WW	HQ223	Lake 223 Near Kenora	05QD017
223	LA	HW223	Lake 223 Near Kenora	05QD021
224	WW	HQ224	Lake 224 Outlet Near Kenora	05QD018
225	WW	HQ225	Lake 225 Outlet Near Kenora	05QD019
226	WW	HQ226	Lake 226 Outlet Near Kenora	05QD015
227	WW	HQ227	Lake 227 Outlet Near Kenora	05QD008
227	LA	HW227	Lake 227 Near Kenora	05QD009
230	WW	HQ230	Lake 230 Outlet Near Kenora	05QD011
239	WW	HQ239	Lake 239 Outlet Near Kenora	05PD023
239	LA	HW239	Lake 239 Near Kenora	05PD021
239	NWT	HQNW	Northwest Tributary to Lake 239 Near Kenora	05PD022
239	UET	HQUET	Lake 239, Upper East Inlet, Near Kenora	05PD025
239	ET	HQE	Lake 239, Lower East Inlet, Near Kenora	05PD024
239	NET	HQNE	Lake 239, Northeast Inlet, Near Kenora	05PD031
240	WW	HQ240	Lake 240 Outlet Near Kenora	05PD015
261	WW	HQ261	Lake 261 Outlet Near Kenora	05QD012
265	WW	HQ265	Lake 265 Outlet Near Kenora	05QD013
302	WW	HQ302	Lake 302 Outlet Near Kenora	05QD023
302	LA	HW302	Lake 302 Near Kenora	05QD022
303	WW	HQ303	Lake 303 Outlet Near Kenora	05PD019
303	LA	HW303	Lake 303 Near Kenora	05PD020

304	LA	HW304	Lake 304 Near Kenora	05PD018
305	LA	HW305	Lake 305 Near Kenora	05QD007
470	WW	HQ470	Lake 470 Outlet Near Kenora	05PD017
661	WW	HQ661	Lake 661 Outlet Near Kenora	05PD028

Hydrometric data

Surface water data: The lake level and discharge data in this report are surface water data. It is important to understand the difference between outflow and surface water data when working with streamflow records, particularly lake outflow data. The true or total outflow from a lake or flow between two lakes may include a groundwater seepage (subsurface flow) component that is not easily detectable in addition to that which is visible on the surface as open channel flow.

Subsurface flow: To date, only surface water data have been included in the ELA data base. Subsurface flow or groundwater seepage may not exist for most ELA study lakes and is likely insignificant in others. Smooth continuous bedrock control at lake outlets is usually the case. However, the assumption that no groundwater flow exists should not be made without examination of the site and hydrometric record if available. For example, examination of Lake 224 surface water flow data raised suspicion of a groundwater seepage loss from the lake that was later confirmed by data from a previous experiment involving a whole lake spike addition of tritium. It was estimated that approximately 12,000 m^3 per year was lost by seepage from lake 224 to adjacent Lake 222. This contribution was approximately 2% of the volume of Lake 222 per year or about 15% of the average reported Lake 224 surface outflow (Beaty 1984). As a second example, a small seepage inflow has also been located on the east beach of Lake 240 (see discussion for Lake 240). Where possible, a general assessment of each station with respect to the potential or presence of groundwater seepage has been included in the station discussions that follow where relevant.

The Lake 239 watershed is the only ELA basin where detailed groundwater investigations have been carried out. These investigations were mainly carried out during the early years (1969 to 1974). Methods, drill logs and groundwater wells and piezometer locations have been previously reported (Beaty 1981, Part III). Methods and results for hydraulic conductivity and groundwater flow estimates in the Rawson Lake Watershed have also been previously summarized in an unpublished report (Newbury and Cherry, April 1971). From these early investigations it was concluded that "it is apparent that the seepage inflows and outflows of Rawson Lake will not significantly alter the lake water budget quantities".

In the years that followed, other studies that included groundwater investigations have been carried out by various external researchers at lakes 979, 632, 115 and 658. These works are not within the scope of this document. Some findings have been published but the data has not been incorporated in the ELA data base.

Period of record: Most of the ELA hydrometric stations (discharge and lake level) are operated as "seasonal" stations that are operated generally from April 1 to October 31 each year. The only stations that have been heated for winter operation to provide 12-month record were Lake 239 Outflow, Lake 239 Lake Level, Lake 470 Outflow, and, until 1988, Lake 240 Outflow (see Winter flow).

Winter flow: In the early years of the project, winter flow was somewhat neglected as a major component of the annual water budget. Initially, it was assumed that winter flow from small ELA headwater lakes would be relatively minor with almost all flow occurring during the April to October period. Also, in the early years of the project, equipment such as reliable snowmobiles, all-terrain vehicles and 4-wheel drive trucks were not available as in present day. Winter excursions were much more difficult to carry out.

In winter, all ELA lakes freeze over and accumulate a snow pack on the ice surface. As winter progresses, inflow from the terrestrial area surrounding the lake diminish to zero or near zero due to freezing temperatures and an accumulating snow cover that does not melt until April. ELA does not experience mid-winter melt-runoff events. Because small hydrometric stations are difficult to service and impractical to operate in winter, most of the stations were operated from late March to early November for complete April to October (seven months) record. However, it became apparent that, in some cases, it was possible for winter flow to be a substantial portion of the annual flow. Analysis of the first 18 years of Lake 239 record showed that 19% of the total annual flow occurred in the November to March five-month winter period. Whole lake water budgets calculated for Lake 226 for the years 1973 to 1980 suggested the same average winter flow rate as for Lake 239 for the same period. Observations indicate that small winter flows often exist from ELA lakes. This flow is caused and sustained in a couple of ways. First, if a lake level is controlled by a beaver dam located at its outlet, flow will likely occur as seepage through or under the dam even in winter as has been the case in many years on lakes 223, 224, 226, 227, 302, 303, 373, 470 and 661. And secondly, as winter progresses, a winter snow pack accumulates on the ice surface that exerts downward pressure that causes the displacement of lake water from beneath the ice sheet that is forced out of the outflow. The stream channel, once iced over, often develops a deep insulating snow cover which allows flow to occur beneath even at air temperatures below -30 ^oC.

Since 1980, efforts have been made to obtain monthly manual measurements of flow during the winter. These winter values are included in the database with a qualifier code to indicate a manual observation. These observations, along with data recorded at heated all-season stations and climate record, provide the basis for winter flow estimates that appear in the ELA database. Similarly, winter estimates have been flagged with a qualifier code to differentiate them from monitored record (see "Qualifier codes").

<u>Units of measure and accuracy:</u> In Canada, metrification occurred in 1978. Prior to 1979, the unit of measure for discharge was cubic feet per second (f^3s^{-1}) reported to two decimal places. Flow volumes were reported in acre-feet reported to one decimal place. The unit of measure for lake level was feet reported to two decimal places. All data collected and previously reported in English units have been converted for the ELA database for consistency. Hydrological units are as follows:

- Discharge = cubic metres per second (m^3s^{-1}) reported to 4 decimal places
- Flow volume = cubic metres (m^3) reported to the nearest whole cubic metre
- Lake level (stage) = metres (m) reported to 3 decimal places (1 mm precision).

Qualifier codes: Letter codes were used to qualify discharge and water level data where necessary. These codes are defined as follows.

A – manual observation: Mean daily flow or water level were coded "A" to indicate that the value was an estimate based on one or more manual gauge readings or in combination with partial recorded record for that day,

B - ice conditions: The presence of ice in the channel or structure affected, or may have affected, the stage-discharge relationship. The value reported is a "best estimate" due to the presence of ice,

C – capacity exceeded: A major or unusual runoff event occurred resulting in flow that exceeded the station capacity for all or part of the day reported. This code indicates that flow for the reported value was in the overflow range of the gauging structure or outside of the range of calibration and should be regarded as a "best estimate",

D - beaver activity: Mean daily discharge values were coded "D" when beaver have placed debris or constructed a dam in directly in the gauging structure resulting in false recorded stage data. Estimates were made for missing or suspicious data during the period of beaver influence. If estimates were not possible, the entry in the ELA Data Base will be "null". In either case the entry was coded "D",

D1 – beaver activity: Beaver have constructed a dam above or below the gauging structure that may have influenced the "best estimate" reported value,

D2 – beaver activity: A beaver dam located above the gauging station was opened resulting in an increase in flow not associated with a normal precipitation event but indicated a valid flow value,

E - estimated value: This indicates a value that was determined by some indirect method such as interpolation, graph of observed readings, discharge measurement, comparison with other stations or by considering meteorological data,

F- frozen conditions: The hydrometric gauging station was frozen resulting in missing record. Estimates were made when possible.

H- FLUDEX effect: This code applies to the Lake 239 NW Inflow station only. From 1999 to 2003 inclusive, The Upland Flooding Experiment (FLUDEX) operated a reservoir (Site 2) at the top end of the Northwest Sub-basin of the Lake 239 Watershed. While the reservoir discharged to Roddy Lake, seepage and end-of-season draining resulted in additional water, originating from Roddy Lake, to the NW Sub-basin. This additional water is included in the reported values for those station years of record.

I – linear interpolation: This indicates a value that was estimated by linear interpolation between two manual observations. In most cases, estimates by interpolation were made to complete data sets during stable low flow periods (i.e. winter) that were not influenced by precipitation events or other hydrologic events in order to provide complete data sets for analyses such as chemical mass balances. Mean daily values that could not be estimated by interpolation resulted in "null" values in the data base that were coded "M".

L – leakage: This indicates that leakage or seepage under or around a weir or flume was present and that an adjustment was made to the reported value.

M - missing record: Mean daily values that could not be reliably estimated were considered "missing record" resulting in a "null" entry in the data base,

R – regulated flow or water level: This indicates that the reported discharge or water level value was influenced by human regulation for experimental or other purposes. This code is intended for "natural" systems that are not normally regulated and is reserved for situations that last only days or weeks in duration. Stations that were regulated for longer periods (one or more seasons) are noted in station discussions.

S – unnatural flow or water level: This code indicates a mean daily value that was influenced by unnatural causes resulting water being removed or foreign water being added to the system. Examples have included pumped water for irrigation (NE Sub-basin), pumped water to fill FLUDEX reservoirs (NW Sub-basin), and the siphoning of water from Lake 226.

U – controlled flow release: This code indicates a value that was influenced by a manual flow release of water such as spilling water impounded by a dam.

Survey Benchmarks:

Where long-term or continuous water level records are to be collected, it is necessary to establish and frequently refer to local survey benchmarks. Since there are no survey benchmarks with an established elevation above mean sea level (MSL) in the ELA area, survey benchmarks at ELA have been assigned arbitrary elevations that are not relative to MSL. Approximate MSL elevations are shown on 1:50,000 scale National Topographic Survey Maps for some lakes and is the reference datum for the land contours provided on those maps. Local survey benchmarks have been established in most ELA watersheds and have been assigned elevations relative to an arbitrary datum that are specific, in most cases, only to that particular watershed. The exception is for benchmarks 1 to 24a, 45 and 46 which are all relative to BM #1 which was established by WSC on February 25, 1969 with an assigned elevation of 30.480 m (100.00 ft.). BM #1 is approximately 391 m above MSL.

The following benchmarks were destroyed by forest fires in 1974 and 1980: 2, 3, 4, 6, 7, 9, 11, 12, 13, 13a, 14, 15, 16, 17, 18, 21, and 22. BM #'s 27 and 28 at 114 Outflow were destroyed during weir re-construction in 2000. The following table summarizes survey benchmark information according to each lake basin.

Notes:

1. The orientation convention used for all stream surveys and notes is that the right bank or side is on the right while looking downstream.
2. BR means bedrock.
3. BC means a brass cap benchmark.
4. AB means an anchor bolt or lag bolt benchmark.
5. CR means chipped ring in bedrock as a benchmark.
6. The specified elevation is the highest point on the BC, AC or inside the CR.
7. Survey accuracy is generally to 1 mm.

Lake	Station	BM#	Elevation (m)	Description (BR – bedrock)
114	Lake level	25	27.712	Head of AB horizontal in BR 0.6 m west of S end of catwalk
114	Lake level	26	29.018	BC in BR, 4 m SW of S end of catwalk
223	Lake level	29	30.644	BC in BR 8 m NW of instrument shelter marked with iron rod
223	Outflow weir	30	30.480	BC on weir wall
223	Outflow weir	31	30.203	BC in rock 3 m N of weir
224	Lake level	50	10.000	AB on BR rock face, S shore between L.225 stream and BM58
224	Lake level	59	8.505	AB in BR face beside new (2002) WL well and approx. 0.5 m above water level at SW end of lake (ref. survey notebook A25 p.38)
225	Outflow weir	33	30.480	BC 1.5 m W of left weir wall in BR
225	Outflow weir	34	30.721	BC on right weir wall
226	Lake level	51	10.000	AB in BR 1 m from waters edge on sloping rock 20 m N of outlet and 20 m S of dock
226	Outflow weir	35	30.480	AB in 25 cm diameter tree 4 m N of stilling well
226	Outflow weir	36	30.834	CR in BR rock face 1 m SW of end of walkway
227	Lake level	37	32.129	BC 3 m W of catwalk
227	Outflow weir	38	29.050	BC in rock outcrop 0.9 m NE of weir
239	Lake level	7a	31.260	BC in BR 23 m N of pump house
239	Outflow	11b	31.583	BC in rock outcrop 122 m SE of flume
239	Northwest Sub-basin weir	10	31.059	BC in rock outcrop 61 m S of stream mouth at NW corner of lake and 3 m from waters edge
239	East Sub-basin,	14c	31.964	AB set in vertical rock face 30 m N of

	lower weir			weir
239	East Sub-basin, upper weir	24a	45.854	CR in rock outcrop, right side of weir
239	Northeast Sub-basin weir	13c	45.763	BC on BR, left bank, 1 m from end of wall
240	Outflow weir	1	30.480	BC in BR, right side, 8 m downstream of weir, 6 m W of stream. This is the master BM for 239 and 240 watersheds.
240	Outflow weir	1a	30.328	BC on right abutment of weir
240	Outflow weir	1b	30.389	BC on wall of concrete well, downstream side.
302	Lake level	39	30.279	BC in BR, 6 – 7 m ESE of stilling well
302	Outflow weir	40	30.000	BC in BR 1 m upstream of weir, on left side of stilling well
302	Upland weir	42	10.000	AB on weir wall
303	Lake level	19	57.927	BC in BR 15 m S of stilling well location
303	Outflow weir	20a	54.678	BC on wall of weir, right side
304	Lake level	23	55.726	BC in BR 3 m S of stilling well
304	Lake level	24	54.843	Head of iron flag anchor for catwalk
305	Lake level	48	10.000	AB in BR at start of portage trail to L.227
373	Lake level	49	10.000	AB in vertical rock face about 7 m S of first staff gauge (discontinued in 2000)
373	Lake level	49b	10.000	AB in vertical rock face 1 m SW of stilling well (established 2000). Reference survey book A25 p.31 and A27 p.17 for datum correction between two benchmarks.
375	Lake level	56	10.000	AB in BR 4 m from stilling well
382	Outflow weir	43	10.000	No description
442	Lake level	58	10.000	Temporary BM established by GKM. Bottom tip of downward facing red painted arrow on cliff on S shore right of outflow stream.
442	Lake level	58b	9.323	AB in BR 1.2 m from stilling well

				(established 2002).
470	Outflow flume	5	35.659	BC in Br, 6 m downstream, 2 m left of stream
470	Outflow flume	5a	36.152	BC on right abutment of concrete wall
470	Outflow flume	5b	36.158	BC on left abutment of concrete wall
626	Lake level	60	10.000	Bolt in BR on trail to lake gauge
626	Wetland @ RG	61	12.068	Bolt in BR near road and RG24
627	Div. Channel	62	10.044	Bolt in BR south side lower end in clearing
627	Lake level	63	10.419	Bolt in BR, north side, upper channel, near lake gauge
627	Lake level	64	9.882	Top edge of metal gauge board bracket against boulder
632	Lake level	52	10.000	AB on vertical rock face at end of catwalk
658	Outflow	55a	10.000	Large spike in 15 cm diameter Jack Pine, right side, 6 m below monitoring structure
658	Outflow	55b	10.218	AB in BR face 5 m below structure, right side
658	Lake level	55c	9.401	AB on angle support of staff gauge (survey book ref. A26 p.24)
658	Wetland	55d	10.522	AB in large rock on main trail near entrance to wetland, opposite USGS boardwalk 1 (survey book ref. A25 p.8)
658	Wetland	55e	10.219	AB in BR on main trail, opposite flume and USGS boardwalk 2.
658	Wetland	55f	11.773	AB in BR on main trail, at narrows, opposite USGS boardwalk 3 (ref. M. Tate, USGS)
658	Wetland	55g	11.307	AB in BR on main trail, opposite USGS boardwalk 4 (ref. M. Tate, USGS)
661	Outflow weir	44	30.000	BC in BR 9.7 m SSW of stilling well
979	Inflow from L.240	45	26.821	Paint mark on top of large boulder, right bank of L.240 stream, near edge of

				wetland.
979	Outflow	46	26.852	CR with orange paint on BR at 979 outflow, 1 m from dam wall and 4 m from stream

<u>Station UTM Coordinates:</u>

This section is under development. Contact the author directly for information on this topic.

Note: UTM coordinates are for Zone 15 U.

Lake	Station	Easting	Northing	Datum
114	Outflow Weir	444917	5502165	NAD83
114	Lake Level	445257	5502248	NAD83
114	Terrestrial Inflow			
120	Outflow Weir			
223	Outflow Weir			
223	Lake Level			
224	Outflow Weir			
224	Lake Level	447881	5504278	NAD83
225	Outflow Weir			
226	Outflow Weir	446834	5504496	NAD83
226	Lake Level	446824	5504507	NAD83
227	Outflow Weir			
227	Lake Level			
230	Outflow Weir			

239	Lake Level	447540	5501165	NAD83
239	Outflow Flume	447564	5500960	NAD83
239	Northeast Inflow	448245	5501810	NAD83
239	Northwest Inflow	447503	5501785	NAD83
239	East Inflow, lower weir	448535	5501200	NAD83
239	East Upper Weir			
240	Outflow Weir	447603	5499862	NAD83
261	Outflow Weir			
265	Outflow Weir			
302	Outflow Weir	445353	5503349	NAD83
302	Lake Level	444924	5502396	NAD83
302	Upland Weir	444660	5502628	NAD83
303	Outflow Weir			
303	Lake Level			
304	Lake Level			
373	Outflow Weir	442939	5510663	NAD83
373	Lake Level	442520	5510841	NAD83
375	Lake Level	443365	5510654	NAD83
382	Outflow Weir			
442	Lake Level	441244	5513815	NAD83
470	Outflow Flume	447134	5500838	NAD83

626	Outflow Weir	442376	5511643	NAD83
626	Lake Level	442931	5511730	NAD83
627	Lake Level	442873	5512135	NAD83
632	Outflow Weir			
632	Lake Level			
658	Outflow	447307	5509500	NAD83
658	Lake Level			
661	Outflow Weir			
661	Outflow Weir			
979	Outflow Weir	447481	5499262	NAD83
979	Lake Level	447482	5499271	NAD83

Rating Curve Equations:

This section is under development. Contact the author directly for information on this topic.

Typically, the measurement of hydrometric interest is rate of flow or discharge from a terrestrial stream or lake outflow. Discharge values may be expressed as an instantaneous value for a specific point in time or as a mean value for a specified time period. Prior to metrification in Canada (August 1978), the standard units were feet (ft.) for hydraulic head and cubic feet per second (f^3s^{-1}) for discharge. After metrification, the standard units became metres (m) for hydraulic head and cubic metres per second (m^3s^{-1}) for discharge. The convenience is that multiplying the mean discharge for a period by the number of seconds in the period yields the flow volume for that period.

With the exception of Lake 658 outflow, all discharge monitoring stations are either a v-notch sharp crested weir (of varying degrees) or a flume (of varying shapes and sizes). The geometry at the outlet of Lake 658 required a different approach. At that site a crib structure was constructed to house long submerged flow pipe fitted with a flow sensor and data logger. Discharges are calculated simply by multiplying the average flow velocities by the cross-sectional area of the pipe. Flow velocities are routinely verified with field measurements. Refer to the information sheets for hydrometric stations of interest for details on structures and methods.

In the case of weirs and flumes, typically theoretical calibration equations are adopted until enough field measurements can be accumulated through the full range of stage to generate a "computed equation" for a station. This can take several years to accomplish. The following table summarizes rating curve or calibration equations for various stations at ELA.

*Note: The following codes identify the source of the calibration equation.

1 – theoretical, hydraulics textbook

2E – theoretical table, English units, provided by WSC

2 – theoretical, provided by WSC

3 – computed by ELA-HYD from field discharge measurements

Units: where Q is discharge in m^3/s and H is head in metres.

#	Station	Rating Formula	Version, dd/mm/yyyy	Code	Type of Control
1	114 Outflow	$Q = 0.8438H^{2.137}$	4, 03/04/1983	2	2" H-flume, abbreviated, to 1994
	114 Outflow	$Q = 2.344\ H^{2.5}$	1, 2001	1	120° v-weir from 2000
2	114 Inflow	$Q = 1.3425H^{2.47}$		2	90° v-weir to 1979-83
	114 Inflow	$Q = 2.0444H^{2.445}$	Adopted 303	2	120° v-weir from 1983-87
	114 Inflow	$Q = 1.3425H^{2.47}$	2, __/06/1987	2	90° v-weir from 1987
3	120 Outflow	Table, WSC, English units	1, 30/04/1970	2E	60° v-weir from 1972-74

4	223 Outflow	$Q = 1.3425H^{2.47}$	3, 01/04/1983	2	90^{o} v-weir from 1975-98
5	224 Outflow	$Q = 1.046H^{2.366}$	1, 15/12/1987	3	90^{o} v-weir
	224 Outflow	$Q = 1.3425H^{2.47}$		2	90^{o} v-weir from 1975-86
	224 Outflow	$Q = 1.4197H^{2.47}$	3, 08/02/1989	3	90^{o} v-weir from 1986-99
7	225 Outflow	$Q = 0.8212H^{2.51}$	2, 30/04/1971	2	60^{o} v-weir from 1975-92
8	226 Outflow	$Q = 1.3425H^{2.47}$	1, 30/04/1971	2	90^{o} v-weir from 1971-88
	226 Outflow	$Q = 2.3278\ H^{2.642}$	2, 30/01/1989	3	90^{o} v-weir from 1989-98
9	227 Outflow	$Q = 1.3425H^{2.47}$	1, 30/04/1971	2	90^{o} v-weir from 1969-98
10	230 Outflow	$Q = 0.8212H^{2.51}$	2, 30/04/1971	2	60^{o} v-weir from 1971-80
11	239 Outflow	$Q = 1.624\ H^{1.876}$	7, 14/02/1989	3	12” trapezoidal flume
12	239 NEIF	$Q = 4.1306\ H^{2.602}$	18, 22/09/1989	3	120^{o} v-weir from 18/08/1985
13	239 NWIF	$Q = 2.9802\ H^{2.5511}$	8, 12/11/1991	3	120^{o} v-weir, 1986 rebuild
14	239 EIF	$Q = 13.1892\ H^{2.407}$	8, 01/06/2004	3	Shallow v in steel box flume
15	239 EUW				90^{o} v-weir from 1973-74
	239 EUW	$Q = 2.3506\ H^{2.48}$	4, 01/04/1983	2	120^{o} v-weir from 1974-84
16	240 Outflow	a) $Q = 2.4052\ H^{2.3853}$ for $H \leq 0.3$ m b) $Q = 7.5587\ H^{3.0436}$ for $H > 0.3$ m	6, 22/09/1989	3	Combination weir, 120^{o} v-notch to H = 0.305 m, concrete broad-crested overflow above that.
17	261 Outflow	$Q = 1.47\ H^{2.51}$	1, 30/04/1971	2E	60^{o} v-weir from 1971-80
18	265 Outflow	Table, WSC, English units	3, 16/08/1973	2E	2” H-flume, abbreviated, 1971-80

19	302 Outflow	$Q = 0.8213\,H^{2.51}$	2, 01/04/1983	2	60° v-weir
20	302 Upland	$Q = 1.4135\,H^{2.4752}$	5, 01/10/1996	3	90° v-weir
21	303 Outflow				
22	373 Outflow	$Q = 2.344\,H^{2.5}$	1, 21/01/1991	1	120° v-weir
23	382 Outflow				
24	470 Outflow	$Q = 2.024\,H^{2.155}$	5, 02/02/1989	3	6" trapezoidal flume, abbreviated
25	626 Outflow	$Q = 7.0839\,H^{2.6835}$	1, 17/12/2010	3	150° v-weir
26	627 Div. Channel				
27	632 Outflow				
28	658 Outflow	Q = A * V	n/a	1	Recorded V in a 20 cm diameter pipe
29	661 Outflow				
30	979 Outflow	$Q = 6.3674\,H^{2.5588}$	4, 01/06/2005	3	150° v-weir

Raw Data Files

Beginning in 1969 and through the 1980's all original record was on analog charts. From 1969 to April 30, 1985 (except 1974), data was analyzed by WSC, initially by hand-scaling and later by computer digitizer. Record was made available to ELA users and published in EC-WSC data publications in the form of mean daily discharges (initially f^3s^{-1} then m^3s^{-1} after 1982) water levels (initially in ft. then m after 1982). On April 1, 1985, WSC withdrew support and ELA assumed full responsibility for all hydrometric monitoring activities. Software was developed and hardware acquired to digitize water level charts and process data to a standard comparable with the methods and formats used by WSC. By the late 1990's, data loggers that provided direct digital data were being phased in to replace chart recorders. By 2002, all hydrometric stations at ELA were equipped with data loggers.

The only hydrometric data that have been archived in the ELA database for general use are mean daily discharges and water levels. Raw data files from digitized record or data loggers exist outside of the ELA database. While these files provide the capability to examine flow and level to a greater resolution (i.e. storm hydrograph analysis), this capability has not been fully developed as yet.

Station Record

The following table summarizes the station-years of record that are available. To the end of 2018, **1,010** station-years of records have been collected. Some records of low priority may not yet be processed or loaded into the ELA database.

Discharge Stations: 694 station-years collected to end of 2018.

Some station-years of record remain unprocessed due to low priority or "unfunded" status.

#	Station Name	Period of record	Record (stn years)	Status
1	L 114 Outflow	1971 to 1994; 2001 to....	42	active
2	L 114 Inflow	1984 to 2000	17	discontinued
3	L 120 Outflow	1973, 1974	2	discontinued
4	L 223 Outflow	1975 to 1998	24	discontinued
5	L 224 Outflow	1975 to 1999	25	discontinued
6	L 225 Outflow	1975 to 1992	18	discontinued
7	L 226 Outflow	1972 to 1994; 1998	24	discontinued
8	L 227 Outflow	1970 to 1998	29	discontinued
9	L 230 Outflow	1971 to 1980	10	discontinued
10	L 239 Outflow	1970 to	49	active
11	L 239 East Inflow	1971 to	48	active

12	L239 East Upper Weir	1973 to 1984	12	discontinued
13	L 239 Northwest Inflow	1970 to	49	active
14	L 239 Northeast Inflow	1971 to	48	active
15	L 240 Outflow	1969 to	50	active
16	L 261 Outflow	1971 to 1978	8	discontinued
17	L 265 Outflow	1971 to 1980	10	discontinued
18	L 302 Outflow	1981 to 2008	28	discontinued
19	L 302 Upland Weir	1986 to 2009	24	discontinued
20	L 303 Outflow	1970 to 1997	28	discontinued
22	L 373 Outflow	1990 to ……	28	active
23	L 382 Outflow	1986 to 1997	12	discontinued
24	L 470 Outflow	1969 to 2008; 2010 to …..	49	active
25	L 626 Outflow	2009 to	10	active
26	L 632 Outflow	1991 to 1997	7	discontinued
27	L 658 Outflow	2000 to 2008	9	discontinued
28	L 661 Outflow	1983 to 1997	15	discontinued
29	L 979 Outflow	1991 to 2009	19	discontinued

Lake Level Stations: 316 station-years collected to end of 2018

#	Lake Level Station	Period of record	Record (stn years)	Status
1	L 112	2018 to ……	1	active
2	L 114	1981 to 1990; 2001	28	active
3	L 223	1981 to 1998	18	discontinued
4	L 224	2002 to	17	active
5	L 226	1995 to 1998	4	discontinued
6	L 227	1969, 1970; 1977 to 1998	24	discontinued
7	L 239	1969 to	50	active
8	L 260	2017 to ……	2	active
9	L 302	1981 to 2008	28	discontinued
10	L 303	1969 to 1990	22	discontinued
11	L 304	1969 to 1990	22	discontinued
12	L 373	2003 to	16	active
13	L 375	2003 to 2012	10	discontinued
14	L 442	2002 to	17	active
15	L 626	2008 to	11	active
16	L 632	1991 to 1993	3	discontinued
17	L 658	2000 to 2011	12	discontinued
18	L 660	2000 to 2011	12	discontinued
19	L 979	1991 to 2009	19	discontinued

Human and Natural Disruptions

Logging: This section is under development. Contact the author directly for information on this topic.

Storms: This section is under development. Contact the author directly for information on this topic.

Forest fires: This section is under development. Contact the author directly for information on this topic.

From 1968 to1987, ELA designated watersheds with or without hydrometric installations affected by forest fire were as follows:

1. 1974 - Lakes 239, 240, and 230
2. 1978 - Lake 382
3. 1979 - Lake 226
4. 1980 - Lakes 240, 239, 470, 661, 303, and 304
5. 2006 – Lakes 383, 265, Winnange, Teggau

Surveys, Mapping and Aerial Photography

Mapping:

This section is under development. Contact the author directly for information on this topic.

Accurate catchment and lake surface area data is fundamental to understanding hydrologic behaviour in watersheds and carrying out hydrometric computations. These areas are usually derived from topographic and bathymetric maps and aerial photographs.

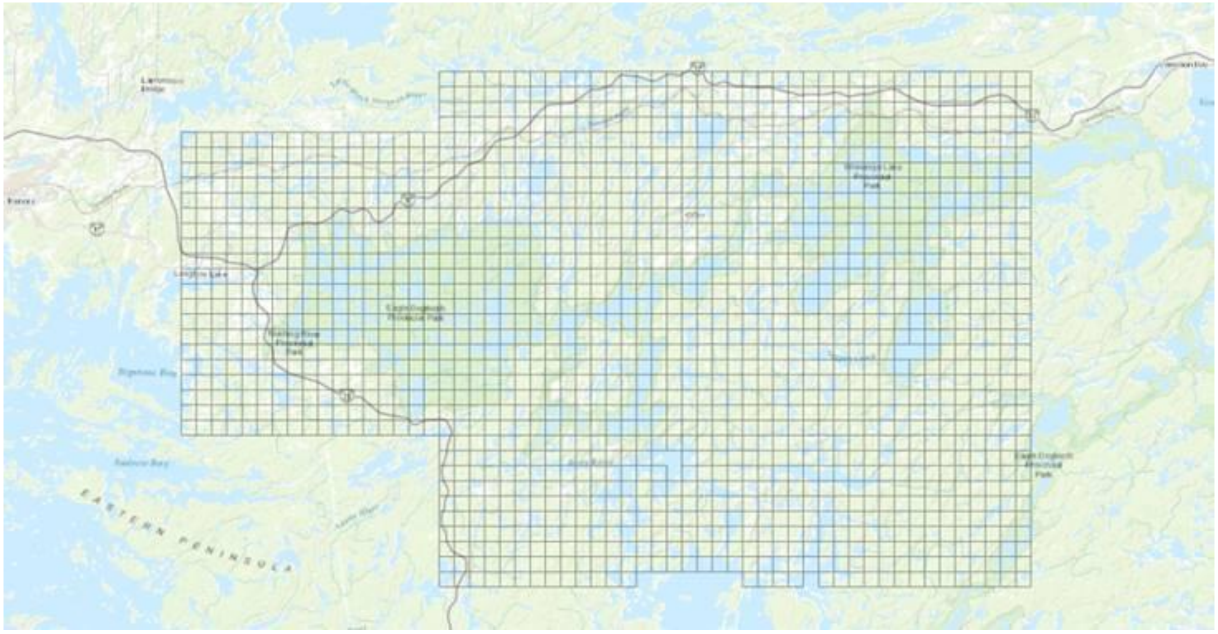
The accuracy of area measurements is based on a number of factors including the quality and scale of the mapping, the scale of the photography, the experience of the individual and whether or not ground truthing or ground measurements were incorporated in the analysis.

Aerial Photography:

There are multiple years of aerial photographs available for the Experimental Lakes Area region. These photographs were captured over multiple contracts, by multiple companies, at various scales and altitudes. The ELA Air Photo Catalogue contains a list of all the available photographs, as well as how to use them and an image sign-out. In general, there are physical photographs for parts of the ELA from 1965, 1968, 1969, 1970, 1976, 1982, 1988, 1991, 1992, 1993, and 1995. Some of these photographs are accompanied by flight line maps. In the near future, we hope to digitize all of these photographs. There are also high-resolution digital images for the region, captured in 2017.

Digital elevation maps are being created using ArcGIS software, based on digital aerial photography carried out as part of the North West Ontario Orthophotos Project (NWOOP). The images were received from the Ontario Ministry of Natural Resources. Photo acquisition was contracted out to Fugro Geospatial. An ADS100 Leica digital camera system was used to capture the imagery which covers approximately 22,700 kilometres square in northwest Ontario and was taken during leaf off conditions between May 7th and May 19th, 2017. The 4 band Red Green Blue Near infrared (RGBNir) imagery has a pixel resolution of 20 cm and is available in 1 km tiles.

Flights over ELA took place between May 7 and May 9, 2017, at approximately 2,437 m above mean terrain. The grid patterned area in the image below indicates where aerial photos were captured.



Photographed region surrounding ELA captured during in the NWOOP flights in 2017.

These georeferenced images are available in Universal Transverse Mercator (UTM) coordinates; horizontal datum is North American Datum (NAD) 83. Data are stored as 1km x 1km jpg2 tiles.

These data are provided for personal use for academic, research, and/or teaching purposes. The Ontario Ministry of Natural Resources must be acknowledged on any derivative product, whether printed or electronic, including for example, a printed map, a raster or vector graphic, a web-based application, etc. Patrons are advised to fully respect the provisions of Canada's Copyright Act as well as terms and conditions imposed by the data provider.

Discuss UTM, WGS84 NAD83 NAD27.

History of mapping at ELA

This section is under development. Contact the author directly for information on this topic.

Survey datum: Where long term or continuous lake level records are to be collected, it is necessary to refer local survey benchmarks to a selected reference datum. Since there was no geodetic survey benchmark close to ELA to relate local elevations to mean sea level (MSL), the lake levels in the following data tables have been referenced to an arbitrary assumed datum. In most cases, individual lakes were not related to the same datum. The exception was for the Lake 240 drainage basin (includes 239, 470, 661, 303 and 304) in which all surveys were referenced to a master assumed benchmark at the Lake 240 outflow weir.

Lake ordering: Lake order is a number that we use to describe a watershed in terms of how many lakes are contained within the entire drainage basin. The order number is simply the number of lakes above the outflow including its own lake. For example, Lake 223 is an order 3 system meaning that it has 3 lakes above its outflow while Lake 239 is an order 1 or headwater lake.

Other considerations

Construction methods and materials: It is possible that factors such as disturbance due to construction, weir relocation, or choice of building materials may be thought responsible for local changes in chemistry or biology. With this in mind, the station discussions that follow provide information including dates of construction or major modification and also the type of materials used i.e.: concrete (sealed or unsealed), lumber containing preservatives, etc. Whether construction was conducted by Water Survey of Canada (WSC) or ELA hydrologic studies personnel has also been indicated. All construction, repairs or changes after October 1984 were carried out by ELA staff due to the withdrawal of WSC support.

Station relocations:

In some instances, hydrometric stations have been relocated for various reasons. It is therefore important to read the information sheets for the stations to a data analysis. A good example is in the case of Lake 373 Outflow Weir. The first weir was located above the road, some distance below the natural lake outlet. Due to serious ice conditions in most winter and spring periods, the weir was relocated to a better site downstream of the road. This resulted in an increase in the catchment area. This is discussed in full in the information sheet for Lake 373.

Hydrometric References

The following reports or papers are referenced in some of the hydrometric station information sheets that follow and are available in the ELA electronic data base.

1. Assessment and Remediation of 25 Hydrometric Stations in Northwestern Ontario, Kenora/Thunder bay Areas. Project Summary Report. March 30, 2002. Dillon Consulting (for PWGSC and EC-Water Survey of Canada).

2. BEATY, K.G. 1981. Hydrometeorological data for the Experimental Lakes Area, northwestern Ontario, 1969 through 1978 (in three parts). Can. Data Rep. Fish. Aquat. Sci. 285: 1-367.

3. BEATY, K.G. 1984. Hydrometeorological data for the Experimental Lakes Area, northwestern Ontario, 1979 through 1981. Can. Data Rep. Fish. Aquat. Sci. 480: 146 p.

4. BEATY, K.G., AND M.E. LYNG. 1989. Hydrometeorological data for the Experimental Lakes Area, northwestern Ontario, 1982 through 1987. Can. Data Rep. Fish. Aquat. Sci. 759: 280 p.

5. LONG, J. A., P. Eng. 1972. A preliminary assessment of the weirs and flumes operating in the Kenora Experimental Lakes Area. Water Survey of Canada, Inland Waters Branch, Department of the Environment, Winnipeg, Manitoba, May, 1972. 58 p.

6. CANADA. DEPARTMENT OF THE ENVIRONMENT. WATER SURVEY OF CANADA (WSC). 1969-1987. Surface water data: Ontario.

7. ENVIRONMENT CANADA. INLAND WATERS DIRECTORATE. WATER RESOURCES BRANCH. OTTAWA, CANADA, 1984. Methods for the Estimation of Hydrometric Data. 23 p.

8. HESSLEIN, R. 1980. Whole-lake radiocarbon experiment in an oligotrophic lake at the Experimental Lakes Area, northwestern Ontario. Canadian Journal of Fisheries and Aquatic Sciences. Vol. 37, 3 pages: 454-463.

9. NEWBURY R.W. and J.A. CHERRY. April 1971. Geohydrology of the Kenora Research Watershed FRB Experimental Lakes Area, northwestern Ontario. (unpublished) Report no. 2. Departments of Civil Engineering and Earth Sciences, University of Manitoba.

Station Information Sheets:

Lake 112 Hydrometric Information Sheet

Lake 114 Hydrometric Information Sheet

Lake 120 Hydrometric Information Sheet

Lake 223 Hydrometric Information Sheet

Lake 224 Hydrometric Information Sheet

Lake 225 Hydrometric Information Sheet

Lake 226 Hydrometric Information Sheet

Lake 227 Hydrometric Information Sheet

Lake 230 Hydrometric Information Sheet

Lake 239 Hydrometric Information Sheet

Lake 239 East Sub-basin Hydrometric Information Sheet

Lake 239 East Upper Weir Hydrometric Information Sheet

Lake 239 Northwest Sub-basin Hydrometric Information Sheet

Lake 239 Northeast Sub-basin Hydrometric Information Sheet

Lake 240 Hydrometric Information Sheet

Lake 261 Hydrometric Information Sheet

Lake 265 Hydrometric Information Sheet

Lake 302 Hydrometric Information Sheet

Lake 303 Hydrometric Information Sheet

Lake 304 Hydrometric Information Sheet

Lake 373 Hydrometric Information Sheet

Lake 375 Hydrometric Information Sheet

Lake 382 Hydrometric Information Sheet

Lake 442 Hydrometric Information Sheet

Lake 470 Hydrometric Information Sheet

Lake 626 Hydrometric Information Sheet

Lake 627 Hydrometric Information Sheet

Lake 632 Hydrometric Information Sheet

Lake 658 Hydrometric Information Sheet

Lake 660 Hydrometric Information Sheet

Lake 661 Hydrometric Information Sheet

Lake 979 Hydrometric Information Sheet