

Appendix A

Hurst Report on 1950 Flood

Appendix A

The Red River Flood of 1950

by W.D. Hurst, Chief Engineer, City of Winnipeg

(Paper presented to Historical and Scientific Society of Manitoba, 1957)

<http://www.mhs.mb.ca/docs/transactions/3/flood1950.shtml>

The Flood Year of 1950

I think it might be well to examine the conditions which led up to the fourth largest flood in this region which occurred in May and June, 1950. The City Engineer's office, as before stated, had been keeping records of high water at Main Street Bridge since 1874, but during certain years, presumably when the water was low, no record was kept. In 1896, Mr. William Aldridge commenced to draw a graph of river elevations for each spring break-up and he continued this practice until his retirement as Deputy City Engineer in 1945. Commencing in 1922, he added a diary narrative to each year's break-up as well as the drawing of the hydrograph.

In 1933 I had the opportunity of attending an engineering meeting in Grand Forks, North Dakota. At this meeting I was privileged to meet one of the most interesting hydraulic engineers who has ever lived in this Valley, the late Dean Elwyn F. Chandler, Dean of Engineering of the University of North Dakota. We were discussing at that time pollution of the Red River and the Dean pointed out that pollution was only one problem which the Red River posed and he drew to my attention several booklets [27], [28], [29], and [30] that had appeared under his name concerning flooding of the Red River during past years. The Dean told me that as far as the Grand Forks area was concerned, that it had had no flooding disaster since 1897 with the exception of minor floodings in 1904 and 1916, but he went on to say "one of these days the river will rise again and flood the valley". He told me that following the 1916 flooding there was a great uproar in the United States section of the Red River Valley with the result that the U.S. Federal Government had prepared a report [32] on this subject which recommended that, by improvement of the river channel, flood heights could be reduced by 5 feet or more. However, as floods did not recur no action was taken. The Dean said: "I am an old man and you are young (at that time) ; watch for the critical conditions, for some day, probably before you wind up your professional career, you will face a great flood in the Red River Valley." I was greatly impressed by the erudition of the Dean and I had been warned.

Strangely enough, at that time local interest was again taken in this same subject, articles having appeared in the Winnipeg Evening Tribune in 1933 [33] by A. V. Thomas, in 1934 [34 and 35] by H. C. Knox, and in 1937 [36] by C. E. L'Ami.

When I became City Engineer in 1944, I determined to carry on with the diary and graphs which had been prepared in the past by Deputy City Engineer Aldridge.

In 1947, serious flooding occurred in and around the area of Grand Forks, but climatically, conditions were such that the Valley north of the International Boundary escaped.

In 1948 my diary reads in part as follows:

"The winter of 1948 was long with steady cold. The Red River Valley is filled with snow right down to Breckenridge, Minnesota, and City Engineer Hulteng at Grand Forks expects higher water than in 1947 when serious flooding occurred. I also understand that the Valley of the Assiniboine is filled with snow. The stage is all set for very high water in Winnipeg, particularly if warm weather comes suddenly. The weather has remained very cold up to this date (April 14th) about 10 degrees below normal for this time of year. The Weather Bureau says one mass after the other of cold polar air, has been forming in the Aleutian Islands and is sweeping down over the prairies. The radio reported this morning (April 14th) that Grand Forks, North Dakota, was flooded and one hundred people out of their homes."

The rest is history. Minto, North Dakota, in turn became flooded, Cavalier, North Dakota was isolated, the Northern Pacific Railway at Drayton, North Dakota, was cut. Emerson, Manitoba, was flooded, as were Gretna, Altona, Horndean and Plum Coulee, Manitoba. Then, in order, the towns along the Red River north of the boundary, and finally St. Vital, the Riverview districts in Winnipeg and low lying areas of St. Boniface and West Kildonan. The flood fortunately diminished and temporary dykes hastily erected had saved the day, but we had had our warning.

In the early part of 1950, my diary shows some significant notations; it read as follows: "This winter (1949-50) is one of the worst I have experienced even rivalling 1936. It turned cold on December 20th and up to January 26th temperatures have been very low averaging about 13 degrees Fahrenheit. Cold persists day after day with no relief in sight. In Eastern Canada and in Southern Minnesota and Illinois the warmest winter on record is being experienced, temperature at Windsor, Ontario, on January 25th, being 65 degrees above zero. The West Coast, however, is plagued with cold and snow. December brought an abnormal amount of snow and our snow clearing costs reached an all-time monthly high of \$82,000.00. Heavy snow again on January 24th. January, 1950 was the second coldest month in Winnipeg's history. The average temperature was 15.9 degrees below zero, and only one-tenth of a degree above that of the coldest month on record (January 1875, mean temperature minus 16.0 degrees Fahrenheit). Snowfall was slightly more than double the normal amount but 2 inches less than in January, 1949. Total snow fall up to January 31st was 49.6 inches, compared with 40.2 inches last year (1949). February was somewhat milder but temperatures averaged slightly below normal. Snowfall was 6.7 inches, bringing the total for the season up to 60.3 inches. The normal is 51 inches. March was again cold and no real thaw began until March 20th. Storm broke March 26th, blowing snow, heavy snows in Central Minnesota. (Red rising at Fargo, North Dakota).

Rain and snow, March 26th and 27th at Fargo. Letter from the Corps of Engineers, U. S. Army, Saint Paul, Minnesota, dated March 24, 1950, says that water content of snow in stream basins down stream from Sandhill River 35% greater than in 1949. From present snow cover, flooding will be most likely on the Red north of Grand Forks and on the Sandhill, Red Lake, Clear Water, Last, Snake, Middle, Tamarack, Roseau, Park, Tongue, and Pembina Rivers. The weather remained cold up to April 13th and then a thaw set in with temperatures up to 52 degrees above zero in the day time and 35 degrees above zero at night. This thaw has continued until April 18th. Radio Station KFGO at Fargo said on the night of April 17th, that North Dakota and Western Minnesota have been declared flood disaster areas with Jamestown as headquarters, 241 families being housed. Jamestown is having the worst flood in its history. In Beulah and Hazen families are trapped. Almonte, North Dakota, is under water. Red River to stage 38 feet at Grand Forks. North of Grand Forks the river is rising, no trains operating north of Grand Forks night of April 17th. Families being evacuated in Grand Forks and around Grand Forks. The Red dropped at Fargo to stage 19.71. Red Lake River rose 2 feet today (April 17) to reach a 15-foot stage at Crookston. April 18, 1950, flood is expected at Winnipeg with high water first week in May. Co-operation (arranged) with Public Works Department of Provincial Government and Canadian Red Cross Society".

After this date our troubles had begun. My time became completely taken up with arrangements for the building of dykes, the acquisition of sandbags, the deployment of labour, giving technical advice to the Mayor and the Council, and being questioned morning, noon and night by the newspapers.

On March 31, of the previous year I had given a paper before the Winnipeg Branch of the Engineering Institute of Canada, entitled "The Red River Valley Flood Problem". This paper was printed in the newspapers as of current interest and I was besieged with questions. This part of the account I would like to tell later and confine myself at this juncture to the scientific aspects leading up to the flood.

Because of general pressure of business I was completely worn out after my day's work. I had to abandon keeping a daily diary. My last entry is May 4, 1950, "This flood is the worst to have struck the Valley since 1882, Grand Forks, Crookston, Oslo, Pembina, Emerson, Letellier, Dominion City, St. Jean, Morris, St. Norbert, Ste. Agathe, and Winnipeg (Metropolitan Winnipeg) have all been badly flooded. For a full account see the daily papers or book of paper clippings in the (City Engineer's) library.

I should have kept my diary from day to day; although the desire was strong the flesh was weak.

Meteorological Conditions

Now let us examine the meteorological conditions [37], [38] and [39] of the winter of 1949-1950. The flood of April - June, 1950, was the result of a critical combination of factors:

1. High soil moisture.

2. Abnormal amounts of snow.
3. An unusually cold spring with delayed melting of snow until mid-April.
4. A sudden surge of warm weather followed by above normal precipitation, and rapid snow melt.

Soil moisture in the river basin was above normal when the ground was frozen in the fall of 1949.

October, 1949

Precipitation in October, 1949, was 63% and 300% greater than normal at Fargo, North Dakota and Winnipeg respectively, Winnipeg having the wettest October on record. This excessive precipitation caused increased stream flow, the filling of ponds and swamps and charging of the soil.

November, 1949

November was exceptionally warm throughout the basin, but precipitation only slightly in excess of normal.

December, 1949 and January, 1950

The first hard freeze which fixed the referenced conditions until the spring break-up, occurred in mid-December. Snowfall in December, 1949 and January, 1950 was excessive throughout the drainage area, being 18 inches at Fargo and 25 inches at Winnipeg as at January 31, 1950, while temperatures were generally below normal from mid December until the end of January.

February, 1950

The total precipitation and the mean temperature for February, 1950 were just below normal at Winnipeg and somewhat lower at Fargo, North Dakota.

March, 1950

March, 1950, started off with a continuation of the relentless cold which had gripped the valley since mid-December but from March 4th-7th the temperatures at Winnipeg rose above the freezing mark. Even the southern part of the Valley up to that time had had only two isolated days in February when the temperature rose above 32° Fahrenheit. The referenced warm spell was followed by another cold outburst and although the daily temperatures between March 15th and 31st with one or two exceptions rose above freezing even then the greater part of each day was characterized by below freezing temperatures.

Precipitation for March was below normal in the northern part of the basin but this was not true in the upper part, Fargo having a rainfall of 1.16 inches on the 26th and 27th of March, an all-time record for any March.

Conditions Existing Just Prior to April, 1950

Most of the snowfall had come during blizzards which caused large drifts in locations sheltered from the wind.

The long period of intense cold at the beginning of winter when the ground was saturated and unprotected by heavy snow cover allowed deep penetration of frost, and the continued cold throughout the winter months prevented melting. To these conditions was added heavy precipitation over the southern portion of the watershed in late March added to the excess frozen precipitation of the previous October.

April, 1950

April, 1950 was cold, in fact, in the Minnesota portion of the basin it was the coldest April on record, and the average snowfall was the second greatest on record. In North Dakota it was the coldest April since 1920 and nearly three times the normal snowfall was recorded, again the greatest on record. At Winnipeg temperatures rose above normal on only 4 days during the month making it the coldest April since 1920, together with a new record for snowfall in April, namely, 16.1 inches.

Polar air masses dominated the weather for the first part of April but were replaced by two weak Pacific frontal systems from the 17th to the 24th which caused rapidly rising temperatures causing flood peaks, in the extreme south and snow in a ripened condition in the north.

May, 1950

May was the continuation of one of the most backward seasons ever experienced. Snowfall in Minnesota and North Dakota set new records and the precipitation in both belts was above normal. Rainfall at Winnipeg was approximately 210% above normal (4.60" compared to 2.19"). Polar air covered the basin as May opened, but on the 2nd it was replaced by warm moist air which released very heavy precipitation in the southern part of the valley and lesser amounts further north. This low pressure area was replaced by another on May 4th which caused general precipitation from the headwaters to Lake Winnipeg, lasting until May 6th, and being heaviest in the northern part of the basin, Winnipeg receiving 2 inches of rain, Pembina 3 inches and Fargo. 1 inch.

This low was succeeded by polar air on the 7th, followed by another low on the 8th and 9th which produced a repetition of the storm of the 4th-6th, many stations receiving another inch of precipitation. Precipitation was normal from the 10th to the 17th with the fluctuating temperatures as polar and Pacific air masses alternately occupied the basin. A low pressure trough passed over the basin on the 19th and as it displaced the polar air

more precipitation occurred, Winnipeg receiving one half an inch of rain and Fargo one inch.

As Pacific air covered the basin from the 19th to the end of the, month, only scanty precipitation fell but local showers occurred in Winnipeg on the 27th with one-third inch of rain recorded.

Temperatures were below normal for the first ten days of May but the mean temperature for the balance of the month was well above normal as the flow of southern air sent afternoon temperatures as high as 75 Fahrenheit and kept minimum temperatures well above freezing.

As in past years the exceptional run-off in the Red River Basin in the spring of 1950 was due to the critical combination of the following meteorological conditions, any one of which, considered individually, not departing from normal to such an extent as to have caused so unusual a flood:

- (a) Heavy autumn rains
- (b) A later freeze-up which allowed these rains to penetrate and saturate the soil.
- (c) A deep penetration of frost at the beginning of the winter due to the very cold weather and the saturated condition of the soil.
- (d) A continuous accumulation of winter snowfall due to absence of mid-winter thaws.
- (e) Heavy late winter snow.
- (f) Below normal temperatures in April preventing a gradual thaw.
- (g) Heavy rainfall in May during the run-off period.

Flood Warnings

Following the lesser flood of 1948, the U. S. Corps of Engineers undertook the preparation each March of a survey of the water content of the snow on the ground on the United States portion of the watershed. In 1947, the Corps had invited engineers from the Manitoba Government and from the City of Winnipeg to be their guests on an inspection of the flood control and reclamation works they had constructed in the U. S. portion of the Red River Valley. This was a most informative trip and even more important it had the effect of creating an esprit de corps between the Canadian engineers and their counterparts in Minnesota and North Dakota. While it is the duty of the Corps to prepare information on the water content of the snow cover in drainage areas it is left to the U. S. Weather Bureau to issue flood forecasts and warnings. On March 2, 1950 (40) I received from the Corps the results of the first snow survey of the season together with a confidential interpretation which was cautious but not encouraging. On March 27, 1950 (40) the final results of the snow survey were made available to us and while serious

flooding in the Winnipeg area was still uncertain it was evident that we could expect very high water here and flooding in the Valley of the Red River in the United States. Unfortunately no comparable survey was available for the Red River Basin in Canada. On the 7th of April I visited the Corps of Engineers in Saint Paul, Minnesota. As a result I sent on April 7, 1950, the following wire to the Deputy City Engineer, Mr. A. J. Taunton, "Corps of Engineers expect maximum stage forty-two feet Grand Forks between April 15th and 18th stop 1948 corresponding stage 41.6 feet stop Winnipeg flooding highly probable stop Advise Mayor and Collins (Manitoba Government Deputy Minister of Public Works) stop Believe public should be warned of probability W. D. Hurst City Engineer."

I quote this wire to refute statements that have been made since that local engineers did not believe that a flood was coming and that we issued reassuring statements at the time.

On April 8th the Weather Bureau at Fargo, North Dakota, issued a forecast for a flood stage of 42 feet at Grand Forks, North Dakota, minimum flood stage being 28 feet. At the time the water level at Grand Forks stood at 27 feet. Following the receipt of my wire, Mr. Taunton advised the Mayor to issue a warning that a flood at least equal to that of 1948 was probable. This warning was jointly issued by the City and the Province on April 11th, 1950. Prior to May 7th readings of the water levels at Fargo, Grand Forks, Emerson, Morris and Ste. Agathe were obtained by wire and made available daily by the Department of Mines and Natural Resources of the Manitoba Government. Information on the stage at Brandon, Portage la Prairie and Headingly on the Assiniboine were also made available. The forecasts of the stage to be expected in Winnipeg were being largely based on the Grand Forks and Emerson readings but owing to the character of the spring break-up and the exceedingly high stage being experienced between Grand Forks and Emerson it was realized that this procedure was inadequate and the Mines and Resources Department on the 7th of May instituted a flood stage forecasting system which placed the forecasts on a sounder basis. It was unfortunate that the moisture content of the snow cover was not available for the Canadian part of the Valley and this made forecasting difficult but such a need had not been demonstrated and had only been in effect in the United States portion of the Valley for two years prior to this time. Such surveys are now a regular procedure.

The Great Flood of 1950 United States Section of the Valley [37]:

The flood began with minor flooding of Breckenridge and Wahpeton, North Dakota in late March. On the 25th of March a large storm swept across North Dakota in a north-easterly direction bringing snow to all parts of the state except the south-east where rain fell, Fargo receiving the heaviest rainfall ever recorded in any previous March. The Red River started rising at Wahpeton and by April 2nd it had reached peak discharge, however, damage in this area was nil to minor.

The water rose at Fargo until it reached its peak stage on April 7th of 21.2 feet above local datum. This flooding caused only minor inconvenience with some damage on lower Broadway and in the flats.

The flood passed from Fargo downstream to Grand Forks without spilling over the banks. At Grand Forks the Red Lake River enters from Minnesota, and its waters added to the Red created a flood situation at Grand Forks and downstream which had not been exceeded since 1897. On April 5th, the ice began to move at Grand Forks and by April 7th evacuation of the Lincoln Drive area had become a reality. Six inches of wet snow fell over the Easter weekend (April 8th - 10th) and on April 10th the river was 3 feet above flood stage and still rising. By April 20th a major flood had developed in the United States and the American Red Cross had declared a state of emergency. An estimated 1280 families were homeless, 225 families from the Grand Forks area alone. The Grand Forks business district was not troubled except for flooded basements and vapor troubles arising from the cold water in contact with underground steam piping. It is interesting to note that at this date (April 20th) the stage at Winnipeg was almost minimum flood stage (18 feet). On April 24th, the river reached elevation 44.0 feet above datum and began to fall until it reached elevation 35.5 feet on May 3rd when it began its second rise to reach elevation 46.0 feet on May 12th, then falling to minimum flood stage on June 3rd. The second rise which I believe is without precedent took place in Grand Forks but only one crest reached Winnipeg due to natural attenuation caused by valley flooding to the south. This second crest caused another evacuation of homes in Grand Forks and resulted in real hardship. Neither water nor power supply failed at Grand Forks although operation of both utilities was a very difficult matter. Traffic into the City from the north and south was impossible owing to flooded highways.

The Red River north of Grand Forks in the U. S. resembled for nearly two months a series of lakes rather than a river. Here the story again was the same-evacuation of personnel and precious belongings and all its consequent hardships.

Canadian Section of the Valley [25]:

Following the warning of April 11th, the City Engineer's Department, the various Municipal Public Works Departments and the Public Works Branch of the Manitoba Government began preparations to bolster the dykes which were hastily erected in 1948 and to mobilize men and equipment for flood fighting if necessary.

After the 1948 flood the City Engineering Department on March 3, 1949 proposed to Council the construction of levees (dykes), flood walls and pumping stations in the Riverview area; in the Norwood Bridge area; in the area between Christie Street and James Avenue in the downtown section of the City; in the Point Douglas area; in the Glenwood Crescent area and other miscellaneous work at an estimated cost of \$1,169,000.00 but, owing to the large expenditure, it was not acted upon. It is interesting to note at this juncture that an enlargement of these recommendations was acted upon by the Greater Winnipeg Dyking Board in 1950 and 1951 and the remedial works were then actually constructed.

At this time the Red River crest was expected about April 30th but serious flooding was not expected on the Assiniboine River because of low snowfall over that basin. On April 12th a joint co-ordinating committee consisting of provincial and municipal engineers was set up to arrange for essential flood fighting material and to co-ordinate labor and equipment. On Friday the 14th of April an aerial reconnaissance by the U. S. Corps of Engineers showed a solid sheet of ice and snow blanketing the Red River Valley north of Grand Forks. On this date the weather suddenly warmed up and the flood threat rose accordingly. On the same day, the Provincial Red Cross convened a meeting of representatives of the provincial and municipal governments, the armed forces and community organizations to co-ordinate all relief and evacuation work in the event of a flood. On April 21st the minimum flood stage of 18 feet was reached at Winnipeg. On April 22nd, a flood emergency was declared by the American Red Cross covering the area surrounding Grand Forks. On this date the Rosenfeld, Horndean and Morden areas in Manitoba were seriously troubled with flooding caused by rapidly melting snowfall and flooding of the Plum River. On Saturday, April 22nd, flooding began in Emerson, with 3 feet of water on the streets. By Monday, April 24th, the Seine spilled its banks in suburban St. Vital and the Kingston Row district was under imminent threat. By Thursday, April 27th, flooding had reached Morris and by Tuesday, May 2nd, flood level had reached 23.6 feet in Winnipeg topping the 1948 level and again flooding out the Elm Park district of St. Vital. Minor flooding had been experienced at the rear of the Municipal Hospitals and on Scotia Street in North Winnipeg since the third week in April. Dykes hastily constructed during the 1948 flood in the Riverview district, at the foot of Lombard Avenue, and along Scotia Street in Winnipeg and in the low lying areas of St. Boniface and St. Vital and Fort Garry and West Kildonan were being reinforced and pumping of basements was everywhere to be seen.

The army at this time began to assign soldiers to help in the construction of dykes and the provision of technical services.

On Wednesday, the 3rd of May, the river overflowed its banks and flooded Elm Park causing the evacuation of about 60 homes. We were now feeling real concern for the safety of the dykes in the Riverview district, water was within 18 inches of the top, they were soggy and were showing signs of seeping and I had warned that a heavy rainfall would be disastrous. It was decided to close the Elm Park bridge to all traffic except emergency vehicles serving the Kingston Row area. The Red had dropped 3 inches at Emerson and hope was rising that the City might yet escape serious inundation. On Thursday, May 4th, rain began to fall and continued throughout Friday, May 5th, which was later known as "Black Friday". The river was still rising at Morris and Ste. Agathe but at a diminished rate. By this date a large army of civilian volunteers was assisting the department as well as the Public Works Departments of the suburban municipalities to raise and strengthen the dykes now being constructed in all the low-lying areas of Greater Winnipeg.

In the meantime our ordinary day to day administration was displaced by work on the flood emergency. Answering the constant ringing of the telephones had become almost a

full-time job for many members of our staff and we had set up a battery of telephones over which flood information was given to the public. The maintenance and construction staff and its equipment were busy at dyke building, the quarries branch was hauling large quantities of sand and gravel from Bird's Hill to Winnipeg, and a sandbag brigade was busily engaged in filling sandbags. I had the task of planning the operations in anticipation of a flood crest of 25.5 ft., touring the flooded areas and answering a constant stream of telephone calls day and night. The calls became so frequent at my home that it became necessary to have the line cut and an unlisted number installed. On this date, May 4th, I advised City Council that dykes had been constructed in the Scotia Street district, the Glenwood Crescent district, on Rover Avenue, along the Winnipeg Transfer tracks from McDermot Avenue to Water Avenue, in the vicinity of Bell Avenue and Priscilla Street in the Riverview district and at the foot of Colony Street. In addition we had 28 temporary pumps in operation keeping the water level in the sewers under control. As far as this latter function was concerned we would have been defeated prior to this date except for the pumping operations being carried out at the 21 combined screening and pumping stations by the Greater Winnipeg Sanitary District. These pumping operations were carried out by the Greater Winnipeg Sanitary District. These pumping operations were carried out by the District at considerable hazard as the equipment was not designed for this purpose, the amount of water being pumped to the rivers being in the order of 68 million gallons per day.

By this time we had prepared and had used 90,800 sandbags and had spent about \$55,000 in flood fighting preparations. I told Council on May 4th "From an examination of data it would appear that protective measures will have to be continued for 10 days to 2 weeks. Whether this department will be successful or not in its protective measures depends on the ultimate level which the river will assume, together with the hazards of rain which may fill the sewers beyond the capacity of the pumping equipment to empty them, together with a deterioration of the dyking works. These are hazards over which the Department has naturally no control."

The preceding was dictated on Wednesday, May 3, and I know I did not realize at that time how prophetic my statement was.

Rain fell all day Friday, May 5th, totalling one inch. At about six o'clock that evening I feared that with the rainfall the rising rivers and the pressure from the sewers the dykes were likely to fail. I then arranged with Brigadier R. S. Malone of the Winnipeg Free Press that on receipt of a certain code word he was to cause the sirens on top of the Free Press building to be sounded, and that would mean that a dyke or dykes had failed and that the residents were to take appropriate measures to evacuate the affected districts.

All of us by this time were reaching the point of physical exhaustion and I went to bed early in the evening in order to obtain much needed rest. About midnight I was summoned to an emergency meeting in the Premier's office in the Legislative Building where the entire situation was reviewed. Present were representatives of all three levels of government. It became apparent that the Red River Valley was faced with a disaster of

the first magnitude, and that the Canadian Army with its power of command and its ability to obtain the necessary resources must be placed in charge of the flood fight.

Brigadier R. E. A. Morton, General Officer Commanding, Prairie Command, was placed in charge. While we sat at the meeting we could hear the sirens blowing and knew that at least some of our efforts had come to naught. By the following morning, the Riverview and Point Douglas dykes in Winnipeg and the Wildwood dyke in Fort Garry had failed and complete evacuation of the districts was ordered. During the night the patients at the Municipal Hospitals had been transferred to Deer Lodge Hospital in St. James. Norwood and Provencher Bridges were temporarily closed and underpasses all over the city were flooded due to sewer backup and hundreds of basements were inundated. Other dykes too had failed or were on the verge of failure and the course of the flood had changed from the defensive to the relief stages. The City had exhausted its resources and no attempt could be made to repair the broken dykes but the fight to maintain those left and to retain the utilities and communication was pursued with all despatch. The first and only fatality of the flood in Greater Winnipeg occurred on Kingston Crescent when a man was drowned while working in a basement.

The loss of the dykes and the evacuation of the districts affected was a cruel blow to the residents. Many were the reasons advanced as to the cause of the failure of the dykes and particularly, the Riverview dyke. In this connection the memorandum of the resident engineer, Mr. G. C. Dennis is of great interest.

He states: "When I arrived in the area just before midnight, Friday, May 5th, I began to check the dyke from the Baltimore Road end. I found the mud dyke paralleling Baltimore Road about a foot above the water and taking a beating from the waves. The dyke itself was very soft-too soft in fact to walk on. Baltimore Road was all but impassible."

"There were several volunteers waiting to help, one, a Colonel Merritt, agreed to round up more volunteers if we could get sand bags in. However, the condition of the roads and the dyke made this impossible even if sand bags had been available.

"At Eccles Street the water was lapping at the top of the dyke over a length of about 50 feet. The depression behind the dyke was filling with water and half a dozen were wading waist deep with sand bags in an attempt to raise the dyke. I rounded up about 15 men to work on this point before leaving to inspect the rest of the dyke. The ground behind the dyke was just a lake of mud and the dyke much too soft even to climb.

"On returning to the roadway it was reported to me that there was a major break near the Brandon Avenue end. As I passed Mabel Street, I saw one of the two mechanical shovels on rental from Geo. Gelhorn and Sons badly mired in the mud and almost on its side-the other shovelling like mad in a vain attempt to raise the dyke. I passed the Red Cross Ambulances and Army transports sent to evacuate the Municipal Hospitals, and knew that the general evacuation of the area had started. Red Cross personnel were going from door to door on Arnold Avenue, warning the residents.

"Volunteers working under a Water Works foreman temporarily stopped the break near Brandon Avenue with sandbags scrounged from I know not where.

"At this point I had hopes that the wind and rain would die down and by morning we would again be in control of the situation. However, when I returned to Mabel and Arnold, the lowest spot in the area, the pressure was so great in the sewer that the flow was floating the (cast iron) manhole cover. By this time everyone was on the move from the area and I realized by morning that the area would fill to river level. Any city cars I could locate were pressed into service evacuating patients: from the hospital.

"Knowing now (May 31st) the subsequent rapid rise in the river, I realize that even if unlimited sandbags had been available it would have been impossible to raise the dykes as fast as the river was rising and the dykes softened by the rain as they were would not have supported the added load of sandbags and even with the dykes sufficiently high and solid, the area would have been flooded from the sewers with the limited pumping capacity at the outlet.

"With regard to criticism that frozen earth caused the Arnold Avenue dam to fail-this is nonsense. In the early stages of the flood there was a great deal of seepage, undoubtedly caused by frozen chunky earth but this was largely stopped by a secondary dyke extending over 150 feet in length. I sincerely believe that everything possible was done to protect Riverview-short of an all out preparation for a rapid rise in the river level to elevation 30.3 and (having) pumps at the (trunk sewer) outlet equal to the capacity of the Baltimore trunk."

I quote Mr. Dennis' memorandum to give a word picture of conditions in one of the low lying areas on the night of "Black Friday". At the time no one ever imagined that an elevation of 30.3 feet would be realized and of course pumps having the enormous capacity of the Baltimore trunk were unobtainable even from pump manufacturer's stock.

On Saturday morning, May 6th, City Council held an emergency meeting and were briefed on this situation by the departmental officials.

Council, after hearing the reports, set up a committee consisting of the City Engineer, the General Manager of the Hydro Electric System, the Fire Chief, the Chief of Police, the Medical Health Officer and the Supervisor of Emergency Housing, with "full powers to take whatever steps were necessary for the protection of life and property and for the alleviation of distress." The Committee was "authorized to incur the necessary expenditures required to implement its decisions." The Committee was also given authority to add to its membership as it might see fit and was authorized to co-operate to the fullest extent with the armed services and the Red Cross and other agencies engaged in flood fighting and relief measures.

The City Engineer was named Chairman of the Committee and Director of Operations.

To the best of my knowledge this Committee of Department Heads was given more power than any other committee has ever been given in the history of the City of Winnipeg. I firmly believe that all in all this was a wise move. The Committee could meet at any time, night or day, at the call of the Chair; it had the power to carry out necessary decisions and it was composed of men who had long experience in operating their respective departments and knew their work thoroughly and, moreover, I believe they had the confidence of the public at large.

The City Engineer's office was selected as the Committee's Headquarters, despite the fact that it was on relatively low ground. This building had already installed in it an emergency diesel set to supply power, and gasoline pumps to keep the basement dry, and was convenient to the City Hall, Police Headquarters and the Central Dispatching Yards.

Communication was now beginning to give trouble. The telephone lines to the Department were plugged with calls, and with the co-operation of the Manitoba Telephone System, a battery of telephones, manned 24 hours a day, was installed at headquarters to deal with citizen enquiries and to give such advice as might be useful. These special telephone numbers were published daily in the newspapers.

In 1934, the Water Works Branch of the Engineering Department installed radio sets in its trucks and this system had been expanded until, at the time of the flood, the Department had, jointly with the Fire Department, its own transmitting station at the City Yards, and had installed in its vehicles some twenty-five 2-way radio sets.

Remote control sets connected by land lines with the main transmitter were available at Committee Headquarters and at Police Headquarters. In the meantime, Military Headquarters was set up at the Legislative Buildings on Broadway and a remote control broadcasting station was installed in the Royal Canadian Engineer's Office, thus tying in the City's transmitter with the Military. In addition a direct telephone line was installed between Committee Headquarters and Flood Control Headquarters in the Legislative Buildings.

The Chairman of the Committee had installed in his home a special private line and a remote control broadcasting station so that night or day he was able to have contact with Committee Headquarters or Military Headquarters, or with the working parties on the street.

The communication system turned out to be one of the most important factors in fighting the flood.

It was decided that newspaper reporters would be allowed to sit in on all meetings of the Committee. The reporters were requested to discuss all matters with the Committee's Press Liaison Officer before committing their reports to press but it was agreed that the Press Liaison Officer would not have the power to actually censor. The Committee was anxious to keep the public as fully informed as possible but there were, from time to time,

matters under discussion which might have. created panic if reported upon sensationally and they had to be handled circumspectly.

In retrospect, I can say that the press and radio were completely honourable and fair in handling the matters under discussion at the Committee meetings and no censorship problem arose during the flood emergency.

The Committee held its meetings at 10 o'clock each morning and almost at once increased its membership to include the following: The Deputy City Engineer; the Chief Engineer of the Winnipeg Electric Company; the Chief Engineer of the Manitoba Telephone System; the Director of the Division of Sanitary Engineering, Ontario Department of Health, Doctor Albert E. Berry, who was loaned to the Winnipeg Committee by Premier Leslie Frost of Ontario; the Director of the Council of Social Agencies; the General Manager of the Greater Winnipeg Water and Sanitary Districts and the Secretary and Registrar of the Association of Professional Engineers of the Province of Manitoba was named and acted as Secretary of the Committee.

At each meeting of the Committee, His Worship, Mayor Garnet Coulter, K.C., and the Chairman of the Finance Committee, Alderman C. E. Simonite, were in attendance. Their advice was invariably sought by the Committee and to their everlasting credit neither of these gentlemen ever attempted to interfere in the functioning of the Committee despite their position of authority.

At each meeting reports were received from the members and appropriate action was taken where required.

To cover the decisions made by the Committee between May 6th and May 27th is manifestly beyond the scope of this address, but I can assure you that matters of great importance were decided upon each morning and decisions were made with the minimum of debate. It would not be reasonable now to say that every decision taken was a sound one, but it was more important at that time to arrive at a reasonable decision quickly than to try to arrive at a studied appreciation of any problem followed by a decision taken at leisure.

Pumps were secured from all parts of the Dominion and the Manitoba Government made arrangements to bring in generating sets to provide a separate means of power for hospitals and institutions and other essential services.

The Medical Health Officer of the Health Department provided for orderly evacuation of patients from nursing homes and hospitals, for the mass inoculation of the public against typhoid fever, and for the protection of foodstuffs, and in co-operation with the Director of Sanitary Engineering of Ontario, for the sanitary protection of the water supply.

The Supervisor of Emergency Housing worked with flood control on the housing of evacuees and on mass evacuation problems. The Hydro, Winnipeg Electric and Manitoba Government Telephones worked day and night to maintain utility services. The Director

of the Council of Social Agencies kept the Committee informed on social problems and closely cooperated with Flood Control Headquarters. The Police and Fire Chiefs carried an enormous burden in maintaining a crime and fire-free city there was only one case of petty thievery during the entire period of the flood in a metropolitan area of 350,000 people, which we think is quite a record, and there were virtually no major fires during that period either - and control of traffic of course was very difficult.

In the meanwhile, the City Engineering Department was endeavouring to keep the sewers operating, the water supply intact, the roads open and to supply from its utilities sand, gravel and stone and from its stores vital equipment and materials. We supplied as much sand and stone from our gravel pits and our quarries in 10 days' time as compared with the fourth largest year in our history, in other words, we turned out a year's supply of materials in roughly 10 days. It took a little organization to do it.

The Committee was then in effect a co-ordinating and co-operating committee, the actual work being carried out by the Head of each department with only general direction from the Director of Operations. Each Department Head knew his own problem best and it would have been the height of folly to replace his direction with outside overall direction.

The Committee was the clearing house, and each Department Head. was willing and anxious to help another and to seek the advice and assistance of all. The resources of each Department were available to the other wherever possible.

The Committee meetings lasted about 1½ hours each morning after which each head of a department or committee member returned to his regular work. In the afternoon the regular meeting of the Army-Provincial Flood Control Committee was held. The Director of the City of Winnipeg Flood Control Committee and a number of other members of the Winnipeg Committee were also members of that larger Committee. Thus Flood Control Headquarters was kept in close touch with what the City Officials were doing and the City Committee knew, through its Director, what Flood Control was accomplishing.

During the period of flood fighting and in anticipation of the problems of reconstruction, the Winnipeg Committee set up a Rehabilitation Subcommittee under the Chairmanship of the General Manager of the Greater Winnipeg Water and Sanitary Districts to work out recommendations for the rehabilitation work.

The Committee wound up its work on May 27 and was disbanded.

Provincial Flood Authority

Following the appointment of Brigadier R. E. A. Morton early on May 6th, he assumed immediate command and urged complete cooperation with the armed forces. He also announced that the Red Cross would continue to handle emergency aid for flood victims. The Royal Canadian Air Force commenced its operation "Red Ramp" which consisted of a giant airlift of flood emergency materials (then in very short supply). Trans Canada Air Lines threw the weight of their system into a similar emergency airlift. A total of 35 aircraft was in operation during Red Ramp some of which were used for aerial

photography of the flooded areas to allow technical personnel on Brigadier Morton's and the various governmental staffs to evaluate the progress of the flood and the flood fight. Radio communication was very effectively used to provide communication on a 24-hour basis, the broadcasting stations being placed at the disposal of the flood authority.

By May 6th, 400 square miles in the Red River Valley was under water increasing to 560 square miles at the height of the flood (May 13th). In the City 6 square miles was under water and volunteers were fighting to save a further 10 square miles in the Greater Winnipeg area.

By May 8th, the river had risen to elevation 27.9 feet but the Lyndale dyke in St. Boniface and the Glenwood Crescent dyke in Winnipeg were being held by the herculean efforts of civilian volunteers and army personnel. Taxi companies had organized a special bus service to transport workers to and from the dykes. Winnipeg's plight was serious, 1000 homes and buildings were without heat, mass evacuation of parts of St. Vital had taken place, warnings of further mass evacuations were being issued by the flood commander, a positive threat to the Mill Street Power station of the Winnipeg Electric Company and the Rover Avenue Terminal station of the City Hydro existed. Approaches to the various bridges were under water and for a short time the old Redwood Bridge, linking the east and west sides of the Red River, was the only usable crossing. The Flood Commander was greatly concerned over the development and he asked the City Engineering Department to try to restore communication with St. Boniface by building a stone ramp 1/3 mile in length along Water Avenue. This work was set under way by employment of over 100 trucks to haul some 10,000 cubic yards of rock from Stony Mountain, Manitoba, for this purpose. The ramp was completed on May 14th. We were also concerned with the maintenance of water pressure in our water distribution network. This network was 1,800,000 feet in length and had some 1,400,000 feet of service pipe connecting these mains to the individual premises. The Ontario Government had sent Dr. A. E. Berry, the Director of the Ontario Department of Sanitary Engineering, to assist us in maintaining a disease free water supply, and the Halifax Public Service Commission had loaned us their General Manager, Dr. Ira P. Macnab, to assist in setting up standby diesel generating units in the event of power failure and consequent water supply failure. By this time seven of the nine sewage pumping stations had been closed down and the level of the flow in most of the sewers followed closely those of river elevation. We were fearful of the consequences of failure of the sewage pumping stations as the sewers now were operating under pressure, with heads ranging from 10 to 15 feet for which they were not designed and we feared that the City's sewer system might have to be largely rebuilt at the conclusion of the flood. Fortunately this did not materialize.

On May 10th, Brigadier Morton urged evacuation of all women and children from Winnipeg to thin out the population and relieve overtaxed facilities. It was believed that approximately 70,000 people obeyed this appeal. In the 96 hours period ending May 12th, the R.C.A.F. had flown into this area about a million pounds of freight while T.C.A. and the Ontario Lands and Forest Department had flown 58,000 air miles and had brought in 403,000 pounds of equipment respectively.

The Department now turned its attention to the construction of a rock causeway on Sutherland Avenue to service the terminal station of the City Hydro on Rover Avenue and the gas plant of the Winnipeg Electric Co. on Gladstone Street. I told the City's flood committee on May 10th: "If we can save the power stations and the gas works, then everything else can go by the board". The issuance of such a statement underlined the desperateness of the situation.

On this date the rivers stood at 29.2 feet and Maryland Street Bridge on the Assiniboine was being threatened. On May 11th, the East Kildonan dyke near Leighton Avenue collapsed, but the power situation was beginning to improve. Just as this bright spot appeared Osborne and Maryland and Norwood Bridges were threatened. On May 13th, Osborne and Maryland Street Bridge approaches were awash and Norwood Bridge was abandoned. Fortunately the causeway to Provencher Street Bridge was completed on May 14, thus relieving the situation somewhat.

We were now becoming concerned about restoration and organized a committee to assist in rehabilitation of flooded areas as we felt sure at this time that the crest had been reached.

The Flood Control Authority had been giving their attention to the possibility that the rivers would reach elevation 32.5 feet. If the waters reached this height the majority of Winnipeg's downtown area would have been submerged, the central railway installations would have been inoperative, the warehouse area of the City with its stocks of food and supplies would have been inaccessible, with bakeries and dairies crippled. But most serious, all means of communication would have been blacked out and the water supply crippled and sanitary facilities non-existent with very large segments of the population stranded in their homes without the facilities to maintain themselves.

Brigadier Morton had consequently struck off a planning committee under the chairmanship of Brigadier R. S. Malone to prepare what was known as "Operation Blackboy" and another committee under the chairmanship of Brigadier W. Megill to prepare a rehabilitation plan known as "Operation Rainbow". "Operation Blackboy" fortunately never required proclamation and was to go into effect only by authority of the Premier of Manitoba. It would have given Brigadier R. E. A. Morton complete administrative control of Greater Winnipeg; would have provided for the evacuation of 40,000 persons per day by rail, air and road leaving 75,000 men and women in the City as a flood fighting force; and it would have provided for standby trainloads of food and clothing. The master evacuation plan including large overlay maps showed proposed zone headquarters, temporary shelters, sites for fire fighting and other emergency equipment, loading areas for railways and all other information essential to its operation.

However, after May 13th, a steady slow daily fall in river levels made any such considerations unnecessary.

On Monday, May 15th, Flood Control found it necessary to advise a large scale evacuation of St. Boniface and Norwood owing to the fear that a sudden collapse of the

dykes might drown many people and accordingly some 15,000 residents left the city. As the river started to fall slowly, the volunteer effort slackened and Brigadier Morton warned that there must be no let down.

The first public intimation of the existence of "Operation Blackboy" came with the announcement from Ottawa on May 15th, that the Air Transport Board was preparing a gigantic airlift capable of evacuating 9,000 persons daily from Winnipeg. Our only fear by May 16th was that relaxation of work on the remaining saturated dykes might cause their collapse. On May 18th we had succeeded in putting into operation a very large pump obtained from the City of Ottawa to keep dewatered part of the flooded portion of downtown Winnipeg.

The threat now turned to the south side of the City where McGillivray Boulevard was holding back what was known as "Lake Morris", a solid sheet of water extending back to Morris, Manitoba. High winds and rain were threatening to drive this water across McGillivray Boulevard and then overland to the Assiniboine River which would have flooded the River Heights district of Winnipeg. Weary volunteers and sandbags prevented this from happening and a portion of the rail line of the Canadian National Railway south of Fort Garry was dug out to relieve the pressure. By May 22nd it was apparent that the river was receding and we were now becoming more concerned with rehabilitation than with flood fighting.

On May 27, the City of Winnipeg Flood Control Committee closed its doors and we returned to ordinary departmental administration which was faced with the immediate need for cleaning up and for rehabilitation of the City. It was thought at first that this might be carried out as a metropolitan effort under "Operation Rainbow" but this was abandoned in favour of each community attending to its own problems. The Rehabilitation effort might be likened to the period of convalescence following a very serious illness, a slow upward climb filled at times with despair.

The story of the flood that I have related concerns largely the engineering and public works aspects of the same and deals principally with matters with which the author was directly concerned. It does not in any way purport to deal with the magnificent work carried out by the Red Cross, the welfare agencies, the transportation and communication services, the provision of food and clothing, the tremendous volunteer effort, the medical problems, survey and intelligence, and the public information services, to name only a few. There are also other matters of interest and importance with which I have not dealt; for example, the establishment of the financial relief commissions, the subsequent establishment of the Greater Winnipeg Dyking Board and the remedial works constructed by it, and the later report of the Red River Basin Investigation and the work of the various rehabilitation committees and organizations. These are all matters which in themselves justify a separate paper, and the author having only nominal contact with most of them proposes to leave the task to others.

The convalescence, however, was so successful that a year later it was most difficult to find physical evidence of the damage created by this disaster.

Now what of the future:

Snow surveys are now made by the Manitoba Government as well as by the U.S. Corps of Engineers and a flood forecasting technical committee has been set up. This together with numerous level and gauging stations along the rivers provides necessary technical information.

The Winnipeg Dyking Board constructed in 1951 a system of dykes and pumping stations covering a large portion of the areas along the Red River in Greater Winnipeg, and the City of Winnipeg up to the present time has added and is adding further dykes and pumping stations along the areas adjacent to the Assiniboine and along that portion of the areas adjacent to the Red River which the Dyking Board did not cover. These substantial works under enforced maintenance by a provincial dyking commissioner should easily be able to contain a flood 4 feet below the level of the 1950 flood with provision being made for emergency raising of the dykes to contain the 1950 flood level in Winnipeg and certain of the suburban municipalities. Works to contain floods of greater magnitude must await the implementation of the Red River Basin Investigation report. In a paper delivered in March, 1950, to the Winnipeg Branch of the Engineering Institute of Canada, I said: "Flooding of the Red River has been a problem since the area was first settled by white men-that we will have floods in the future appears certain from a study of the history of the past." This is as true today as it was in early 1950, but, with the provision of engineering works constructed since that time we should be able to contain floods of medium proportions such as those of 1948 and 1950. If the economic prosperity of Canada continues and very large expenditures are justified, control measures can be fashioned to take care of floods of almost any magnitude in the Greater Winnipeg area. Unfortunately, however, the full protection of the Valley south of Ste. Agathe does not seem probable.

Since Archbishop Matheson read his paper in 1932, the engineering profession has undertaken works of a kind that should serve to relieve human suffering and protect property when natural conditions give rise to the flooding of our fruitful and beloved Red River Valley.

Bibliography

1. H. S. Seaman - Manitoba Landmarks and Red Letter Days 1610-1920 (Winnipeg N.N., 1920) page 17.
2. Elliott Cones, ed., The Manuscript Journals of Alexander Henry and of David Thompson, Volume I, The Red River of the North (New York: Francis P. Harper, 1897) et passim.
3. Alexander Ross, The Red River Settlement, Its Rise, Progress and Present State (London: Smith, Elder and Co. 1856) Page 107.

4. M. M. Quaife, *Alexander Henry's Travel and Adventures* (Chicago Lakeside Press, 1921) Chapters 10 and 11.
5. Mr. Fidlers Journal Selkirk Papers, Vol. 69, Hudson's Bay Company Archives No. 18460.
6. D. Gunn and C. R. Tuttle - *The History of Manitoba*, MacLean, Roger and Company, Ottawa, 1880.
7. Hudson's Bay Company Archives B235/a/7, folios 32d - 46. Journal of Occurances by Francis Heron kept at Fort Garry, 1 January 1825 to 31 July 1826.
8. Hudson's Bay Company Archives D.4/89 folios 71-73d. Report of Governor George Simpson to Hudson's Bay Company Committee, London, Norway House, June 14, 1826.
9. Documents relating to Northwest Mission 1815-1827. A letter of Bishop Provencher to Bishop Panet July 15, 1826. Grace Lu Nute, Editor, Minnesota Historical Society, Saint Paul, 1942.
10. L'Abbe G. Dugas, *Monseigneur Provencher et les Missions de la Riviere Rouge*, Montreal, C. V. Beauchemin and Fils, 1889.
11. A letter by Jim Pritchard written in 1826 cited in a paper by S. P. Matheson, "Floods at Red River" before Historical and Scientific Society of Manitoba, Series III, No. 2 Winnipeg, 1947.
12. D. Anderson, *First Bishop of Rupert's Land, Notes of the Flood at Red River in 1852* (London, Hatchards, 1873).
13. Hudson's Bay Company Archives B235/a/15 folios 4d-7, Mr. Black's Private Journal, Upper Fort Garry, 1852.
14. Diary of Dr. William Cowan, Surgeon to enrolled army pensioners at Fort Garry from April 21, 1852 to May 28, 1853. Manitoba Provincial Library Archives.
15. Hudson's Bay Company Archives D5/34, folios 49-49d. A letter by Chief Factor James Bird, dated July 6, 1852 at Red River Settlement and addressed to Sir George Simpson.
16. Hudson's Bay Company Archives D 5 /34 folio 21d, from a letter by Chief Factor Donald Ross, dated July 2, 1852, at Red River Settlement to Sir George Simpson.
17. Hudson's Bay Company Archive A 12/13, folios 94-5, from a letter by Governor Eden Caldwell, dated May 18, 1852, at Lower Fort Garry to Arch'd Barclay, Secretary.
18. Flood of 1852 by Abbey Leonide Primeau, *Annual Chronicle*, 1852.

19. "Bishop Provencher, Pioneer" Winnipeg Free Press, February 17, 1940, from a letter of Bishop Provencher to Archbishop of Quebec, July 6, 1852.
20. Hudson's Bay Company Archives All/96 folio 569d. From a letter dated at Fort Garry, May 16, 1861 by W. Mactavish, A/Governor of Rupert's Land to Thomas Fraser, Secretary.
21. The Nor'Wester issues of May 1, 1861 and June 1, 1861, A fortnightly newspaper, Fort Garry Territory of Rupert's Land.
22. Manitoba Daily Free Press, May 6, 1882.
23. Canada Sessional Papers, Vol. XIII, No. 11, 1880, paper 123, Appendix 16, pages 264 to 285.
24. The Glacial Lake Agassiz - U. S. Geological Survey. Monograph XXV, 1896, Warren Upham, Government Printing Office, Washington.
25. Notes on Red River Floods, R. H. Clark, Department of Mines and Natural Resources, Manitoba Government, 1950.
26. Narrative of the Canadian Exploring Expedition of 1857. H. Hinds, London, Longman, 1860.
27. The Floods of the Red River Valley, Elwyn F. Chandler, Quarterly Journal, University of North Dakota, Volume VIII, No. 3, April, 1918.
28. What Becomes of Rainfall in North Dakota, Elwyn F. Chandler, Quarterly Journal, University of North Dakota, 1924.
29. Area of the North Dakota River Basins, Elwyn F. Chandler, Quarterly Journal, University of North Dakota, Volume XII, No. 3, April, 1922.
30. Damming the Red River of the North - Elwyn F. Chandler, Quarterly Journal, University of North Dakota, 1924.
31. The Dakota-Minnesota Interstate Drainage Suit - The Quarterly Journal, University of North Dakota, Volume XI, No. 3, April, 1921.
32. Report on Drainage and Prevention of Overflow in the Red River of the North. U. S. Department of Agriculture, Bulletin 1017, March 31.1922.
33. Diversion of Water from the Missouri River into Red Proposed - Winnipeg Evening Tribune, A. V. Thomas, November 11, 1933.

34. Records of Century Disprove Theory that West is Becoming Desert Area - H. C. Knox, Winnipeg Evening Tribune, November 4, 1943.

35. Winnipeg Will Experience No Floods in Spring - H. C. Knox, Winnipeg Evening Tribune, March 3, 1934.

36. Cost of Floods - C. E. L'ami, Winnipeg Evening Tribune, February 6, 1937.