

WINNIPEG RIVER

Establishment of Sounding Datum

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ESTABLISHMENT OF SOUNDING DATUM

PROJECT: Establish sounding datum for the Winnipeg River. (from Kenora to Whitedog Falls) and collect data on the river gradients and gradient changes for use in establishing chart datum.

PERSONNEL: B. Tinney Tidal Officer
J. Gervais Tidal Technician
D. Robertson Seaman (available from Kenora survey)

DURATION: May 12, 1977 - May 23, 1977
D. Robertson was involved May 18, 20, 21st

BACKGROUND AND OBJECTIVES

Due to the lack of datum information on the area of the Winnipeg River which will be surveyed during the summer of 1977, it will be necessary to establish sounding datum and to gather information for the definition of chart datum during the survey.

Some information concerning the hydraulic gradient of the river between Kenora and Boundary Falls was available from Ontario Hydro, who are mainly concerned with the operation of power stations, and from Water Survey of Canada, Winnipeg. Water levels were available from the tailwater gauges at the Kenora and Norman generating stations at Kenora, from the gauge at Minaki, from the headwater and tailwater gauges at the Whitedog Falls generating station and from the tailwater gauge at the Caribou Falls generating station. Daily mean water levels from these gauges since the completion of the Whitedog Falls generating station in 1958 can be analyzed to determine suitable levels for sounding datum at these gauge sites.

However, there is a difference in river level between Kenora and Whitedog Falls of several feet under average flow conditions. The change in level does not occur gradually. There are several locations where there are abrupt changes in level. The major task in establishing datum will be to determine locations on the river where significant changes in level occur and to assess the magnitude of these changes. Specifically, it will be necessary:

- (i) to determine whether the tailwater gauge at the Kenora generating station represents the levels in the river below the dam. This will require the establishment of a temporary gauge in the river below the dam and the comparison of levels from the two gauges.

In the event that the tailwater gauge does not represent river levels, the temporary gauge must be retained to supply levels during sounding operations. Otherwise the tailwater gauge will suffice.

- (ii) to install temporary gauges above and below the channel "the Dalles" using a bench mark available in the area. The levels from the gauge above the channel will be compared with those from Kenora to determine if there is a significant drop in this portion of the river. The levels from above and below the channel will be used to assess the drop in level through the channel. The levels from below the channel will be compared with levels from the gauge at Minaki to assess the drop in this portion of the river.
- (iii) to examine either one or two areas in the west branch of the river between Kenora and Minaki where significant drops in the river surface are reported. It will be necessary to install gauges above and below these stretches of the river, to run level lines between the two gauges (there are no bench marks in this area) and to compare the drop in river level through these stretches with the difference in levels between Kenora and Minaki.
- (iv) to determine if a significant drop in river level occurs in the area at the railway bridge in Minaki. This will require the installation of a temporary gauge below the bridge using local bench marks, and the comparison of levels from this gauge with those from the Minaki gauge (located above the bridge). If there is a significant difference in these levels then the temporary gauge must be retained below the bridge to provide levels for reduction purposes while the area from Minaki down to Whitedog Falls is being surveyed. Otherwise, the permanent gauge at Minaki may be used.

- (v) to examine either one or two reported stretches of fast water in the section of the river from the outlet of Rough Rock Lake down to the Whitedog Falls generating station. It will be necessary to level through these stretches (there is at least one existing bench mark in this area) and to compare the change in elevation with the difference in water levels at Minaki and at the Whitedog Falls headwater gauge.
- (vi) to determine if the water levels at the Whitedog Falls headwater gauge accurately reflect the water levels in the river above the dam (i.e., if there is significant draw-down in the headwater pond).
- (vii) to ensure that there is reasonable agreement between the sum of the changes in elevation of the river surface at the sites mentioned above and the total change in water level as measured at the Kenora and at the Whitedog Falls gauges.

Based on the above data, the river will be divided into sections and a sounding datum assigned to each section to reflect the hydraulic gradient of the river. Hopefully, chart datum will be determined using this data and the historic water levels, however, the river is apparently at record low levels this summer and the hydraulic gradient determined from the above levelling may not be applicable during average flow conditions.

SURVEY RESULTS

In order to establish any sounding datums for the various river sections between Kenora and Whitedog Dam, water level records for certain locations had to be examined. Before 1958, the river was free flowing but in 1958 the Whitedog Generating Station was built making the river a controlled system dammed at both ends. Therefore, daily mean water levels from 1959 to the present were obtained from Ontario Hydro for the Whitedog Generating Station headwater gauge and the permanent gauge just above the bridge at Minaki. To complete the data, daily means for the Kenora Dam and Power House tailrace gauge were obtained from Water Survey of Canada.

With this information, frequency distribution curves were drawn for:

(1) Whitedog G.S. (headwater); (2) Minaki; (3) Kenora Power House (tailrace). These curves then allowed us to select sounding datums for each of the above locations in accordance with the hydrographic definition which states that sounding datum will be such that the water shall seldom fall below it. For the above locations, the following values were determined:

- | | |
|------------------|-------------------|
| 1) Whitedog G.S. | 314.9 metres, GSC |
| 2) Minaki | 316.1 metres, GSC |
| 3) Kenora | 316.8 metres, GSC |

However, the hydraulic characteristics of the river had to be determined and the river divided into sections on the basis of these characteristics so that a sounding datum could be assigned to each section. This field work was done in several stages.

1. The survey camp was situated at Millers Rapids, approximately 2.5 kilometres downstream from the Kenora Powerhouse and Dam. The drop in river elevation from the powerhouse to the camp had to be determined. A level line was run from a GSC bench mark (69-0-023-'69 - 326.691 metres) on Highway 17 to the bench marks established at camp while tying into the bench marks and staff at the powerhouse. First order accuracy was obtained over the 8.1 km circuit. The stated elevation of the powerhouse B.M. MHS 2-A obtained from W.S.C. personnel was confirmed at 324.49 metres Lake of the Woods datum. (To obtain GSC datum from Lake of the Woods datum, you must subtract 0.58 feet). The elevations of the three bench marks established at Millers Rapids were determined to be:

- | | | |
|-----|------|-------------|
| B-1 | 1977 | 320.045 GSC |
| B-2 | 1977 | 320.897 GSC |
| B-3 | 1977 | 320.557 GSC |

With an elevation at Millers Rapids it was possible to measure the water level drop from the Kenora powerhouse tailwater. Using the elevations of a temporary bench mark at the Kenora dam and

B-1 at camp, the water levels at the above locations were levelled in and a drop of 0.08 metres from the Kenora dam tailwater to the camp was found.

2. The drop from the camp to the Dalles in the east arm and the as yet unknown constriction in the west arm had to be determined, GSC bench mark 26-K ('23) at 319.095 metres GSC just above the Dalles was recovered. Levelling to the water above the Dalles showed a drop of 0.05 metres from the camp to the head of the Dalles. The terrain at the Dalles made it impossible to run a level line around the swift current there.

The west arm had no available bench marks so after observing the current flow at several likely constrictions, a level line was run around the constriction at Throat Rapids. This constriction was the only one in the west arm with a noticeable current. The drop was found to be 0.003 metres. The west arm has several possible locations for a sharp gradient including Myrtle Rapids, but Throat Rapids appeared to be the most significant. According to local fishing guides the situation is quite different during higher water conditions.

3. The water level had to be determined at Minaki to evaluate the drop through both arms from Kenora. Bench mark CNRY 944('20) was recovered at Minaki. The B.M. has an elevation of 324.764 metres GSC and is located on the CNR bridge at Minaki. The water level was then checked at Minaki above the bridge and showed a 0.02 m drop from above the Dalles. A bench mark was recovered at MacFarlane River, CNRY 946 ('20) 325.562 m to check the drop from below the Dalles to Minaki. The water level at MacFarlane River was 0.01 m below upper Dalles and 0.01 m above Minaki's level. While it appears that B.M. 946 could be on the gradient of MacFarlane River, there was no current visible below the railway bridge.
4. The drop from above the bridge at Minaki to the Whitedog Generating Station had to be determined. The water level at Whitedog was read at the headwater staff and, when compared with the level at Minaki above

the bridge, a drop of 0.03 m was found. There were two constrictions in the river just above the generating station and it appeared that most of the drop should occur there although no current was visible. The constriction at the Minaki bridge appears very wide and deep when compared to the other locations and no current was visible there either.

The water level elevations to GSC are shown below, including the dates in May when the readings were taken:

Kenora Powerhouse (below)	May 17, 18	316.25
Millers Rapids	May 18, 19, 20, 21, 22	316.17
The Dalles (above)	May 18, 20	316.12
MacFarlane River	May 20	316.11
Minaki (above)	May 19, 20, 21	316.10
Whitedog G.S. (above)	May 19, 21	316.07

The weather was excellent and the water level readings were within ± 0.01 metres at each location.

All but one of the drops were determined by differences in elevation. The levelling around Throat Rapids did show a drop although minute. This indicates that the gradient in this area is much more constant and no obvious boundary line could be seen in the west arm. Since the drop overall is so small, Throat Rapids could be called the western counterpart to the Dalles and delineate the upper section.

Below Minaki, there is a unique constriction about 3 km upstream from Whitedog Generating Station. The water below this point is at the controlled high water of the dam. The water above this point appeared to be 1 to 2 feet below the high water line clearly evident on the shore. There was no current in this area but the evidence of usual high water on the shoreline indicates that the area above this constriction to Minaki should be on separate datum. Since it is almost flat now, we could not determine the usual drop. For now, the Minaki datum should suffice until higher levels occur and usual gradients can be determined.

The sounding datums chosen and supplied to George Macdonald (HIC - Winnipeg River Survey) are:

- | | |
|---|---------------------------|
| 1) Kenora to Throat Rapids and Dalles
based on 7.81% daily means at Kenora
(1959-1976) | 316.70 metres *
G.S.C. |
| 2) Dalles and Throat Rapids to Minaki
based on 7.25% daily means at Minaki
(1959-1976) | 316.10 metres
G.S.C. |
| 3) Minaki to Constriction above Whitedog
Generating Station not established -
assumed the same as (2) | 316.10 metres
G.S.C. |
| 4) Constriction above Whitedog Generating
Station to Whitedog Generation Station
based on 7.04% daily means at Whitedog
Generating Station (1959-1976) | 314.90 metres
G.S.C. |

* This value has been reviewed to 316.50 metres and is described in the next section.

NOTES ON WINNIPEG RIVER WATER LEVEL REGULATION - KENORA TO WHITEDOG GENERATING STATION

1. The Lake of the Woods control board determines the outflow from Lake of the Woods.
2. Whitedog Generating Station can use up to 17,000 cfs; flows over this amount must be passed over the sluice gates.
3. For flows up to 25,000 cfs, the level at Minaki is held as close as possible to 316.26 metres GSC by regulating the level of the Whitedog Generating Station forebay.
4. For flows in excess, the Whitedog Generating Station has no effect on the water levels at Minaki.
5. Levels at Minaki can fluctuate when outflow is less than 17,000 due to using the Whitedog Generating Station as a "peaking plant".
6. For flows greater than 21,000 cfs, the Whitedog Generating Station forebay is held low (not affecting Minaki) at 314.89 m G.S.C.

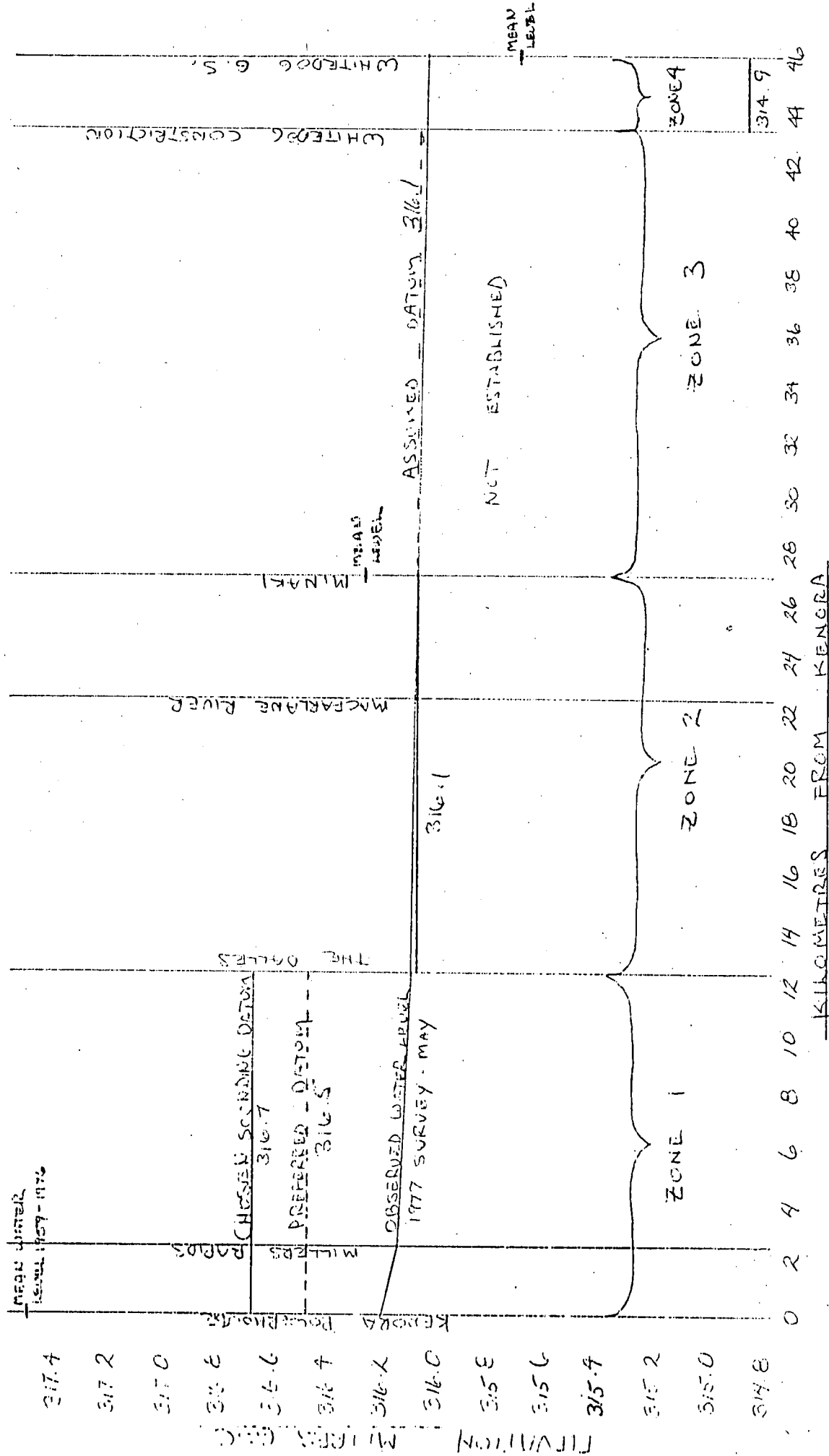
Upon returning to Burlington, a discrepancy was discovered in the datum of the Kenora Powerhouse Tailwater water levels. The Water Survey office in Keewatin has been sending the above data to Winnipeg as Lake of the Woods datum just as it is recorded. The Water Survey office in Winnipeg has assumed the water levels are to Geodetic Datum and no corrections were made. A change of datum elevation was necessary as we had followed the Geodetic note. The discrepancy has been cleared up with Water Survey of Canada in Winnipeg and a preferred sounding datum established for the section between Throat Rapids and the Dalles. This datum is 316.50 metres GSC based on 5.94% exceedance value of daily means at Kenora (1959-1976).

The outflow during the survey was very low at 2200 cfs. This is a very low year with the current water level at Kenora 0.23 m below the all-time low

of 1959-1976. The evidence of this can be clearly seen on the shoreline. The high water line (it appears to be a usual water line) is about 3 feet dry at Kenora, 2 feet above Minaki and 1-2 feet above the Whitedog constriction. Discussions with the wharfingers indicate several locations of strong current during high outflow periods. These locations are marked on the attached map. Further investigation is required during a period of increased outflow to properly establish the normal hydraulic gradient of the river. This will be necessary before accurate Chart Datums can be chosen.

WINNIPEG RIVER

DATUM SURVEY RESULTS



MANITOBA
ONTARIO

WINNIPEG RIVER

1:250000

Hwy 17

Hwy 641

THROAT RAPIDS

CONSTRICION

Keewatin
BM 67-C-023

DAM (KENORA)

MILLERS RAPIDS

BM 133

THE DALLIES

BM 26 K

BM 946

MINAKI BM 944

3

SAND LAKE

ROUGHROCK LAKE

DAM

CONSTRICION

WHITE ROCK CONSTRUCTION

WHITE ROCK C.S.

DAM

CONSTRICION

4

DAM

DAM

