

## Explanation of Datum Conversions near Round Lake

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Several historic documents indicate that some of the gages and benchmarks in the Round Lake region may not be accurate and that they are not all relative to the same datum. This document describes some of the noted discrepancies and describe the conversions necessary to bring the data into a common local datum.

### Discussion of Discrepancies

Historic documents indicate that the Tiger Cat Dam benchmarks were established on or before August 2, 1938 (CAR 0406). Dates for establishment of the other benchmarks were not determined, but it appears that the Lake Placid Dam and Little Round Lake Dam benchmarks were in the same datum as the Tiger Cat Dam (CAR 0420). Benchmarks that are in the same local datum would, by definition, have the same conversion to NGVD 29<sup>1</sup>: the two datums would be parallel and a set distance apart.

The local datum elevation is an assumed arbitrary elevation (typically elevation 100) defined when a benchmark is established and not connected to any other known datum. A local datum is typically established at one benchmark and other benchmarks in the area are established relative to the original benchmark to maintain consistency of elevations within the area (typically by transferring elevations in a survey).

Table 1 lists the local datum elevations (A) of the benchmarks in the Round Lake area. The historic NGVD 29 elevation at each of the benchmarks appears to have been defined in the late 1980's and was hand written on several historic documents (as noted in Table 1 (B)). The computed conversion between the local datum and NGVD 29 (based on historic records) is also listed (C). The computed conversions between local datum and NGVD 29 ranged from 1268.02 to 1268.31, a difference of 0.29 feet.

Other survey data from 2002, conducted by Dave Rieder using global positioning system (GPS) equipment, indicated a conversion of 1267.75 at the Little Round Lake Dam (1127C) and a conversion of 1268.02 at County Highway NN (1127E) between the local datum and NAVD 88<sup>2</sup>. These new conversions have been used in the past to convert between local datum and NAVD 88<sup>2</sup> (MA 1276 – MA 1280) elevations, thus increasing the range of conversions from 1267.75 to 1268.31, a difference of 0.56 feet.

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<sup>1</sup> NGVD 29 (National Geodetic Vertical Datum of 1929) established by the National Geodetic Survey (NGS) as the national vertical control network, related to mean sea level.

<sup>2</sup> NAVD 88 (National American Vertical Datum of 1988) is the new national standard established by the National Geodetic Survey (NGS) for the national vertical control network, related to mean sea level.

## Explanation of Datum Conversions near Round Lake (Cont.)

In addition to the range of conversions, readings taken at Kaiser's Resort staff gage were also noted to read 0.27 to 0.37 feet too high<sup>3</sup> when compared to readings based on other benchmarks. Historic documents do not typically refer to this staff gage for lake level readings; however it was used to determine the state designated levels (as discussed below).

**Table 1**  
**Historic Local Datum Conversions to NGVD 29**

Benchmark		Local Datum Elevation (A) (feet)	Historic NGVD 29 Elevation (B) (feet msl)	Computed Conversion (C) (feet)	Source
Location	Number				
Tiger Cat Dam	854B	93.84	1361.86	1268.02	CAR 0396 & CAR 0406
Lake Placid Dam	879A	102.26	1370.57	1268.31	CAR 0416 & CAR 0431 & DNR 01642
Lake Placid Dam	879B	93.52	1361.83	1268.31	CAR 0416 & CAR 0431 & DNR 01642
Little Round Lake Dam	1127C	85.34	1353.59	1268.25	DNR 00649 & DNR 01644
County Highway NN	1127E	82.56	1350.81	1268.25	DNR 00595

Computations:  $(C) = (B) - (A)$

### Conversion to NAVD 88 Datum

The discrepancies described above may have a significant impact on an analysis of historic levels and a floodplain analysis because the recorded levels may be incorrect if the benchmarks are not tied (connected) to the same local datum.

Therefore, additional analyses were conducted to bring all of the data into a common datum. The adjustments were developed based on a GPS survey of the benchmarks and converting the historic data using the best available information from historic documents.

The conversion has to be tied to one benchmark that is assumed to have the correct conversion; the Tiger Cat Dam datum was assumed to have the correct conversion to the local datum (NAVD 88 elevation - 1268.02 = adjusted local datum elevation<sup>4</sup>). This assumption

<sup>3</sup> References:      1967 – DNR 00623      1959 – DNR 00660  
                         1966 – SC 1241      1960 – SC 0869

<sup>4</sup> The conversion from NGVD29 to NAVD88 was obtained after the data was adjusted and the conversion established. Near Round Lake the conversion ranges from -0.07 to -0.10 feet (Corpscon software).

## Explanation of Datum Conversions near Round Lake (Cont.)

eliminated any need to adjust measurements on the Tiger Cat Flowage. If a different benchmark were selected as the base, all of the levels would be adjusted with the same factor and the results would be identical but shifted up or down by this factor.

The GPS survey was conducted by North 40 Land Surveying using the ProMark2 GPS system. Specifications for this equipment are attached, along with data from the Sawyer County GPS network and information from the survey. The vertical accuracy of the instrument is 0.01 meters, which is 0.4 inches or 0.03 feet. The required vertical accuracy for this survey was within 0.04 meters, which is 1.6 inches or 0.13 feet.

Table 2 compares the historic NGVD 29 datum elevations (A) (from historic documents) to the NAVD 88 elevations (B) that were surveyed using the GPS equipment. The historic local datum elevations (C) from documents are also compared to the adjusted local datum elevations (D) (computed by subtracting 1268.02 from the GPS elevation). The adjustment to historic levels (E) is the difference between the historic local datum elevation and the adjusted local datum elevation. These adjustments for each benchmark were used to convert the historic water levels to the adjusted local datum. For example, all the historic Round Lake levels that were taken based on the Little Round Lake Dam benchmark were adjusted down by 0.27 feet to convert them to the adjusted local datum.

**Table 2**  
**Local Datum Conversion using NAVD 88**

Benchmark		Historic NGVD 29 Elevation (A) (feet msl)	GPS NAVD 88 Elevation (B) (feet msl)	Historic Local Datum Elevation (C) (feet)	Adjusted Local Datum Elevation (D) (feet)	Adjustment to Historic Levels (E) (feet)
Location	Number					
Tiger Cat Dam	854B	1361.86	N.A.	93.84	93.84	0.00
Lake Placid Dam	879A	1370.57	1370.20	102.26	102.18	0.08
Lake Placid Dam	879B	1361.83	1361.41	93.52	93.39	0.13
Little Round Lake Dam	1127C	1353.59	1353.09	85.34	85.07	0.27
County Highway NN	1127E	1350.81	1350.58	82.56	82.56	0.00

Computations:           (D) = (B) – 1268.02  
                                  (E) = (C) – (D)

## Explanation of Datum Conversions near Round Lake (Cont.)

### State Designated Water Level Conversion

According to PSC Order 2-WP-513, on July 29<sup>th</sup> and 30<sup>th</sup>, 1941 the staff gage at Kaiser's Resort was used to define normal water level, which was used to establish the state designated normal and maximum water levels. However, Kaiser's staff gage<sup>5</sup> was noted to read 0.27 - 0.38 feet high on various occasions between 1959 and 1967<sup>3</sup>, when compared to lake level readings based on the Lake Placid Dam benchmark.

Based on this reported discrepancy, the state designated levels were lowered using a conversion of 0.37 feet (historic records from 1959, 1966, and 1967 all note conversions of 0.37 – 0.38 feet).

Table 3 lists the historic data from the Kaiser's staff gage at the state designated normal water level and also shows the conversion made to the adjusted local datum. The conversion to the adjusted local datum was taken from the Lake Placid Dam benchmark (0.13 feet).

The normal water level on Round Lake in this adjusted local datum is 76.5 and the designated maximum water level is 76.75.

**Table 3**  
**State Designated Normal Water Level Conversion**

Source	Round Lake Elevation (A) (feet)	Local Datum (B) (feet)	Adjusted Local Datum (C) (feet)	NAVD 88 Elevation (D) (feet msl)
	Kaiser's Staff Gage	Lake Placid Dam Monument	Barr Conversion	GPS Survey
Historic Data (1941 – 1967)	77.0	76.63	Not Available	Not Available
GPS Survey (2003)	Not Available	76.63	76.50	1344.52

Computations:      (B) = (A) – 0.37  
                               (C) = (B) – 0.13  
                               (D) = (C) + 1268.02

<sup>5</sup> The staff gage at Kaiser's Resort has been removed, and data can no longer be obtained or verified.