RADIOCARBON DATING OF BEACHES AND OUTLETS OF DEVILS LAKE

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Introduction

Devils Lake has been generally rising since 1940 (fig. 1). It reached a level of 1,428 feet above sea level in 1988, but has since fallen about four feet, due to drought conditions during the past three years. North Dakota Geological Survey geologists began studies about three years ago to try to determine the frequency with which the level of the lake fluctuates, specifically to determine how recently the lake has risen higher than the 1,445-foot level. At that level, Devils Lake overflows to the east into Stump Lake. When the water reaches a level of 1,457 feet, the combined Devils Lake-Stump Lake overflows to the Sheyenne River through Tolna Coulee. It has not been known for certain, until now, whether Devils Lake overflowed into Stump Lake at any time since sometime prior to Hypsithermal time, more than 7,000 years ago and it has been considered unlikely that the combined Devils Lake-Stump Lake system overflowed to the Sheyenne River since that time. Hobbs and Bluemle (1987) suggested that overflow to Stump Lake occurred more recently than that, perhaps as recently as two or three thousand years ago; even so, they had no firm evidence to prove or disprove that assertion.

In November of 1987, geologists with the North Dakota Geological Survey sampled a buried soil horizon along the shore of Devils Lake in several places. Samples were submitted to the United States Geological Survey Radiocarbon Laboratory in Reston, Virginia for radiocarbon dating and we got the results in March, 1988. In September, 1988, NDGS geologists sampled buried soil horizons and a buried bone sample from the Jerusalem outlet east of Devils Lake and from the outlet leading from Stump Lake to Tolna Coulee. These samples were also submitted to the USGS Radiocarbon Laboratory. We obtained the results in September, 1990. This report is a summary of the results of this study along with a brief analysis of the implications of the dates.

Description of Field Studies

Samples from Beach Deposits

The beaches along the northeast shore of the East Bay of Devils Lake about two miles southeast of the town of Devils Lake were sampled in 1987 by using a backhoe to dig trenches across the beach ridges. Samples were obtained from the highest beaches, which range from 20 to 30 feet above the modern lake level. Some of the buried soil samples were not submitted for dating because they appeared to be contaminated by modern plant roots, but four samples judged to be datable were obtained from three localities near the Mertens Lakeview Dairy Farm (Sec. 7, T. 153 N., R. 63 W. and Sec. 12, T. 153 N., R. 64 W.).

The buried soil zones studied along the northeast shore of Devils Lake are overlain by beach gravels and underlain by offshore and nearshore lake sediments. Although it was possible to identify what appeared to be the same buried soil zones in several other places as far as four or five miles to the west of Mertens Lakeview Farm, the soils were well preserved only in the area of Lakeview Farm. Descriptions of the geologic sequences encountered in the backhoe excavations are included in figures 3, 4, and 5.

Samples from the Jerusalem Outlet

The Jerusalem Outlet is the natural channel that carries overflow from Devils Lake to Stump Lake when the water level in Devils Lake rises high enough. The location of the excavation was the SE/4 SE/4 Sec. 24, T. 152 N., R. 62 W. and the surface elevation at the floor of the outlet at this is 1,444 feet. We excavated a 10-foot-deep trench in a meadow near the center of the channel, sampling a buried soil developed on a black lake clay at a depth of 4.5 feet. The lake clay lay beneath two separate fluvial layers, which are separated by

another lake clay. It can be inferred that, at some time after the sampled soil formed, it was washed by running water. A lake then flooded the area again, drained away, and the area was again washed by running water. The geologic sequence exposed in the cut is illustrated on figure 6.

Outlet from Stump Lake to Tolna Coulee

Stump Lake would overflow into Tolna Coulee and on to the Sheyenne and Red Rivers through this outlet if the lake rose to a level of 1,457 feet. We excavated a 20-foot-long trench to a total depth of between 9 and 10 feet in the middle of the outlet channel. The excavation penetrated mainly layered gravelly sand that was interpreted to be of fluvial origin (because the sediments were wet, they ran into the excavation, making an accurate description of the stratigraphy impossible). At a depth of 9 feet, we found a bone in a gray to black carbonaceous material that appeared to be a paleosol; this material was not sampled.

The bone was identified as part of a right metatarsal of a bison. Its small size suggested that it was from either a juvenile or female animal. The bone was submitted to the USGS for possible dating and, although it appeared to be solid and well preserved, it was not possible to date it.

Preliminary Conclusions

Generally, the sequence of beds exposed by the backhoe cuts , both in the beaches and in the outlet channels, suggests that, after Devils Lake had risen to relatively high levels that resulted in the deposition of beach sediments, its level dropped sufficiently and for long enough periods of time to allow extensive soil development on the beaches and in the channels. When the lake rose again, it flooded the soils and deposited more beach sands over them. Each time the lake rose high enough to overflow out of its channel into Stump Lake, the flowing water deposited gravel over the existing soils. The lake remained at levels high enough to flood the areas of the channels for prolonged periods of time and layers of lake sediment accumulated there.

The radiocarbon dates we obtained on the soils we sampled indicate that Devils Lake has risen, several times, to levels higher than 1,447 feet in post-Hypsithermal time (since 4,000 years ago). Whenever Devils Lake reaches a level of 1,445 feet, it overflows into Stump Lake. The dates we obtained from the soils further show us that a complex series of relatively recent fluctuations (since 2,800 years ago) have occurred in the level of the lake.

Sample 1 (the lower sample at the first beach excavation) was dated at 2,760 $\pm$ 200 years B.P. (before present) and sample 2 (the upper sample at the same beach excavation) was dated at 2,150 $\pm$ 200 years B.P. The two horizons are separated by beach sand and the upper horizon that we dated (sample 2) is covered by multiple beach deposits.

The dates on samples 1 and 2 indicate that, at least twice in the interval between 2,760 and 2,150 years ago, the level of Devils Lake dropped below about 1,443 feet. It rose above that level (although we don't know how high) at least once in that time interval. It then rose above 1,443 feet, to at least 1,447 to 1,448 feet, sometime since 2,150 years ago (perhaps several times).

Sample 3, which was dated at 720 $\pm$ 200 years B.P., is inconclusive insofar as defining the geologic situation of the changing levels of Devils Lake. The date may, however, be useful in our further interpretations of the geologic history.

Sample 4, dated at 1,800 $\pm$ 200 years B.P., shows that Devils Lake rose above a level of 1,455 feet--to at least 1,457 feet--sometime since 1,800 years ago. This is important new information in view of the fact that, until now, we had no real evidence that Devils Lake had nearly that high at any time since the Hypsithermal. As noted earlier, at a level of 1,457 feet, the combined Devils Lake-Stump Lake would overflow through Tolna Coulee into the Sheyenne/Red River drainage system.

Sample 5, taken from a buried soil in the Jerusalem Outlet channel, was dated at 2,380 $\pm$ 120 years B.P. It shows that Devils Lake reached a level high enough to overflow into Stump Lake at some time since 2,380 years ago. This information verifies the evidence indicated by the radiocarbon dates on the beaches. The presence of a 1 1/2-foot-thick layer of lake clay overlying the dated soil, also a lake

bed, indicates that the lake remained at a level high enough to flood the channel for a prolonged period of time at some time since 2,380 years ago.

Discussion

Dates on soils are often imprecise. Soils may be multiple and they may span a long period of time. A date on a soil may be a combination of an accretionary age (when the soil accumulated), the age of the decomposed rootlets (which may include modern contaminants), and humic acid additions. All of these contribute to a large potential error for radiocarbon dating of soils. Even so, the dates obtained for the Lakeview Farm beach paleosols and the Jerusalem Outlet channel paleosol are definitely post-Hypsithermal in age. The dates on the soils show that the lake has risen high enough within the past 1,800 years to overflow to the Sheyenne River.

The radiocarbon dates on the soils suggest that the level of Devils Lake has fluctuated more widely and more often than had been thought.

Table 1. Radiocarbon Dates

Sample 1. USGS Lab. No. W-5999. Age: 2,760 $\pm$ 200 years B.P.
Sample 2. USGS Lab. No. W-6003. Age: 2,150 $\pm$ 200 years B.P.
Sample 3. USGS Lab. No. W-6002. Age: 720 $\pm$ 200 years B.P.
Sample 4. USGS Lab. No. W-5998. Age: 1,800 $\pm$ 200 years B.P.
Sample 5. USGS Lab. No. W-6245. Age: 2,380 $\pm$ 120 years B.P.

References

Hobbs, H. C., and Bluemle, J. P., 1987, Geology of Ramsey County, North Dakota: North Dakota Geological Survey Bulletin 71--Part I and North Dakota State Water Commission County Ground Water Studies 26--Part I, 69 p.

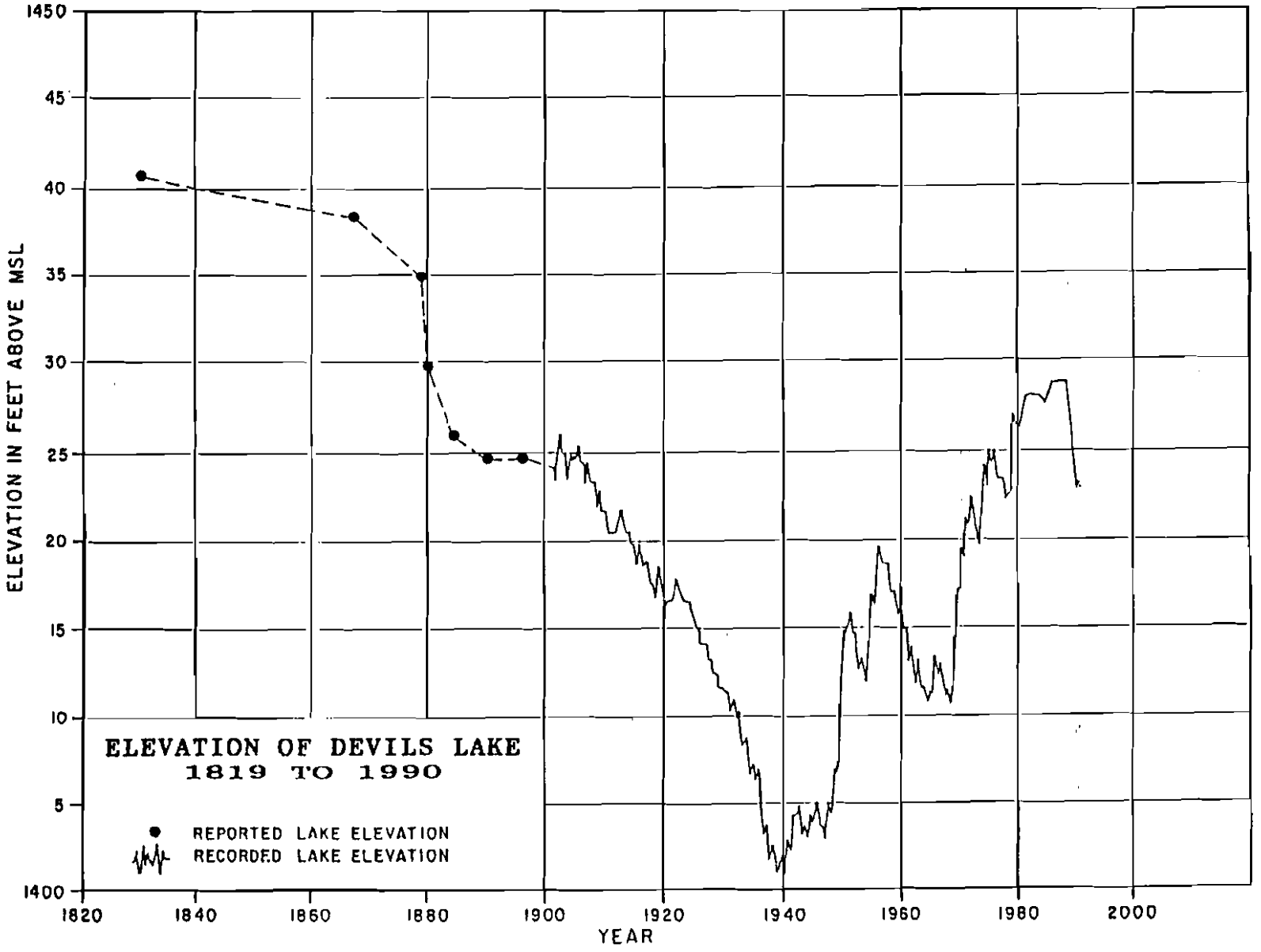


Figure 1. Graph of the fluctuating level of Devils Lake from 1819 until 1990. The water-level record since about 1900 is based on actual measurements. Prior to that time, the record is less certain and is based on eyewitness and hearsay accounts. The graph shows how drastically the lake can fluctuate. It illustrates that the lake level fluctuates almost constantly.

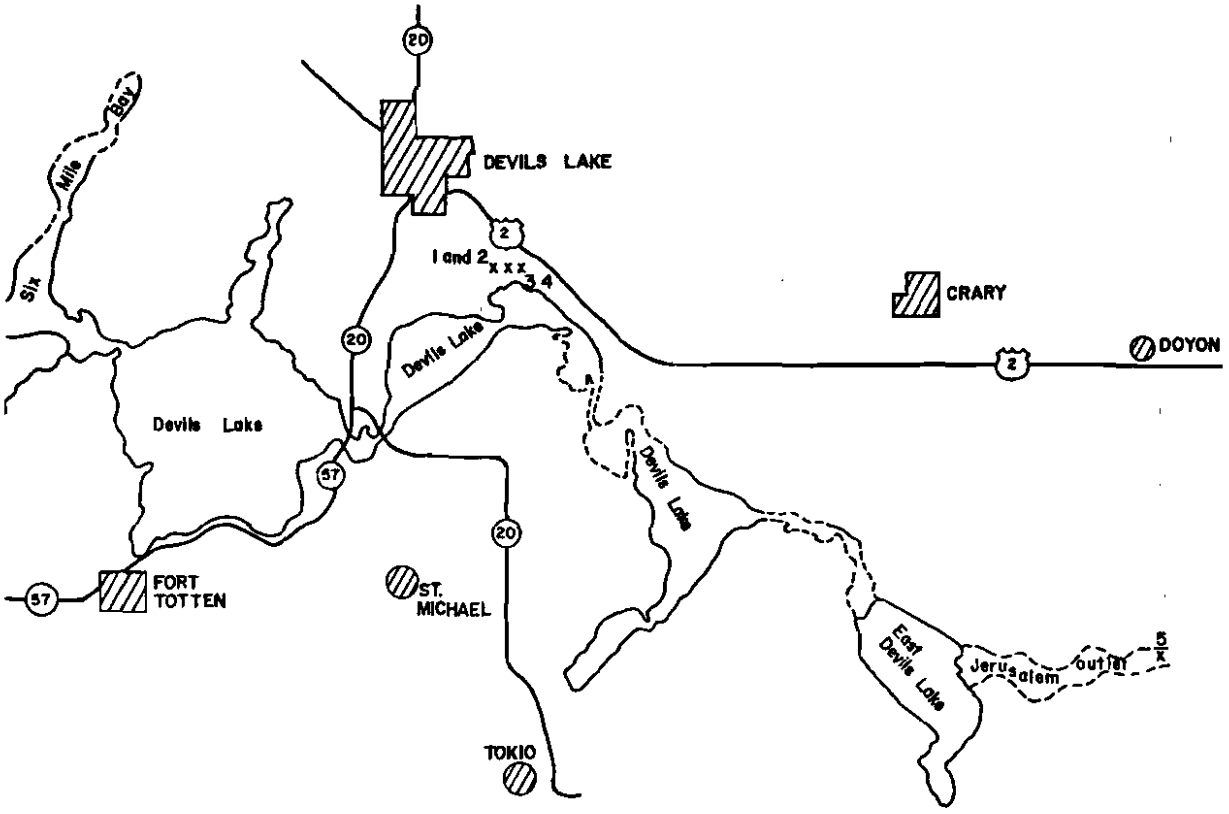
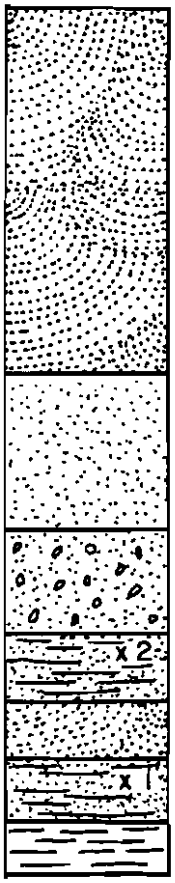


Figure 2. Map of the Devils Lake Area, showing the locations of the samples that were submitted for radiocarbon dating. Samples 1, 2, 3, and 4 were taken from a high beach along the north shore of the lake. Sample 5 came from the Jerusalem Outlet, the spillway route through which Devils Lake overflows into Stump Lake when it rises to a level of about 1,445 feet.



Unit 7. Three feet of medium-grained, well-sorted, cross-bedded sand (a beach deposit).

Unit 6. One foot of fine- to medium-grained, well-sorted sand with alternating light and dark layers. Elevation: 1,445 feet.

Unit 5. Eight inches of gravelly, gray sand; no apparent structure. Elevation: 1,444 feet +.

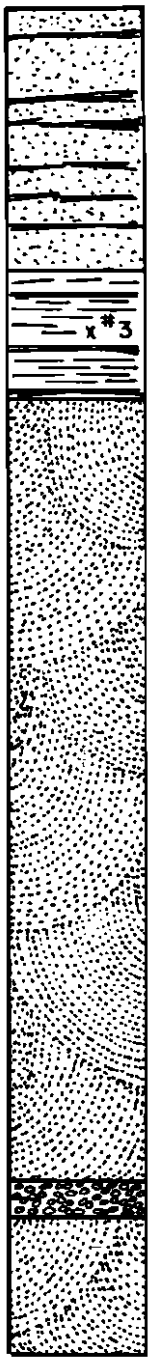
Unit 4. Four inches of dark brown, organic, sandy material (a paleosol). Sample 2 was taken from this horizon for radiocarbon dating (sample 2 has USGS Lab. No. W-6003). Elevation of sample: 1,444 feet.

Unit 3. Four inches of clean sand containing no organic matter; cross-bedded, coarse, quartz-rich sand. Elevation: 1,443 feet +.

Unit 2. Four inches of dark brown, richly organic sand that appears to contain more organic material than Unit 4, above (a paleosol). Sample 1 was taken from this horizon (sample 1 has USGS Lab. No. W-5999). Elevation of sample: 1,443 feet.

Unit 1. Sticky, dark gray sandy clay with vague bedding visible (offshore lake sediments). Elevation: below 1,443 feet.

Figure 3. West Cut, Mertens Lakeview Farm. The top of the excavation at the westernmost of two cuts was in a lake strandline at an elevation of about 1,447 to 1,448 feet, approximately 20 feet above the modern lake level (SW/4 SE/4 Sec. 12, T. 153 N., R. 64 W.). Samples 1 and 2 were taken at this excavation from separate soil zones buried beneath and separated by beach deposits. The stratigraphic sequence exposed in this excavation was as follows:



Unit 5. Two feet of alternating, one- to two-inch-thick bands of clean sand and thin organic-rich beds. All of this unit appears to be alluvial, washed-in material. Elevation at top: 1,458 feet.

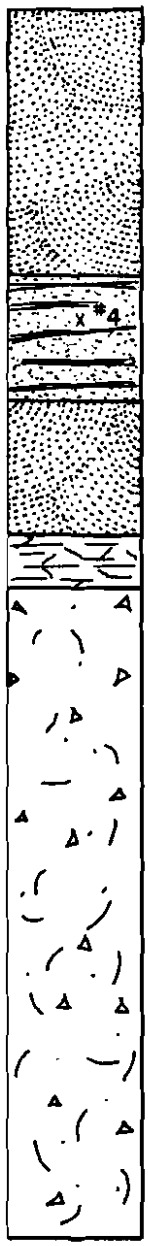
Unit 4. One foot of black to very dark brown, organic-rich material. This is an in-place, buried soil zone. Sample 3 (USGS Lab. No. W-6002) was taken from this horizon. Elevation of sample: 1,455.5 feet.

Unit 3. Six feet of coarse, cross-bedded sand with scattered streaks of organic material. Probably beach sediments. Elevation at top of unit: 1,455 feet.

Unit 2. Three inches of "pea gravel," mostly 1/4" to 1/2" size, containing abundant shale pebbles. Elevation: 1,449 feet.

Unit 1. (Same as Unit 3). One foot of sand was exposed to the bottom of the cut. Elevation at bottom of cut: 1,448 feet.

Figure 4. Grainbin Cut, Mertens Lakeview Farm. The top of the excavation at this location was in a lake strandline at an elevation of about 1,458 feet, approximately 30 feet above the modern lake level (location is SE/4 SE/4 Sec. 12, T. 153 N., R. 64 W.). Sample 3 was taken from a very dark brown to black, buried, organic soil zone. The stratigraphic sequence exposed in this backhoe cut was as follows:



Unit 5. Two feet of clean, well-sorted, cross-bedded sand (a beach deposit). Elevation at top: 1,457 feet.

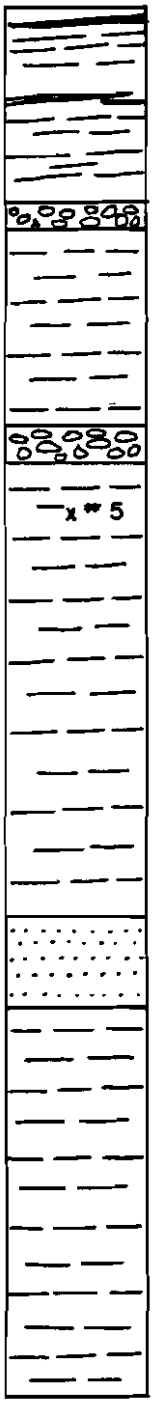
Unit 4. One foot of sandy, black, organic-rich material (a buried soil profile). Sample 4 (USGS Lab. No. W-5998) was taken from this horizon. Elevation: 1,454 feet.

Unit 3. One foot of clean, well-sorted, cross-bedded sand, essentially similar to unit 5 (a beach deposit). Elevation: 1,453 feet.

Unit 2. Highly fossiliferous shell zone, four to five inches thick. A mash of soft and disintegrating shells, enclosed in soft, wet lake clay. Elevation: 1,452 feet.

Unit 1. Five feet of hard, pebbly glacial sediment (till). Elevation at bottom of excavation: 1,447 feet.

Figure 5. Silo Cut, Mertens Lakeview Farm. The sample taken here was from a nine-foot-deep excavation, just west of a large silo (SW/4 SW/4 Sec. 7, T. 153 N., R. 63 W). The surface elevation at this location is 1,457 feet. The geologic sequence exposed by the excavation was as follows:



Unit 7. One and a half feet of black soil

Unit 6. Two inches of clean, discontinuous gravel (a fluvial deposit).

Unit 5. One and a half feet of gray, fossiliferous clay (a lake deposit).

Unit 4. Three inches of clean gravel (a fluvial deposit).

Unit 3. Three and a half feet of gray, fossiliferous clay (a lake deposit). The upper foot of this unit is a very dark colored paleosol. A sample of this soil (sample 5) was taken from this horizon for radiocarbon dating (sample 5 has USGS Lab No. W-6245).

Unit 2. Eight inches of light gray, very wet, bedded, fossiliferous sand (probably a lake deposit).

Unit 1. Three feet of gray, finely bedded, sandy silt (a lake deposit).

Figure 6. The stratigraphic section encountered in the Jerusalem outlet (SE/4SE/4 Sec. 24, T. 152 N., R. 62 W.) is shown above. The elevation at this location is 1,444 feet.

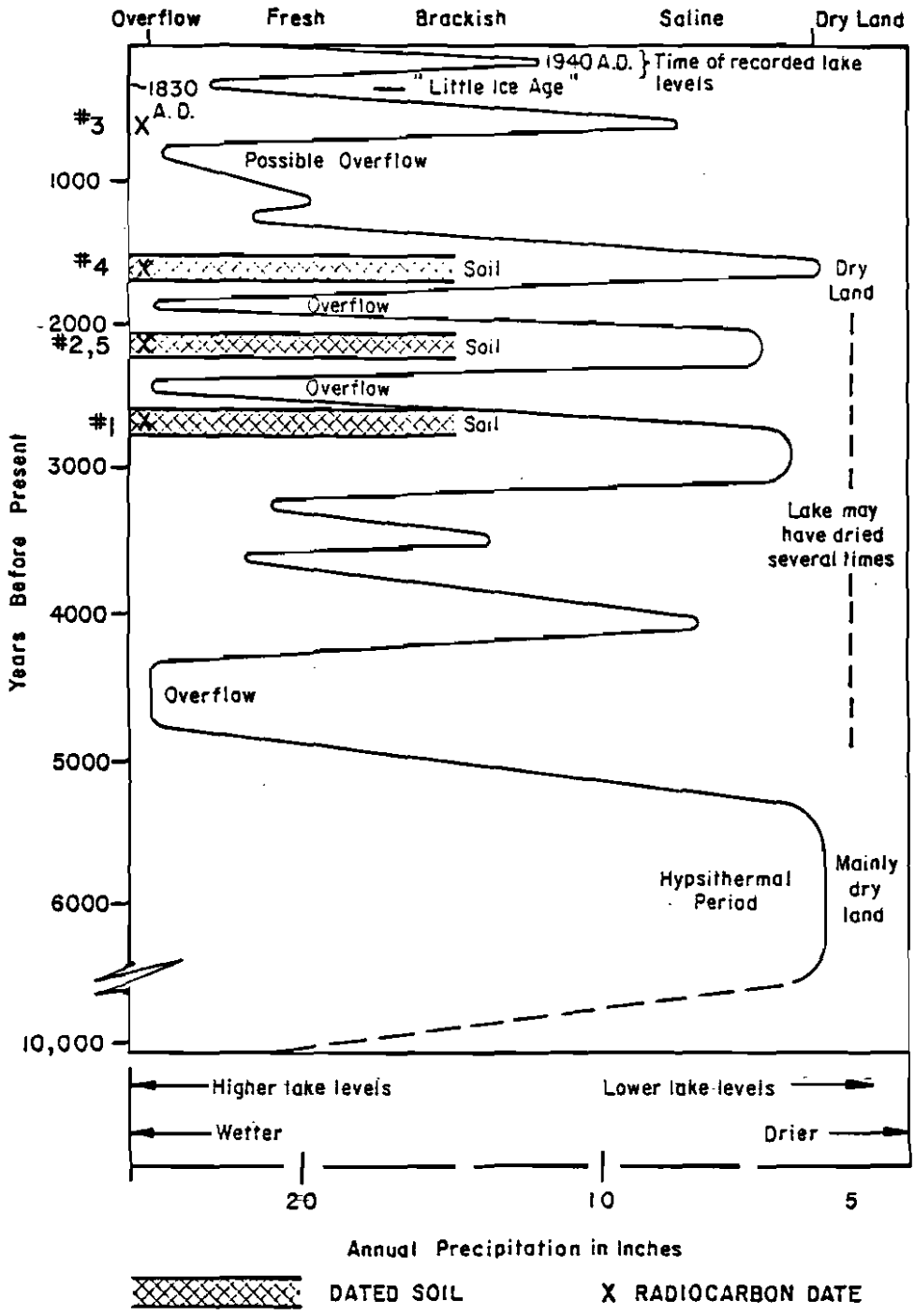


Figure 7. Time/event diagram for Devils Lake. The lake has dried comletely a number of times and it has overflowed to Stump Lake several times. Geologic evidence obtained during the present study---radiocarbon dates on soils covered by beach deposits--prove that the lake overflowed to Stump Lake about 1,800 years ago.