Avulsion by Chautauqua Creek

William Boria
Chautauqua County Department of Health, Mayville, NY 14724
boriaw@co.chautauqua.ny.us

Victoria Boria
Gustavus Adolphus Learning Center, Jamestown, NY 14701
vicki2102@fairpoint.net

Bryan Mentley
Chautauqua County Department of Health, Mayville, NY 14724
mentleyb@co.chautauqua.ny.us

INTRODUCTION

During December 2005 Chautauqua Creek cut through a high (10 to 30 meters) interfluve abandoning an oxbow of about 100 meters diameter. Sections of the interfluve were composed of glacially-deposited and buried outwash and shale bedrock, originally photographed by Dr. Ernie Muller ca.1960 (Muller 1963). The 1999 NYSGA trip to this site examined pre-avulsion features. The features of the 2005 break-through and 5-to-8 meter drop in stream-bed elevation are visually crisp. The location is an outstanding example of directly-juxtaposed, temporally-contrasted features. Interfluves preserve the contents of a glacially buried-valley that was cut obliquely by modern Chautauqua Creek; shale-sediment buried-valley contacts are preserved in modern valley walls. The approach to this site involves splash-hiking the shale creek-bed for a mile or more. The route begins down a gravel trail with switch-backs, about 300 feet of relief. Cone-in-cone structures, pop-up folds and fossils can be viewed in the creek-bed shale along the way. In addition, Chautauqua Creek serves as the primary drinking water source for the Village of Westfield. Water supply history, watershed protection and current/future source water issues will also be discussed. This trek is very scenic, having been considered as a possible location for a state park in contention with Allegheny State Park. Above-the-ankle soft boots or other foot-wear that can get wet are good options for the creek walk.

BEDROCK GEOLOGY

Although not part of our immediate objective, we will bring with us copies of the 1990 NYSGA Guidebook article by Gilman and Berkley. Their article included one of the stops that we will visit (our Stop 2). Their trek down Chautauqua Creek (and other parts of their article) paid particular attention to brittle structures in the bedrock. We will point these out while we hike to our Stop 2. We have been especially interested in the timing of the development of the pop-up folds. In scanning cliff walls of western and central New York streams, we note the absence of these folds. On the other hand, pop-ups occur routinely at quarter or half mile intervals in stream beds or Lake Erie cliffs. Also noteworthy is that one-meter amplitude folds are very commonly associated with basal tills. The non-glacial pop-ups are apparently related to erosional unloading.

SURFICIAL GEOLOGY

While looking at buried valley fills in northern Chautauqua County we have noticed that the fills are not internally deformed unless involved in modern landslides. The exception to this scenario occurs where the fills include near-surface outwash and lacustrine sediments among the Lake Escarpment and Lavery Moraines (Wilson and Boria 1999). These settings show ample evidence of deformation from the melt of underlying ice. Surface land morphology shows well-defined kettle holes and gently undulating surfaces with 10 or more meters of relief. Gravel pits show dips that range to between 50 and 90 degrees. Outcrops show folded and faulted sediments.

This trip will provide an opportunity to discuss recent meander incision across a buried valley wall (Figure 1). Our sketches and photography, in addition to published information, allow for a nearly complete reconstruction of meander movement during recent decades, and final avulsion of the meander by Chautauqua Creek.

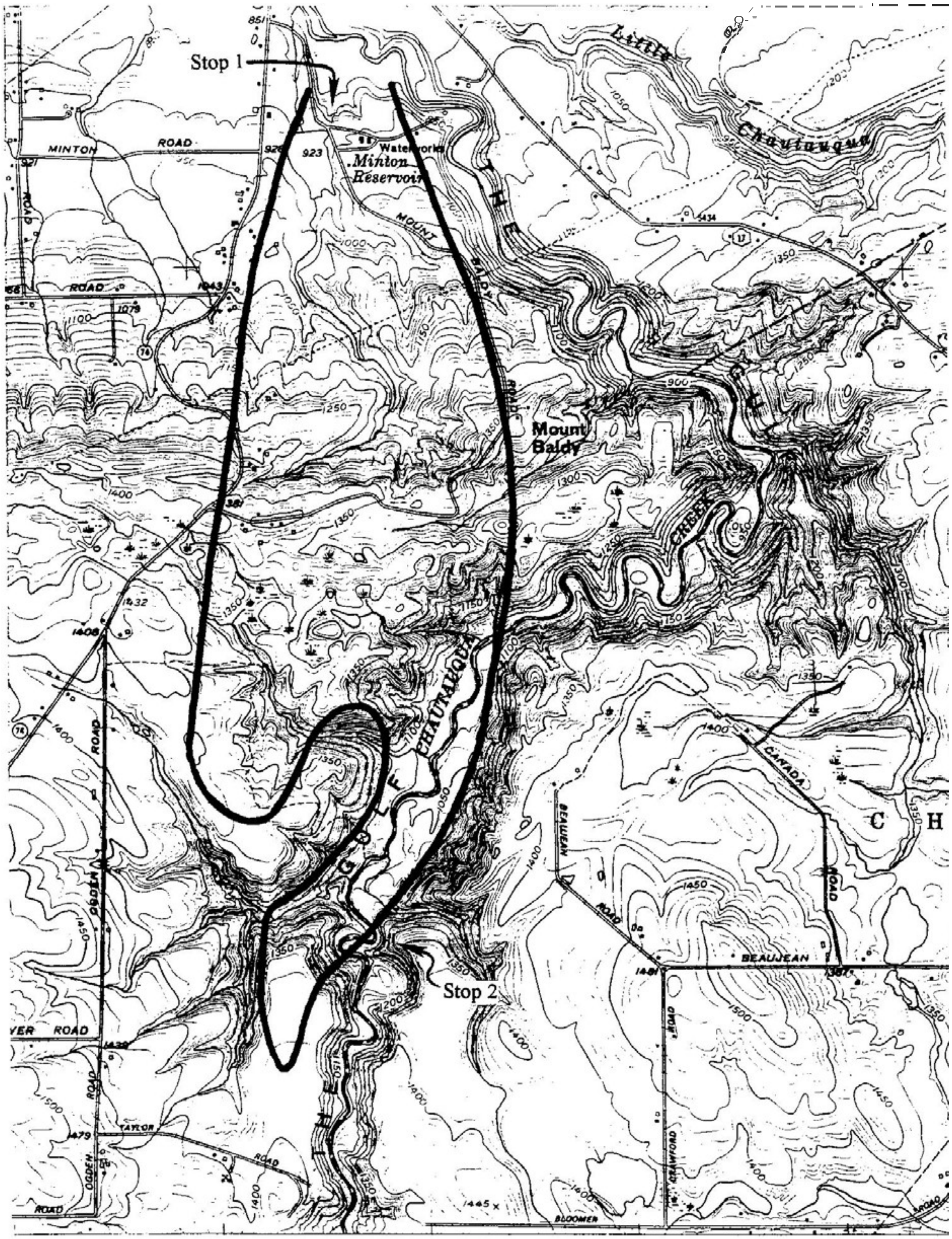


Figure 1: Topographic map of the region, showing stop locations and approximate boundary of deeply buried bedrock. This is based primarily on mapping of the elevations of exposed bedrock in tributaries (courtesy of the late Ken Fahnestock). Approximate Scale 1" = 2,000'

Figures 2 and 3 show the historic positions of the meander loops at Stop 2 (the undeformed sediments at Stop 1 are exposed by a combination of natural gully growth and reservoir outlet erosion). From the dates it can be seen that the stream alternates periods of erosion between the two faces of the meander loop, which led to the avulsion of the deposit in 2005.

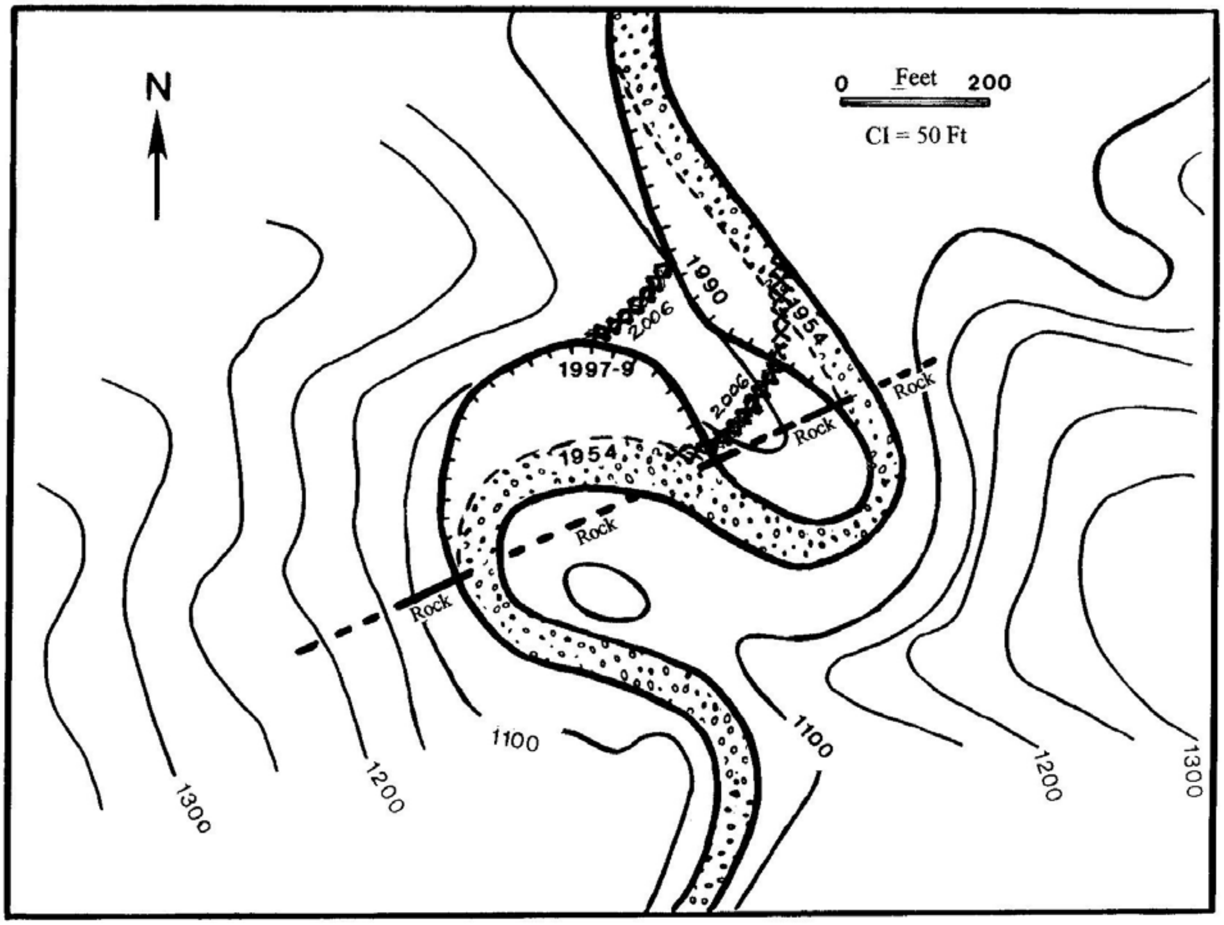


Figure 2: Map showing 1954 location of Chautauqua Creek with locations and dates of lateral erosion since then, followed by final avulsion of the deposit which occurred in December 2005 and photographed in February 2006. Further erosion has occurred since then.

Figure 4 presents a sketch compiled from our periodic visits since 1988. Figure 5 gives some food for thought. To what extent did Lake Escarpment glacial oscillations create this outcrop as opposed to a more complicated history that could include earlier glacial episodes? Lack of radiometric or other dates makes the answer difficult. Another idea for discussion … are the gravels at the base of the outcrop from subglacial processes?

Figure 3: Post-avulsion aerial photograph taken in 2008. The position of the center line of the creek in 1954 is shown with a single heavy dashed line. The position of the creek in 2000 is shown with thin continuous lines that depict the approximate water channel. (Source: Chautauqua County GIS)

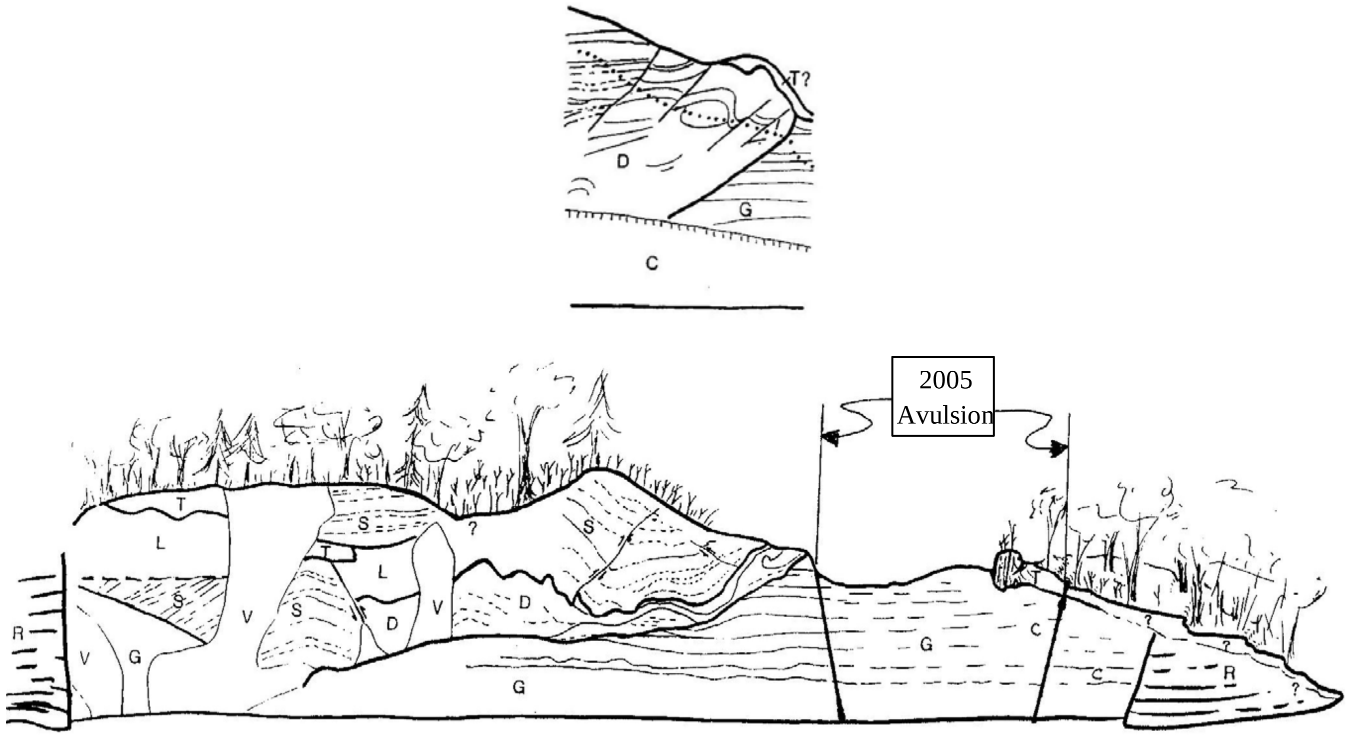
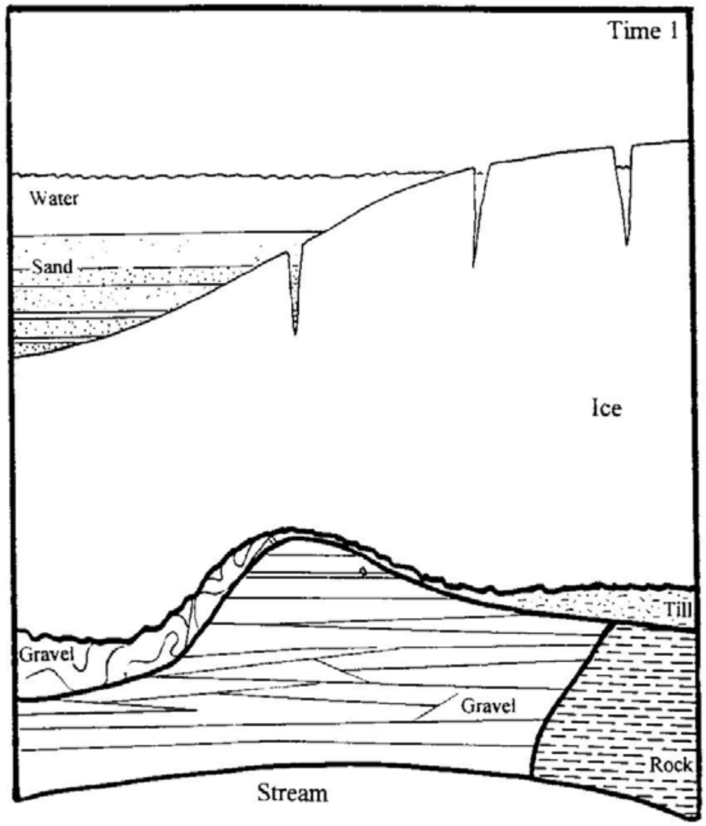


Figure 4: Composite section of the south face, primarily representing sediments as exposed in 1997, and showing the approximate location of the 2005 avulsion. Upper drawing is central section as exposed in 1988 (dotted line matches 1997 skyline). Symbols are: G = Gravel; D = Disturbed gravel; S = sand; L = lake sediments; T = till; V = vegetation; C = covered.

Time 1 shows the glacier stagnant after deformation of underlying gravel (left) and deposition of till (right).



Time 2 shows subsequent let-down of sand layers as they would have been seen prior to avulsion. Till at upper left post-dates deformation (and till at upper right may also).

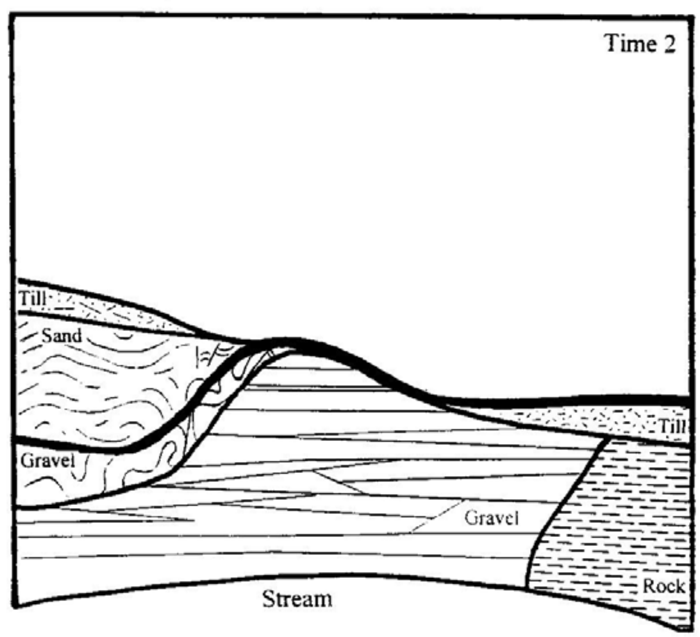


Figure 4: Schematic diagram of the central and eastern portions of the south face.


Figure 5: 1988 photograph of the south face

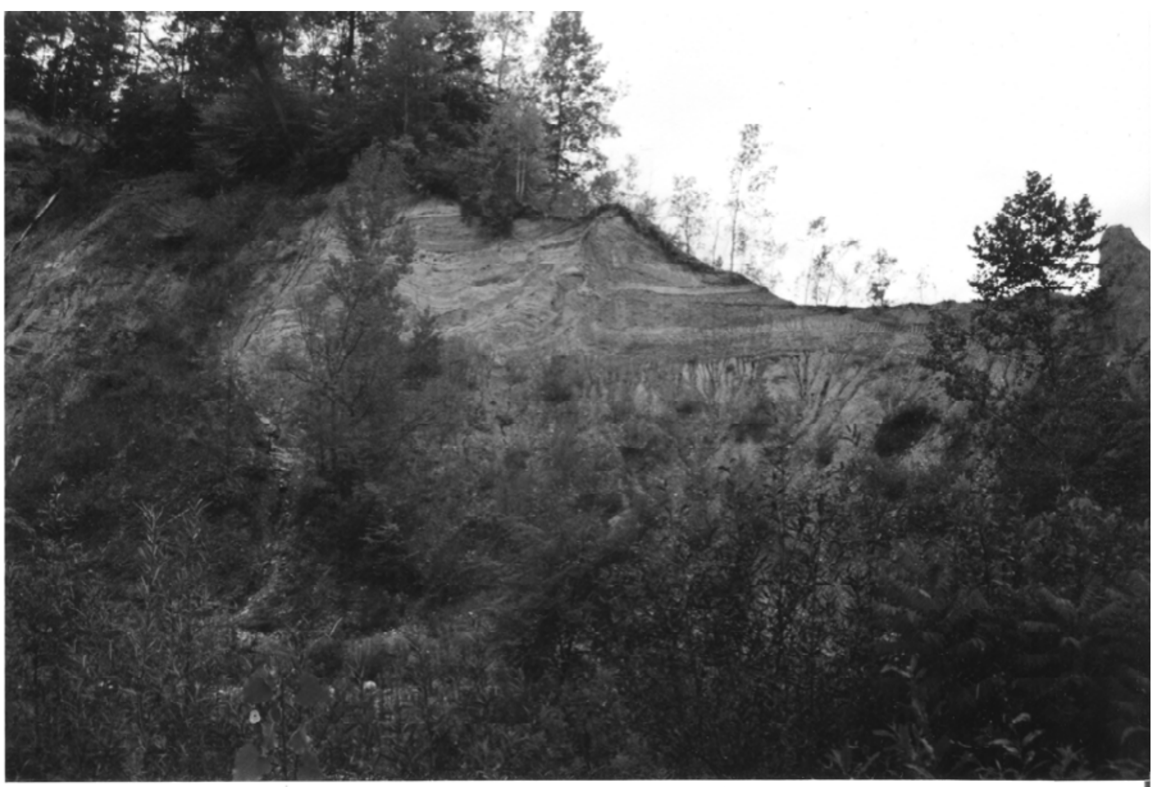


Figure 6: 1993 photograph of the south face. Note lack of vegetation on right side of photo compared to 1988

DRINKING WATER SOURCE

The Village of Westfield relies on the Chautauqua Creek watershed for drinking water. They serve a residential population of 4,000, a number of commercial businesses, three fruit processing plants, the Westfield Central School and the Westfield Memorial Hospital. The village is situated along the Lake Erie plain on and between glacial Lake Warren and Lake Whittlesey beach ridge deposits. Micro-climates created by the proximity of Lake Erie, along with the presence of the sand and gravel beach ridge deposits, make the Lake Erie plain an excellent grape growing location. Average daily water demand is approximately 0.5 MGD but, in the fall during grape processing season, it increases to over 1.0 MGD.

The first public water supply and distribution system to serve the village was constructed in the early 1890's. This system conveyed water from Chautauqua Creek to the village through a gravity pipeline whose intake was located several miles upstream from the present day water treatment plant. Much of the pipeline was laid along the creek bank and was subject to breaks caused by stream erosion, making it a high maintenance system. Water flowed from the source, through the village distribution system and up to an uncovered reservoir where it was stored for later use. The drinking water received no type of treatment until 1915, when a water-borne typhoid fever outbreak occurred in Westfield creating a serious need for chlorination. Eventually this system could not meet village water needs so, in 1939, the Minton Reservoir was built on a tributary to Chautauqua Creek. The watershed area of this 55 MG reservoir is just 0.7 square miles (448 acres), and was designed to provide only a portion of the water demand. The primary source of water to the village continues to be from Chautauqua Creek, which has a watershed area of approximately 27 square miles (17,280 acres). A low-flow diversion dam fitted with high capacity pumps transfers water from the creek to the reservoir when creek turbidity is relatively low.

In 1951, a conventional filtration plant was constructed consisting of coagulation, sedimentation, rapid sand filtration, chlorination and fluoridation. Increasingly stricter drinking water turbidity standards have been established by EPA and NYSDOH (prior to 1962: 10.0 NTU, 1962: 5.0 NTU, 1977: 1.0 NTU, 1988: 0.5 NTU and 2005: 0.3 NTU). These increasingly stringent standards along with sporadic high turbidity events in the source water caused the village's drinking water to be frequently out of compliance with the turbidity regulation.

By the mid-1980s the Minton Reservoir had lost about 15% of its original capacity to sedimentation (Wilson and Boria 1999). Two approaches were taken to address these issues. The first is improved watershed management; the second is construction of a new filtration plant in 1995. Improved watershed management included:

- Activities within the Minton Reservoir and Chautauqua Creek watersheds that contribute to the problem (i.e., logging, oil and gas exploration, etc.) are more carefully managed, especially on the 1,400 acres of watershed land owned by the Village.
- The Village updated its Watershed Rules and Regulations (10NYCRR, Title 10, Part 105) to address changes in land use and modern issues unforeseen when the original regulations were enacted in 1933. Watershed Rules and Regulations give the Village legal authority to address violations uncovered during watershed inspections.
- Causes of turbidity including landslides and stream down-cutting in the creek feeding Minton Reservoir were treated using direct structural controls (bank protection and grade stabilizers).

Reduction of stream erosion, improved watershed management and major upgrades to the Westfield Water Treatment Plant dramatically reduced raw and finished water turbidity. Prior to 1995, finished water turbidity often violated NYS Health Department standards, increasing the risk of exposing water customers to microbiological contaminants, which required immediate public notification and sometimes boil water orders.

Since watershed and filter plant improvements have been made, the Village has been in significant compliance with turbidity standards. Finished water turbidity is now consistently below 0.1 NTU.

REFERENCES

Gilman, R.A. and Berkley, J., 1990, A few of our favorite places, *in* New York State Geological Association 62nd Annual Meeting Field Trip Guidebook: SUNY Fredonia.

Muller, E.H. 1963, Geology of Chautauqua County New York part II, Pleistocene geology: New York State Museum and Sciences Service Bulletin No. 392, Albany, NY 60p.

Wilson, M.P., and W. Boria, 1999, Holocene meander incision imposed across a buried valley wall, *in* New York State Geological Association 71st Annual Meeting Field Trip Guidebook: SUNY Fredonia.

Wilson, M.P., and Boria, W.T., 1999, Quaternary geology and water supply issues, *in* New York State Geological Association 71st Annual Meeting Field Trip Guidebook: SUNY Fredonia.

ROAD LOG: AVULSION BY CHAUTAUQUA CREEK

Miles from last point	Cumulative mileage	Route description
0	0.3	From the intersection of Route 20 and Route 394, drive west on Route 20 crossing over the bridge over Chautauqua Creek then turn Left (south) onto Chestnut Street (County Route 21).
1.2	1.5	Turn Left (southeast) onto Mt. Baldy Road.
0.4	1.9	**STOP 1**. Outlet ravine of Minton Reservoir. Park on the roadside. This will be a brief stop to peer into the ravine and observe the nature of the buried valley fill and contrast these materials to those at Stop 2 and to see the Village of Westfield's Minton Reservoir.
		Backtrack (northwest) down Mt. Baldy Road.
0.4	2.3	Turn Left (south) onto Chestnut Street (County Route 21).
2.2	4.5	Turn Left (south) onto Ogden Road
1.5	6.0	Turn Left (east) onto Taylor Road
0.6	6.6	Parking at end of Taylor road (remains of gravel pits in kames).
		STOP 2. Wet foot trek into Chautauqua Gulf (approximately a 1.3 mile hike one way).

Stop 1: Minton Reservoir (Lat: 42.2980; Long: -79.5750)

Stop 2: Avulsion by Chautauqua Creek (Lat: 42.2633; Long: -79.5742)