

LPG Storage in NY Salt Cavern Linked to Salinity Spike in Drinking Water

By **Peter Mantius**, on February 6th, 2015

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Hundreds gathered on an icy January day in Geneva to protest Crestwood Midstream's proposed LPG storage project at the other end of Seneca Lake. (Photo: Peter Mantius)

For decades, scientists have puzzled over why Seneca Lake, the largest of New York State's Finger Lakes, is by far the saltiest of the 11 glacier-carved water bodies.

Now a Nevada hydrologist claims he's solved the mystery. Tom Myers, who was hired by opponents of a plan to store liquid petroleum gas (LPG) in salt caverns at the southern end of Seneca, pins the blame on LPG storage in the same group of caverns between 1964 and 1984. "The risk of saline influx to the lake from LPG is very high and should be avoided," Myers wrote in January.

Formed as ice age glaciers retreated only 10,000 years ago, Seneca Lake was named for the westernmost Native American tribe in the Iroquois League. Running north and south, it is nearly 40 miles long and 1.5 miles wide. The state's deepest lake, Seneca consistently holds 4.2 trillion gallons of water. That's more than the current 3.6 trillion gallons behind the Hoover Dam in drought-plagued Lake Mead, America's largest reservoir.



Tom Myers, PhD.

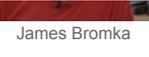
Scientists have suggested both natural and man-made causes for Seneca's unusually high salinity, which comes from dissolved salt. Salt levels spiked dramatically in the late 1960s and have been in gradual decline ever since, easing the hazard for the more than 100,000 who rely on the lake for drinking water. But levels of sodium and/or chloride still exceed the recommended state limits for infants and people on low-salt diets, and water treatment plants along the lake are required to report those elevated levels to their water customers.

For the village of Waterloo at the lake's northern end, the dissolved sodium content of water drawn from Seneca is nearly four times that state limit. James Bromka, chief of Waterloo's water treatment plant, says the water is perfectly safe for most users. But he's concerned that another salt spike could pose a serious threat at hospitals, nursing homes and prisons that count on him to deliver potable tap water.

Bromka has been worried enough to explore a desalinization system for his treatment plant. He found that a reverse osmosis unit that would filter salts from lake water could cost \$2 million. "I think it would cause sticker shock" to water customers, he said. "That's why we're trying to be proactive against threats to water quality."



In January, Bromka filed an affidavit stating his opposition to a plan by Houston-based Crestwood Midstream Partners to store LPG in salt caverns at the southern end of the lake, 40 miles from Waterloo. He stated that Crestwood had failed to adequately consider the project's potential adverse impact on his ability to provide "a consistent, safe and affordable source of drinking water."



James Bromka

The state Department of Environmental Conservation has been considering Crestwood's LPG permit application for five years. On Feb. 12, an administrative law judge at the DEC is expected to consider Bromka's affidavit as well as Myers' analysis. The law judge will determine whether a formal adjudicatory hearing is necessary to resolve project issues still in dispute.



Crestwood's LPG storage plan has drawn fire from several municipalities and counties surrounding the lake, as well as dozens of wineries and hundreds of local businesses. They have been most critical about the potential industrialization of the picturesque lake region that relies economically on agriculture and tourism. They also fear catastrophic explosions or fires triggered by cavern leaks or collapses, based on the salt cavern storage industry's poor safety record. Gas Free Seneca, a non-profit citizens group formed to try to block the project, hired Myers and is counting on his analysis to convince the DEC to reconsider the lake salinity issue as well.

The DEC published a water quality report on the Finger Lakes in 2001, but it has been nearly silent on the subject since. "I think it's pretty clear that DEC has not tested Seneca Lake since the 1990s. And the cause is staff and budget cuts," said Mary Anne Kowalski, president of Seneca Lake Pure Waters Association (SLPWA) a Geneva-based non-profit group.

Myers' analysis rests on several conclusions reached by the DEC and other independent water experts. The consensus is that salt seeps into the two deepest Finger Lakes — Seneca's deepest point is 618 feet, Cayuga's is 435 feet — from salt-laden strata beneath them. Salt is mined at the southern end of both lakes, where the salt beds are 2,000 feet or more below ground level. The salt formation gradually rises as it stretches north, intersecting with the sediments below the lakes at their northern ends.



The presence of dissolved salt in Seneca has been tracked for more than a century by measuring lake concentrations of chloride ions, which when combined with sodium makes common salt. Myers noted that a "massive spike of chloride" that occurred during a five-year period in the late 1960s coincides with TEPPCO Partners' introduction of LPG storage in a salt cavern about three miles north of Watkins Glen.

From 1964 to 1984, TEPPCO stored LPG in a cavern deep in the salt bed. But in 1982 it obtained a DEC permit to dig a new cavern nearby in Genesee shale, which is much closer to ground level and far removed from the salt bed. The company lined the new cavern and transferred its LPG storage activities there, abandoning the old salt cavern. It has been storing LPG in the new cavity since the 1980s. In response to a Freedom of Information request from [DCBureau.org](http://www.dcbureau.org), the DEC said it had no records to shed light on why TEPPCO spent the time and money to move its LPG storage activities out of the salt bed.

A Crestwood subsidiary initially planned to reopen the abandoned TEPPCO salt cavern and use it for LPG storage again. But it dropped that plan in 2010 in favor of using other caverns in the salt bed to store liquid propane and butane. The LPG storage process Crestwood plans to use — like the one TEPPCO used from 1964 to 1984 — involves the repeated transfer of LPG and brine into and out of the salt caverns. Those transfers involve significant changes in pressure against the cavern's sides, which may help explain the fall of a 400,000-ton block from the roof of the old TEPPCO cavern in the late 1960s.

Myers found that changes in pressure in the old TEPPCO salt cavern had far-reaching consequences. "The pressure from the LPG activities is transmitted along the salt formation until it essentially squeezes out high-chloride groundwater into the bottom of Seneca Lake," Myers wrote. "The chloride discharges in the mid-1960s were extremely high, and greatly increased the overall chloride concentration in the lake. The currently-proposed LPG storage in the salt beds would, in my opinion, do the same thing."

Elizabeth Suman, Crestwood Midstream's manager of investor relations and corporate communications, did not respond to phone and email requests for comment on Myers' analysis. Myers, who holds a Ph.D. in hydrology and hydrogeology from the University of Nevada, Reno, declined to comment for the record.



John Halfman

Myers' hypothesis is "plausible," though it lacks data to confirm it, according to John Halfman, a professor of hydrogeology and geomorphology at Hobart and William Smith in Geneva who is widely regarded as the leading expert on Seneca water quality. "Tom may be correct in that TEPPCO started (LPG) storage in 1964, the same time salinity in the lake spiked upward," Halfman said in a recent email. "His educated guess is as good as anyone else's.... Unfortunately, coincidence does not prove causation."

In a recent affidavit, Halfman urged the DEC to require Crestwood to conduct year-long pressure tests on any salt cavern proposed for LPG storage and then to contract with independent monitors to check for changes in the lake's dissolved chloride and sodium levels.

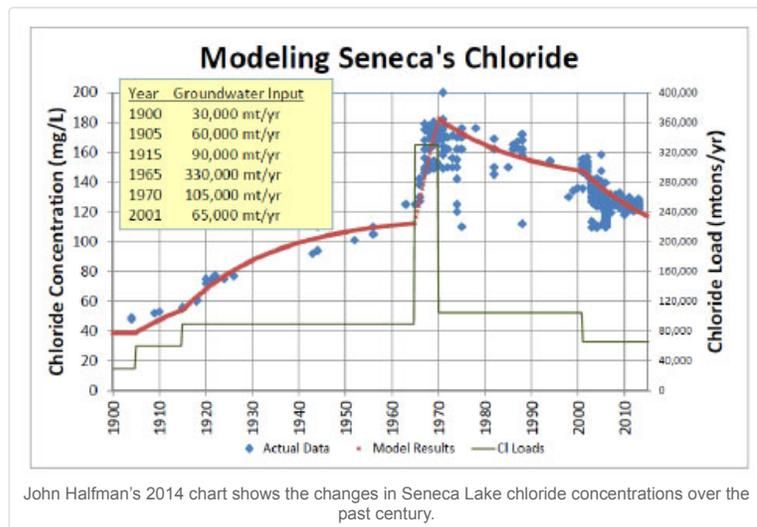
Kowalski of SLPWA seconded that idea.

Kowalski said SLPWA's water experts agree with Myers that Seneca's high salinity is likely the result of prior LPG storage in the salt cavern. "The exact mechanism of

However, said Seneca Lake water experts agree with Myers that Seneca's high salinity is likely the result of prior LPG storage in the salt cavern. "The exact mechanism of the connection between the salt caverns and the lake is not well understood," she said. "But our experts believe there are faults in the area that should be carefully examined before these caverns are used."

Halfman said he'd need more data before drawing a definitive conclusion. "I do not know enough groundwater hydrology to understand/follow Myers' logic on the mechanics of flow through the salt," he said. "Other possibilities exist, however. The simplest: Excess salts could have been dumped directly into the lake from the mines, as they probably had larger waste loads in the less regulated (or unregulated) past."

On the other hand, the 4.2-trillion-gallon lake has a vast capacity to dilute impurities. And every year it receives new water from rain and streams that affect its salinity. Seneca is also constantly losing salinity as its waters are discharged through the Cayuga-Seneca Canal outlet at the northern end of the lake. So its chloride and sodium concentrations vary from year by year.



Halfman has obtained records of annual chloride concentrations in the lake dating back to 1900. In 1900, the chloride concentration was 40 milligrams per liter. It rose steadily to 110 mg/l by 1965, perhaps due to an increase in salt mining at two operations at the southern end of the lake near Watkins Glen during those six decades. Between 1965 and 1970, chloride jumped to more than 180 mg/l. Since 1970 the chloride concentration has gradually fallen off to about 120 mg/l.

That four-decade decline occurred despite a sharp rise in road deicing and legal chloride dumping by the two salt operations near Watkins Glen: U.S. Salt and Cargill. The DEC has issued permits that allow both operations to dump specified daily limits of chloride into the lake.

U.S. Salt was acquired in 2008 by Inergy LP, which proposed the LPG storage project in 2009 before being acquired by Crestwood in 2013. Both Inergy and Crestwood continued salt mining operations while pursuing a permit to store LPG in abandoned salt caverns.

EPA records show that as an Inergy subsidiary, U.S. Salt repeatedly violated its discharge limits, while Cargill generally complied with its limits. And in July 2012, boaters on the lake noted a "geyser" of brine that shot above the treetops on the U.S. Salt property. The company did not report the incident to the DEC until after Gas Free Seneca posted a video on YouTube showing a swath of burned vegetation caused by the brine eruption. The company later told the DEC that less than 2,000 gallons had escaped from a pin-hole leak in a pipe.



Such discharges — authorized or not — probably have a negligible effect on the salinity of the lake. In its draft environmental impact statement for the LPG project, Inergy analyzed the potential impact of a hypothetical instantaneous release of 80 million gallons of brine into the lake. Assuming brine is 25 percent sodium chloride by weight, the company found that such a massive release would only raise the lake's total concentration of sodium and chloride by 2-3 percent.

Halfman did not dispute the company's calculations, though he said the hypothetical release of 80 million gallons of brine (which is 10 times as salty as seawater) would not disperse throughout the lake as quickly as salt that is added gradually.

Halfman noted that leaks from a now-closed Morton Salt operation in Himrod, near the midpoint of the lake, in the early 1970s probably also contributed to Seneca's high salinity. But it's unclear how much. And the Morton discharges occurred years after the primary spike in chloride concentration.

Bob Barton, an engineer who has monitored streams that flow into Seneca for many years, said their sodium and chloride levels are consistently lower than levels in the lake itself. That suggests that Seneca's sodium and chloride loads originate from a point within the lake.

While streamflows don't raise the lake's salinity, the known discharges from the salt mines "don't get you there either," said Barton, an electrical engineer experienced in underwater acoustics who is a board member of the Ithaca-based Community Science Institute. He said he "tends to agree" with Myers' explanation that advection effects from LPG storage in the southern end of the lake encourage salt seepage into the bottom of the lake miles to the north. But he said he thought it would be extremely challenging and costly to prove it. "I don't see anyone who's going to pay" for the necessary lake monitoring, he said.

Myers acknowledged that data to support his conclusion is thin. "The advection process is extremely complex and representative data is very difficult to collect, so it would be very difficult for (Crestwood) or others to complete analyses that suggest LPG storage over the next 50 years could be done safely without causing massive salt influxes to Seneca," he wrote.

For the same reasons, Crestwood would not be able to monitor or prevent such influxes, he added.

Halfman reported in December that the federal Environmental Protection Agency's drinking water advisory threshold for chloride is 250 milligrams per liter. The drinking water advisory level for sodium is 30-50 mg/l, which is lowered to 20 mg/l for newborns and those on low-salt diets. So any increase over the lake's current chloride level (122/128 mg/l, surface/bottom) and/or sodium level (75/79 mg/l, surface/bottom) "would be a concern," he said.

Bromka said Waterloo's sodium level has hovered around 78 mg/l. He said he's not particularly concerned about the proposed LPG project because he doubts the DEC will ever grant the permit in light of the risks.

"I'm watching it," he said. "But I can't believe the DEC would let it happen."

Seneca Lake Hydrology Report

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Peter Mantius is a reporter in New York. He covered business, law and politics at *The Atlanta Constitution* from 1983-2000. He has also served as the editor of business weeklies in Hartford, CT, and Long Island. He is the author of *Shell Game* (St. Martin's Press 1995), a nonfiction book on Saddam Hussein's secret use of a bank office in Atlanta to finance billions of dollars in arms purchases from Western countries before the 1991 Persian Gulf War.

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