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NATURAL RESOURCES DEFENSE COUNCIL

January 16, 2015

James T. McClymonds
Chief Administrative Law Judge
New York State Department of Environmental Conservation
Office of Hearings and Mediation Services
625 Broadway, 1st Floor
Albany, New York 12233-1550
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Re: Matter of Finger Lakes LPG Storage, Application Number 8-4432-00085

Dear Chief Administrative Law Judge McClymonds:

Please find enclosed the Petition for Full Party Status of Seneca County, Yates County, the Town of Fayette, the Town of Geneva, the Town of Ithaca, the Town of Romulus, the Town of Starkey, the Town of Ulysses, the Town of Waterloo, the City of Geneva, the Village of Watkins Glen, and the Village of Waterloo (collectively, the "Seneca Lake Communities") filed in the above-captioned matter pursuant to 6 New York Code Rules & Regulations ("N.Y.C.R.R.") § 624.5(b).

In accordance with the Notice of Extension of Deadline for Filing Petitions for Party Status, issued on November 18, 2014, we file this petition today on behalf of the Seneca Lake Communities with supporting affidavits and other offers of proof. Due to the relatively brief timeframe in which to respond to this issue of great complexity and importance, some of the supporting affidavits in today's time-stamped mailing are not original copies. However, these original copies will be provided by express mail as soon as they are received.

Additionally, because the Seneca Lake Communities rely on expert reports that were today filed in support of the petitions for other proposed parties in this matter, pin citation to those reports is not included in the enclosed petition. This citation can be made available in the form of a revised petition once we have received the final reports.

Thank you for your time and consideration of this matter.

Respectfully submitted,

Katherine Sinding, Esq.
Jon Krois, Esq.
Daniel Raichel, Esq.
Attorneys for Seneca Lake Communities

New York State Department of Environmental Conservation

In the Matter of the Applications of

Application Number
8-4432-00085

FINGER LAKES LPG STORAGE, LLC
For the Liquefied Petroleum Gas Storage Facility at Seneca Lake
for permits to construct and operate pursuant to the
Environmental Conservation Law

PETITION FOR FULL PARTY STATUS

by

Seneca County, Yates County, the Town of Fayette, the Town of Geneva, the Town of Ithaca, the Town of Romulus, the Town of Starkey, the Town of Ulysses, the Town of Waterloo, the City of Geneva, the Village of Watkins Glen, and the Village of Waterloo

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New York State Department of Environmental Conservation

In the Matter of the Applications of	Application Number 8-4432-00085
FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	**PETITION FOR FULL PARTY STATUS**

I. Introduction

Finger Lakes LPG Storage, LLC's proposal to store liquefied petroleum gas ("LPG") in underground salt caverns on the banks of Seneca Lake (hereinafter the "Proposed Project") puts Seneca Lake (or the "Lake"), the people and communities who depend upon it, and the region it defines at risk of several significant adverse environmental impacts that have not been adequately considered or addressed. For that reason, Seneca County, Yates County, the Town of Fayette, the Town of Geneva, the Town of Ithaca, the Town of Romulus, the Town of Starkey, the Town of Ulysses, the Town of Waterloo, the City of Geneva, the Village of Watkins Glen, and the Village of Waterloo (hereinafter the "Seneca Lake Communities" or the "Communities") submit this Petition, through their attorneys, Katherine Sinding, Daniel Raichel and Jonathon Krois, for Full Party Status in the above-captioned matter pursuant to 6 New York Code Rules & Regulations ("N.Y.C.R.R.") § 624.5(b).

The Seneca Lake Communities are counties, towns, cities, and villages located on or near the Lake. They share a common interest in the health of Seneca Lake, including its status as the primary source of drinking water for tens of thousands of their residents, collectively, and in the region's bucolic and increasingly de-industrialized character. The Proposed Project presents a number of significant threats to the Communities that have been insufficiently addressed in the

Draft Supplemental Environmental Impact Statement ("DSEIS"), Document IV.A (2011-08, Accepted DSEIS), or the applicable draft gas storage permit conditions proposed by the Department of Environmental Conservation ("DEC"), Document V.1 (2014-11-10, DEC Staff Draft Permit Conditions). Most significantly, and as addressed in detail below, the DSEIS fails to adequately evaluate or identify practicable mitigation for potentially significant adverse impacts to the community character and emergency resources of the Seneca Lake Communities and the larger Finger Lakes Region, as well as to the water quality of Seneca Lake and the Communities' ability to provide safe, potable drinking water to their residents. It also fails to consider any meaningful alternatives to the Proposed Project. Further, the draft permit conditions are inadequate to indemnify or insure the Communities against the risk of a catastrophic failure at the Proposed Project site.

Simply put, this is the wrong place and the wrong time for the kind of major industrial development the Proposed Project represents. At the hearing, the Seneca Lake Communities would present evidence, expert testimony, and supporting documentation on the above-mentioned potential significant adverse environmental impacts, which have been inadequately considered in the DSEIS and which the draft permit conditions are insufficient to address. These failures deprive the Commissioner of the legally necessary environmental analysis and record upon which to issue findings pursuant to the State Environmental Quality Review Act ("SEQRA"), N.Y. Environmental Conservation Law ("ECL") § 8-010 *et seq.,* as set forth in 6 N.Y.C.R.R. § 617.11, or to issue necessary permits for the Proposed Project. As such, they raise substantive and significant issues for adjudication pursuant to 6 N.Y.C.R.R. § 624.4(c).

II. Summary of the Substantive and Significant Issues

The Seneca Lake Communities, by this Petition, present the following substantive and significant issues for adjudication: (1) the DSEIS does not reasonably evaluate the potential significant adverse impacts of this major industrial use to community character within the Seneca Lake Communities and the broader Finger Lakes Region; (2) the DSEIS does not reasonably evaluate the potential significant adverse impacts to the water quality of Seneca Lake and to municipal drinking water supplies dependent upon the Lake; (3) the DSEIS does not reasonably evaluate the potential significant adverse impacts of a spill, accident, or catastrophic event on local emergency resources; (4) the DSEIS's consideration of alternatives is totally insufficient as a matter of law; and (5) the draft permit conditions fail to provide indemnity or insurance adequate to protect the interests of the Communities. These issues are addressed in full in Section IV, *infra*.

III. The Identities, Environmental Interests, Statutory Interests, and Precise Grounds for Opposition of the Seneca Lake Communities, as Required by 6 N.Y.C.R.R. § 624.5(b)(1)

Seneca County, Yates County, the Town of Fayette, the Town of Geneva, the Town of Ithaca, the Town of Romulus, the Town of Starkey, the Town of Ulysses, the Town of Waterloo, the City of Geneva, the Village of Watkins Glen, and the Village of Waterloo are municipalities located on or near Seneca Lake in New York State's Finger Lakes Region. These Seneca Lake Communities possess a common interest in Seneca Lake, its water quality, and the broader – and evolving – community character that defines their region.

The Seneca Lake Communities are deeply concerned that the Proposed Project would negatively impact Seneca Lake's water quality and the bucolic, and increasingly de-industrialized character of the region, thus threatening their water supply, community character and quality of life, and the social and economic viability of the region and its individual communities. The Communities are also concerned that the Proposed Project has not met necessary requirements under SEQRA. For these reasons, the Communities listed above petition for full party status and request the identification of the below-enumerated issues for adjudication.

An intervening party must establish "an adequate environmental interest" to participate as a full party in the issues conference and adjudicatory hearing. 6 N.Y.C.R.R. § 624.5(d)(1)(iii). Generally, the standard for demonstrating an environmental interest is "very low and challenges to an intervener's environmental interest have rarely been sustained." *See In the Matter of the Application of E. Tetz & Sons, Inc.*, NYSDEC No. 3-3352-00255/00001, 2003 WL 1736444, at *9 (Mar. 20, 2003).

The Seneca Lake Communities' environmental interest in this proceeding is multifold. First, the Communities are strongly concerned that the Proposed Project would have a significant and unmitigatable adverse impact on Seneca Lake's water quality. Seneca Lake is the largest of the Finger Lakes by volume and the second-largest by length. It supports a robust community – the City of Geneva sits on the north end of the lake, the Village of Watkins Glen is on the south end, and there are many others along its banks and within its watershed.

Most of the Communities rely on the Lake for at least a portion of their drinking water – with Geneva and Watkins relying entirely on the Lake for their municipally supplied water. *See* Section IV.B, *infra*. Municipalities whose drinking water supply may be jeopardized by the permitting of a proposed activity have a cognizable environmental interest in an adjudicatory hearing in this matter. *See, e.g.*, *In the Matter of Seven Springs, LLC*, NYSDEC No. 3-5599-00041/00001, 2002 WL 31153615, at *5 (Aug. 23, 2002) (municipalities had "an adequate environmental interest" largely based upon concerns that a proposed golf course's stormwater runoff would enter their surface water supply).

As discussed in detail below, the Communities worry that approving the Proposed Project would result in a re-industrialization of the Finger Lakes Region that would run entirely in opposition to the increasing emphasis on viticulture and agri-tourism as among its primary defining characteristics. The unique climate of the Finger Lakes makes the region ideal for wine cultivation and the area around the Lake is home to over 50 wineries. Through local planning and efforts by the Communities as well as other regional municipalities, the region has purposefully shifted away from an industrial identity toward a regional character and economy defined by and dependent upon on agriculture, related businesses, and tourism. A high-risk, heavy industrial activity is not only incongruent with this regional character, it threatens its very fabric.

Heavy industry on the shores of the region's natural centerpiece not only harms existing land uses and businesses, but the Proposed Project's risk of a calamitous and spectacular incident could stigmatize the emerging identity of the region and endanger the now robust and growing agricultural-and-tourism-based economy. Accordingly, the Seneca Lake Communities – whose well-being and aspirations are tied closely to the character and reputation of the Finger Lakes Region put at risk by this Proposed Project – have a strong environmental and statutory interest in ensuring that any potential impacts to that character are also considered to the fullest extent of SEQRA. *See* Section IV.A, *infra.*

Second, the Proposed Project threatens the integrity of Seneca Lake. Contamination of the Lake due to a catastrophic incident or increased salinity caused by operation of the Proposed Project could make its water undrinkable and impose great costs on the Communities to supply a replacement water supply. Unquestionably, the Communities that depend on the Lake for unsullied drinking water have an environmental interest in ensuring that the environmental risks to that supply posed by the Proposed Facility are fully assessed in accordance with SEQRA and Article 23, Title 13 of the ECL. *See* Section IV.B., *infra.*

Additionally, the Seneca Lake Communities are concerned by: the DSEIS's inadequate consideration of the impact of a spill, accident, or catastrophic failure related to the Proposed Project on the emergency resources of the Communities and other municipalities in the region, *see* Section IV.C, *infra*; the utter failure of the applicant to consider reasonable alternatives to the Proposed Project, including alternative locations and the critical no action alternative, *see* Section IV.D, *infra*; and DEC's failure to provide permit conditions mandating indemnity or insurance adequate to fully insure against the potentially disastrous losses that municipalities may suffer as a result of an serious incident resulting from the Proposed Project. *See* Section IV.E, *infra.*

Collectively, these concerns form the basis of the Seneca Lake Communities' environmental and statutory interests and specific grounds for opposing the Proposed Project. The Communities more fully explain these grounds in Section IV below and provide specific offers of proof.

IV. Issues for Adjudication and Offers of Proof, as Required by Part 624.5(b)(2)

An issue is adjudicable if it is proposed by a potential party and is both substantive and significant. 6 N.Y.C.R.R. § 624.4(c)(1)(iii). An issue is substantive if "there is sufficient doubt about the applicant's ability to meet statutory or regulatory criteria applicable to the project, such that a reasonable person would require further inquiry." *Id.* § 624.4(c)(2). It is significant if "it has the potential to result in the denial of a permit, a major modification to the proposed project or the imposition of significant permit conditions in addition to those proposed in the draft permit." *Id.* at § 624.4(c)(3).

The issues the Seneca Lake Communities will present are substantive and significant, and therefore are appropriate for adjudication. This section identifies each of the substantive and significant issues the Seneca Lake Communities raise along with the relevant offers of proof, pursuant to 6 N.Y.C.R.R. § 624.5(b)(2).

A) The DSEIS Does Not Properly Evaluate the Potential Significant Adverse Impacts to Community Character

The DSEIS wholly fails to assess the impact of the Proposed Project and its operational infrastructure on the character and land use planning goals of the Finger Lakes Region, including the Seneca Lake Communities. This omission is particularly distressing given both the deliberate and conscientious planning efforts of local municipalities to foster and protect the environmentally sensitive land uses and resources that now define the region, and the particular incompatibility of the Proposed Project as a high risk, heavy industrial use located directly on the shores of Seneca Lake.

As detailed in the reports of Susan Christopherson and Harvey Flad being submitted by proposed party Gas Free Seneca in support of its petition for full party status – both of whom are professors of geography and experts on community character impacts – the character of the Finger Lakes region has been increasingly returning to its historic identity as a center for viticulture, agri-business, and recreation and tourism due, in no small part, to the active efforts of local municipalities. This conscious trajectory, reflected in the local planning documents of the Seneca Lake Communities and regional planning efforts, *see, e.g.,* Laberge Group, Village of

Watkins Glen Comprehensive Plan (Dec. 2012);[1] Finger Lakes Regional Sustainability Plan (May 2013),[2] breaks strongly from the region's 20th Century industrial past toward a future that is more bucolic, clean, and environmentally and economically sustainable. The change is already apparent in the predominant physical and economic character of the Finger Lakes Region – which is now characterized by wineries, breweries, and protected natural areas – as well as in the region's growing status as a destination to visit or start a small business.

A good example of the present and evolving character of the region is the robust growth of winemaking and associated tourism and the growing notoriety of the region as a center for viticulture. The Finger Lakes currently represents 75% of New York's wine and wine tourism industry, providing 25,000 jobs to the region. Further, world-class winemakers who a generation earlier may have shunned the Finger Lakes, are now choosing to locate their vineyards along Seneca Lake. *See* Letters from JP Vineyards, LLC and Forge Cellars, copies of which are annexed hereto as Attachment A. As explained in the Christopherson Report, the viability and growth of this important industry is "deeply dependent" on perception of the region as unpolluted and suitable for viticultural activities.

Similarly, the Seneca Lake Communities recognize that the growth and prosperity of their communities and the vitality of their local character is dependent upon perceptions of the Finger Lakes Region as a whole, especially with respect to particularly noteworthy or environmentally sensitive areas, such as the waterfront of Seneca Lake. To show the pains they have taken to protect and improve that waterfront, as well as their rural and/or small town character, the Seneca Lake Communities proffer the Affidavit of Timothy Jensen, Associate Planner in the Ontario County Planning Department, sworn to January 15, 2015, a copy of which

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[1] *Available at* http://bit.ly/1DJkpid.

[2] *Available at* http://sustainable-fingerlakes.org/wp-content/uploads/2013/01/FLRSP-Final-Plan.pdf.

is annexed hereto as Attachment B; and the testimony and Affidavits of Sage Gerling, Director of Neighborhood Initiatives for the City of Geneva, sworn to January 15, 2015, a copy of which is annexed hereto as Attachment C, Scott Gibson, Deputy Mayor of the Village of Watkins Glen, sworn to January 15, 2015, a copy of which is annexed hereto as Attachment D, and Mark Venuti, Supervisor of the Town of Geneva, sworn to January 15, 2015, a copy of which is annexed hereto as Attachment E.

In the environmental setting of the region in which it purports to locate, the Proposed Project is not only anachronistic, but it presents a clear threat to the identity and development scheme purposefully cultivated by the Seneca Lake Communities and other municipalities in the region. Its unique repugnance to the character and land use planning of the region is three fold: (1) as discussed in the Christopherson and Flad Reports, it is a visible, heavy industrial use that is out of step with the trajectory and emerging identity of the region; (2) the siting of such a use directly on the shores of Seneca Lake conflicts with local and regional planning efforts specifically to protect environmental quality and perception of the lakefront area; and (3) it poses significant risks distinct from other industries – both with respect to potential accidents associated with the transportation of LPG through the Seneca Lake Communities as well as the threat of a catastrophic and spectacular failure of the facility itself – that could damage the integrity and reputation of the region as a whole.

The proffered evidence will also demonstrate that the DSEIS's failure to reasonably evaluate potential impacts to the community character of the Seneca Lake Communities and the region at large is a substantial omission and a violation of SEQRA. All environmental impact statements are required to reasonably evaluate potential significant environmental impacts. ECL

§ 8-0109(2); 6 N.Y.C.R.R. § 617.9(b). In this respect the DSEIS is deficient in three major respects.

First, given its aspirations as a large scale regional distributor of LPG, the DSEIS does not discuss the appropriate environmental setting of the Proposed Project, a required component of an EIS. ECL § 8-0109(2)(a); 6 N.Y.C.R.R. § 617.9(b)(5)(ii). Adequate consideration of this setting would need to include both an explanation of the particular sensitivities of the region as an emerging center for specialized agriculture, tourism, and agribusiness, as well as the region's trajectory, thanks to careful land use planning and local efforts, away from its early-to-mid-20th Century identity as a corridor for heavy industry.

While the DSEIS does describe the environmental setting in the Town of Reading briefly – noting a variety of economic activity and acknowledging that wineries are "becoming a major factor in the area's economy," DSEIS at 144-145 – it does not expand on this discussion to include within its description of the environmental setting other likely affected communities or their local character and goals. This discussion is essential given the applicant's vision of providing "large scale truck, rail, and pipeline access" to 2.1 million barrels of LPG, which will no doubt entail greatly increased transportation of LPG through the Seneca Lakes Communities and the region at large. *See* DSEIS at 11-14.[3]

Second, the DSEIS does not evaluate the potential significant adverse impacts that the Proposed Project will have on the community character of other likely affected municipalities or the region as a whole. Analysis of community impacts is limited to traffic, noise, and aesthetics in the areas immediately adjacent to the Proposed Project. DSEIS at 110-120 (noise); 120-131

[3] Despite the applicant's promise that no truck transportation will be used to transport LPG to and from the Proposed Project in its revised transportation allocation, Document I.B.36 (2014-12-02, Product Transportation Allocation – Revised December 2014), DEC has not proposed draft permit conditions that would prevent truck transport. As such, the Seneca Lake Communities are still greatly concerned about the potential significant increase in the trafficking of this explosive material by trucks within their borders.

(traffic); 131-144 (aesthetics). The DSEIS wholly ignores, however, the Proposed Project's potentially significant adverse impacts on the character, perception, and planning goals of other municipalities in the region, including the Seneca Lake Communities.

Third, the DSEIS provides insufficient consideration of the potentially significant adverse impacts that potential accidents or a catastrophic event would have on community character. To demonstrate the appreciable risk and severity of such (an) incident(s), the Seneca Lake Communities will rely on the expert report of H.C. Clark ("Clark Report") and Quantitative Risk Assessment by Dr. Rob Mackenzie ("Mackenzie Report") – both being submitted in support of the petition for full party status by Gas Free Seneca – as well as the affidavit and proposed testimony of Richard Kuprewicz. *See* Affidavit of Richard B. Kuprewicz, sworn to January 15, 2015, a copy of which is annexed hereto as Attachment F ("Kuprewicz Aff.").

In particular, a catastrophic event would have serious consequences to the character, emerging land use patterns, and perception of the Seneca Lake Communities. The DSEIS' evaluation of community character – limited to only noise, traffic, and aesthetics within the immediate area around the Proposed Project site under normal operating conditions – inexcusably omits the substantial and potential long-term injuries that accidents or a catastrophic event would inflict on local identity and development goals of surrounding municipalities in the region, even those that would be directly affected by such (an) incident(s).

B) The DSEIS Does Not Properly Evaluate the Potential Significant Adverse Impacts to Water Quality

Seneca Lake is a key source of municipal water for the Seneca Lake Communities. All of the Seneca Lake Communities bordering the Lake rely on it for some portion of their water. The Communities will present the testimony of Mathew Horn, City Manager of the City of Geneva, that approximately 15,500 people use the water treatment plant in Geneva. Affidavit of Mathew

Horn, sworn to January 15, 2015, a copy of which is annexed hereto as Attachment G ("Horn Aff."), at ¶ 3. They also offer the testimony of Mark Swinnerton, the Mayor of Watkins Glen, and the affidavit and testimony of James Bromka, the water treatment plant operator for the Town of Waterloo, that both of those communities rely on Seneca Lake to supply potable water to their residents. *See* Affidavit of James Bromka, sworn to January 16, 2015, a copy of which is annexed hereto as Attachment H ("Bromka Aff."), at ¶ 2.[4]

The Seneca Lake Communities offer to prove that the Lake and the communities it supports are particularly vulnerable to increases in salinity because the Lake is already significantly saline and because any additional contaminants would remain in the Lake for generations. John Halfman, Ph.D., Professor of Geolimnology & Hydrogeochemistry at Hobart and William Smith Colleges and an expert on Seneca Lake, will show that Seneca Lake has, even without the Proposed Project, significantly more salinity than the other Finger Lakes. Affidavit of John Halfman, Ph.D., sworn to January 15, 2015, a copy of which is annexed hereto as Attachment I ("Halfman Aff."). This level of salinity is already above the recommended level of 20 mg/L set by DEC and the federal Environmental Protection Agency ("EPA") for all infants and adults on low sodium diets. *Id.* at ¶ 3. Seneca Lake also has a long residence time of 20 years, meaning it would take 100 years to flush out contaminants like sodium and chloride. *Id.* at ¶ 5.

Additionally, the Communities offer to prove that unique properties of Seneca Lake raise a serious possibility that prior industrial activity in the caverns at issue here is connected with the increased salinity in the Lake, making the Lake even more vulnerable and requiring further investigation. Specifically, Dr. Halfman will testify that reported mine waste discharges and

[4] The Communities anticipate that Mark Swinnerton will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing on this matter, should one be scheduled.

stream inputs are insufficient to explain the levels of salinity in the Lake, suggesting another source. *Id.* at ¶¶ 7-8. Moreover, the repeated increases and decreases in sodium and chloride indicate a non-steady-state source – a source that has changed over time. *Id.* at ¶ 10. He will show that both the start of the salt mining industry near the Lake and previous LPG storage at this site correlate with massive spikes in chloride in the Lake. This suggests a source connected to that activity. *Id.* at ¶ 11.

That source demands investigation. The Communities offer Dr. Halfman's expert opinion that it is possible that groundwater flow may be the cause, and that the correlations between previous activity in these caverns and spikes in chloride in the Lake raises a question about whether there is a connection. *Id.* at ¶¶ 9, 11. It is also Dr. Halfman's opinion that there is not enough publicly available information to properly answer this question. However, Dr. Halfman will testify that this connection is testable, and that the applicant should perform a year-long pressure test while a third party concurrently measures the lake for sodium and chlorine. *Id.* at ¶¶ 12-13.

The Communities will also rely on the testimony and expert report of Tom Myers, Ph.D., an expert hydrologist, being submitted in support of the petition for full party status of Gas Free Seneca, to show that this pathway exists. Dr. Myers opines that the LPG storage in the salt mines proposed here can cause significant discharges of additional salt into Seneca Lake. This explains the correlation between previous LPG storage at this site and the spike in chloride in the Lake observed by Dr. Halfman. This analysis does not depend on any assumptions about cavern integrity; in Dr. Myers' opinion, the pressure inherent in LPG storage exerts pressure on the surrounding salt formation, squeezing high-chloride groundwater into the bottom of the Lake.

Even relatively small changes in pressure from LPG storage at the site will cause salt discharges into Seneca Lake.

Significant releases into the Lake as the result of a catastrophic event are also a possibility. The Communities offer the affidavit and testimony of Mr. Kuprewicz, an expert in risk assessment, to prove that there is the serious possibility of a catastrophic event at this facility. Mr. Kuprewicz will testify that storage of LPG in underground salt caverns has many more safety risks than above-ground storage and carries with it the potential to release large volumes of product. Kuprewicz Aff. at ¶¶ 10-12. He will also testify that state and local emergency response capacity is insufficient to handle such a catastrophic event. *Id.* at ¶ 15. The Seneca Lake Communities will also rely on the Clark and Mackenzie Reports to show that substantial data gaps remain regarding the serious cavern integrity risks associated with the Proposed Project and that there is a significant possibility – specifically, a 35% chance – of such a catastrophic failure occurring.

Salt in Seneca Lake would pose a public health risk, especially given the Lake's heightened baseline salinity. As noted above, Dr. Halfman will testify that the levels of salt in the Lake are already above DEC and EPA drinking water advisory levels. The Communities will also offer the testimony of Mark Morabito, chief operator of the City of Geneva water treatment plant, that water with salt levels above 270 mg/L should not be consumed.[5] The Communities also offer an EPA report *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sodium* (Feb. 2003).[6] That report notes that high levels of sodium are associated with hypertension, with children and the elderly being especially sensitive. It

[5] The Communities anticipate that Mark Morabito will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing on this matter, should one be scheduled.

[6] *Available at* http://water.epa.gov/action/advisories/drinking/upload/2003_03_05_support_cc1_sodium_dwreport.pdf.

recommends reducing sodium levels in water to between 30 and 60 mg/L based on taste and water quality. For people on sodium-restricted diets, levels greater than 120 mg/L present a health risk.

This potential health impact is compounded by the fact that the Seneca Lake Communities' existing water treatment facilities do not treat for salt, and cannot easily be adapted to do so. The Communities offer the testimony of Mr. Horn that Geneva's plant is typical of water treatment plants in the region and does not treat for salt. Horn Aff. at ¶ 7. James Bromka and Mr. Swinnerton will testify that the same is true of their water treatment facilities. *See* Bromka Aff. at ¶ 3. Mr. Horn will also testify that, if Seneca Lake were to become undrinkable due to salinity, it could take at least a year to bring a suitable system online. Developing this new water treatment system and providing temporary water would cost at least $18 million and, as a result, would raise local water rates many-fold. Horn Aff. at ¶¶ 8-9. Mr. Bromka will testify that building a system capable of treating saline water would likely cost Waterloo at least $2 million in capital costs and would take at least a year to complete. Bromka Aff. at ¶ 4.

This proffered information will show that the DSEIS fails to reasonably evaluate potential impacts to water quality as required under SEQRA. All environmental impact statements are required to reasonably evaluate potential significant environmental impacts. Department regulations provide that "all draft EISs must include . . . a statement and evaluation of the potential significant adverse environmental impacts." This statement and evaluation must be "at a level of detail that reflects the severity of the impacts and the reasonable likelihood of their occurrence." 6 N.Y.C.R.R. § 617.9(b)(5)(iii).

Given that standard, the DSEIS' statement and evaluation of potential impacts to water quality is insufficient because much of the proffered information is unaddressed. First, the DSEIS does not address the particular vulnerability of Seneca Lake and its surrounding communities. The DSEIS acknowledges that Seneca Lake is a source of water for the City of Geneva and the Villages of Hector, Ovid, Waterloo, and Watkins Glen, and it recognizes that Seneca Lake has heightened levels of sodium and chloride. DSEIS at 93-96. That is the extent of the analysis – there is no discussion of the current health risks associated with that salt or how this unusually salty baseline impacts the risks associated with the Proposed Project.

Second, the DSEIS has not addressed the possibility of an additional pathway making Seneca Lake even more vulnerable to elevated salinity. The DSEIS does not present or attempt to explain the data showing spikes in salinity that correlate with both salt mining and previous LPG storage at this location. There has also been no testing of this correlation to determine whether there is a causal link. Finger Lakes LPG Storage, LLC has done some pressure testing on the caverns, from short-duration tests to high-pressure tests for weeks or months. According to the DSEIS, the caverns have always passed those tests. *Id.* at 76. Baseline groundwater monitoring was also performed. *Id.* at 88-89. However, the DSEIS contains no evaluation along the lines of the one Dr. Halfman believes is necessary to rule out a connection between storage in these caverns and salinity in the Lake. Halfman Aff. at ¶ 13. The mechanical integrity testing does not appear to have been done alongside groundwater testing and sampling at the Lake.

Third, the DSEIS does not sufficiently address the risk of a catastrophic failure causing a release of sodium and chloride into the Lake. There is much discussion of how ideal salt caverns are for this kind of storage, and of the testing done on these caverns. *See* DSEIS at 64-82; 147-153. The DSEIS also discusses the possibility of a brine spill in some detail. *Id.* at 99-102.

However, there is no evaluation of the risk and impacts of a catastrophic cavern failure. It is not addressed in discussing potential accidents or in the suitability of these caverns to store LPG. *See id.* at 70-82; 164-166. The most the DSEIS does to address this risk is repeatedly assure that the cavern integrity has been tested and that salt formations are generally impermeable.

Fourth, the DSEIS does not address the potential human health impacts of salt in Seneca Lake. It briefly touches on the possible impacts of a brine pond leak on freshwater aquatic life, but it does not address the potential future health impacts if the Lake were to become more saline. It particularly does not address the health impacts that would result from a catastrophic release of sodium and chloride, either from a cavern event or from a major brine pond release. The DSEIS concludes that a major release from the brine pond would likely result in concentrations of brine of 35,000 to 50,000 mg/L up to one kilometer from the point of release, yet contains no discussion of what salinity like that might mean for human health. *See id.* at 101.

Finally, the DSEIS does not address the capabilities of or risks to local water treatment facilities. As noted above, the Communities offer to prove that their water treatment facilities cannot treat for salt and that adapting to a much saltier Lake Seneca would be significantly costly. The DSEIS, while it notes that the Lake is a source of public water, does not address these potential impacts to public water facilities.

C) The DSEIS Does Not Properly Evaluate the Potential Significant Adverse Impacts on Local Emergency Resources

The DSEIS does not sufficiently address the potential impacts that a spill, accident, or catastrophic event would have on the emergency resources of the localities in the region that would be directly and adversely affected by the Proposed Project. As described in the Mackenzie Report and Mr. Kuprewicz's Affidavit, the consequences of an accident or failure associated with either the storage or transportation of LPG are extremely serious. *See generally,* Mackenzie Report, Kuprewicz Aff. Any such event would not only severely tax limited emergency funds of municipalities that would need to provide emergency personnel, such as police, firefighters, and medical first-responders, it may also be beyond the capacity of local authorities to deal with appropriately.

The Seneca Lake Communities offer the affidavit and proposed testimony of Mr. Kuprewicz to demonstrate the "significantly greater risks" associated with underground storage of LPG compared to storage of natural gas or other LPG storage methods, as well as his expert opinion that local "emergency response plans and emergency response personnel are not likely to be able to effectively handle a catastrophic release of stored LPG from salt caverns at the Proposed Project." Kuprewicz Aff. at ¶ 15. They also offer the affidavit and proposed testimony of Mr. Venuti to demonstrate the significant and perhaps unmanageable strain that such an emergency response would put on the Seneca Lake Communities.

While the DSEIS does address local emergency response, it does so only in a limited and inadequate fashion, noting that local responders will be called if there were a fire or accidental release, and that Finger Lakes LPG Storage, LLC will coordinate with the Watkins Glen Fire Department, which has a "predetermined response plan for a progressive response." DSEIS at 166-167. There is some discussion of the Watkins Glen Fire Department, but it does not include a frank analysis of its resources and effectiveness. A serious incident at the site of the Proposed Project would almost certainly necessitate emergency response from additional and possibly distant municipalities – most likely dwarfing the capacity of local responders. *See* Kuprewicz Aff. at ¶ 15. Without a detailed and accurate understanding of emergency resources and response plans of those municipalities, the DSEIS fails to take the 'hard look' necessary to appreciate the full environmental impact of, or identify any appropriate mitigation for, a potential spill, accident, or catastrophic event as demanded by SEQRA. *See* ECL § 8-0109(2); 6 N.Y.C.R.R. § 617.9(b).

D) The DSEIS' Consideration of Alternatives is Totally Insufficient

In abject violation of one of SEQRA's most fundamental requirements, the DSEIS fails to consider any meaningful alternatives to the Proposed Project. Particularly given the extreme risk the Proposed Project poses, this is a fatal defect. The SEQRA regulations require that all environmental impact statements include "a description and evaluation of the range of reasonable alternatives to the action that are feasible, considering the objectives and capabilities of the project sponsor." 6 N.Y.C.R.R. § 617.9(b)(5)(v). This range of alternatives "must include the no action alternative." *Id.* Although there is no definitive list of kinds of alternatives that must be considered, Part 617 notes that considering alternative sites, scales/magnitudes, designs, and timing, may be appropriate. *Id.*

The Proposed Project's stated purpose is to secure the local supply of propane. DSEIS at 12-14. Specifically, the DSEIS describes the need for the Proposed Project as threefold: (1) the Northeast propane market fluctuates heavily by season and so bulk storage helps ensure a constant supply; (2) there are imbalances where demand exceeds local available supply because of long distances for transport, limited local storage, minimal retailer storage, and locally stored propane being used to supplement pipeline deliveries through the winter and so not being available for local uses; and (3) this imbalance increases costs to consumers, encourages the use of dirtier fuels, and creates demand for "spot market production that is immediately available. *Id.* The Applicant specifically defines the benefit to be provided as "pipeline allocations and the need for large volumes of spot product at high pricing spreads [being] dramatically reduced relieving millions of dollars of potential burden from consumers and helping to ensure the use of clean burning fuels." *Id.* at 14.

Although the DSEIS appears to dedicate a full section and several subsections to discussing alternatives, essentially all of the alternatives considered relate to where the on-site brine pond(s) are to be located. *See id.* 170-173. There are but three sentences about the location of the facility as a whole:

> Given that the solution mining wells already exist, Finger Lakes did not consider other greenfields in the vicinity of the site for an underground storage LPG facility. In addition, given the use of the US Salt property for solution salt mining, underground natural gas storage, and with this application, LPG storage, it was not feasible to locate the surface facility on the US Salt property. Therefore, Finger Lakes acquired property on NYS Route 14A because it is contiguous to property US Salt owns on the west side of NYS Route 14 making the pipeline connection possible without having to acquire any easements from other property owners.

Id. at 170. Aside from these three sentences, alternative sites are not discussed. Neither is the no action alternative, despite the specific regulatory mandate under 6 N.Y.C.R.R. § 617.9(b)(5)(v).

The DSEIS's failure to consider any alternative sites for the Proposed Project is a fatal defect. As discussed above, the Communities will show that both Seneca Lake and its surrounding municipalities are particularly vulnerable to the risks this development poses. At the same time, the project need and purpose as outlined in the DSEIS are based not on Seneca Lake or even the larger Finger Lakes Region, but rather on the propane market in the Northeast region as a whole. Although the DSEIS does not define "Northeast," even a conservative definition includes New York, Vermont, New Hampshire, Connecticut, Rhode Island, Massachusetts, and Maine. *See, e.g.*, U.S. Census Bureau, *Census Regions and Divisions of the United States*, (last visited Jan. 16, 2015) (map showing "Northeast" census region including the above listed states, along with New Jersey and Pennsylvania).[7]

Given the broad geographic scope of the Proposed Project's proffered need and benefits and the unique vulnerabilities involved with this site, it is unreasonable and unlawful for the DSEIS to have no discussion of alternative sites whatsoever. Even if the Applicant is relying on the provision in 6 N.Y.C.R.R. § 617.9(b)(5)(v) allowing private project sponsors to limit site alternatives to parcels owned or under option to the sponsor, the DSEIS makes absolutely no showing to that effect. The Applicant makes no showing that this is, in fact, the only owned or optioned parcel it has in the region. It also does not explain why purchasing or optioning another, more suitably located, parcel is not a viable alternative, rendering the DSEIS' alternatives analysis wholly inadequate.

E) The Draft Permit Conditions Fail to Provide Indemnity or Insurance to Protect the Seneca Lake Communities

The November 14, 2014 draft permit conditions contain one indemnity provision. Condition 9 requires the prospective Permittee to:

> accept[] the full legal responsibility for all damages, direct or indirect, of whatever nature, and by whomever suffered, arising out of the storage facility's construction and operation to the extent such liability is attributable to the actions of the Permittee, its employees, agents, contractors or subcontractors, and to the extent the Permittee is liable under the law for such actions. The Permittee must indemnify and save harmless the State from suits, actions, damages, and costs of every nature and description resulting from such actions.

Draft Permit Conditions at 6, ¶ 9. This draft permit condition is insufficient in two ways.

First, Condition 9's first sentence is ambiguously worded and should be clarified. It is unclear whether it expands the applicant's liability to the general public beyond that provided for

[7] *Available at* http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf.

by law. Parts of the sentence read like an expansion of liability, but others potentially eliminate any such expansion. If the intent of Condition 9 is to make clear that Finger Lakes LPG Storage, LLC's liability extends to all potentially affected entities (including the Communities themselves), it should be stated clearly.

However, it is also possible to read the first sentence of Condition 9 as limiting the applicant's liability to that which applicable law already provides. Although Condition 9 begins with applicant accepting responsibility "for all damages," its responsibility is limited to that which is attributable to it or its agents and to the extent the applicant is liable under law. If this first sentence means only that "Permittee is liable for damages for which it is liable under law," then it adds nothing except ambiguity and should be cut.

Second, Condition 9 does not protect the Seneca Lake Communities or other nearby municipalities threatened by the Proposed Project, particularly in the event of a catastrophic accident. As discussed above, a spill, accident, cavern failure, or other catastrophic event would likely severely tax the emergency resources of the Communities. Further, the costs of replacing or supplementing water treatment systems could run into the millions of dollars for each affected facility, not counting normal operating costs afterward and the costs of providing temporary potable water before new treatment comes online. *See, e.g.,* Horn Aff. at ¶ 8.[8] In the City of Geneva alone, treating for brackish water could cost as much as 600 times more per gallon than current treatment methods. *Id.*

However, Condition 9 appears only to indemnify the State, and even then only from liability and costs related to damages caused by the Project. It provides no evident protection for

[8] The Seneca Lake Communities anticipate that they will be able to offer the testimonies of additional municipal officials regarding the costs and feasibility of additional water treatment at a future adjudicatory hearing, should one be scheduled.

the Communities or other impacted municipalities in the event of an accident, apparently leaving them to seek recompense through a costly, time-consuming lawsuit.

Further, the Communities' expert, Mr. Kuprewicz, opines that the proposed storage of as much as 2.1 million gallons of LPG in underground salt caverns presents unique and extreme risks that have been inadequately considered in the DSEIS, and which state and local regulators are unlikely to be able to manage. Kuprewicz Aff. at ¶¶ 9-15. Mr. Kuprewicz further states that "[b]ecause of the large inventory of LPG that would be stored at the Proposed Facility, the liability associated with a catastrophic failure of either or both of the salt domes would likely number in the hundreds of millions if not billions of dollars." *Id.* at ¶ 16. There has been no showing that the applicant has the financial wherewithal to indemnify the affected parties, even if that is the intent of Condition 9.

As such, the DSEIS both fails to properly evaluate the potential risks associated with the Proposed Project, and fails to identify adequate mitigation for the risks the Proposed Project poses. *Id.* at ¶¶ 9, 17. The SEQRA regulations clearly require that the Department incorporate permit conditions that "minimize adverse environmental impacts to the maximum extent practicable." 6 NYCRR § 617.11(d)(5). Mitigating these impacts in a way that does not risk imposing further hardships on the affected municipalities requires an ex ante solution – a bond, indemnity, or insurance provision protecting local communities. The Seneca Lake Communities offer to prove that failing to require impose a sufficiently substantial bond, indemnity, or other insurance provision here fails to meet this requirement.

V. Conclusion

This is neither the right place nor the right time for a proposal to site this kind of heavy industrial development along the shores of Lake Seneca, and the risks the Proposed Project poses to the health, safety and identity of the Lake and the Seneca Lake Communities have not been sufficiently considered, much less addressed in the DSEIS or draft gas storage permit conditions. These fatal flaws are substantive and significant issues, suitable for adjudication. The Communities respectfully request that they be granted full party status to present those issues for consideration.

TO: Honorable James T. McClymonds, Chief Administrative Law Judge
New York State Department of Environmental Conservation
Office of Hearings and Mediation Services
625 Broadway
Albany, New York 12233

Dated: January 16, 2015
New York, New York

Respectfully Submitted,

/s/ Katherine Sinding
Katherine Sinding, Esq.

Daniel Raichel, Esq.

Jonathon Krois, Esq.

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ATTACHMENT A

Forge
CELLARS

December 7, 2014

The Honorable Andrew M. Cuomo
Governor of New York State
NYS State Capitol Building
Albany, NY 12224

Dear Governor Cuomo:

Since 2011, Forge Cellars, comprised of two New York partners and renowned French winemaker, Louis Barruol, have been making wine in Hector, New York in the heart of the Finger Lakes. In a short time, we have been able to compete on the international stage, receive critical acclaim and realize distribution across the U.S. and soon, Europe and Japan.

We are currently in negotiations to buy 21 acres of land, plant vineyards and build a winery on the east side of Seneca Lake about eight miles north of Watkins Glen. The land surrounding Seneca lake provides everything we need to make world class wine and to create further tax dollars and growth for the region. The 91 and 92 point scores we have thus far received from Wine Spectator come from wines made with grapes nourished by the soil, the air, and the water of Seneca Lake.

We are greatly concerned (better to say "alarmed) about the Crestwood gas storage project under our greatest resource. The threat of toxins and potential for environmental disaster provide long-term risks which we as business people and residents of the community do not wish to take. We stand at the crossroads of making a major financial investment and staking our business and its reputation on the potential of the Finger Lakes, an emerging wine region with limitless opportunity. Allowing Crestwood to proceed with its gas storage operation is unwise in light of the dangers it poses.

Do you want to risk the health and purity of one of New York's most prized tourist, agricultural and manufacturing regions for one corporation's benefit? Do you want to risk the waters, wildlife and surrounding soils of this forty-mile long lake? As the Finger Lakes hits the world wine scene, do you want it to be known as one that is pristine and that can tout its greatest resource with pride? Or do you want it to be known as the wine region that "sold out" to big business because it is ignorant and short-sighted?

Let us present our wines to the world, grow our industry and aim for the pinnacle of quality we know we can achieve. Please halt this operation and protect our valuable industry. Stop the contamination of our land before it can happen. Do everything you can to reverse Crestwood's plans which so many of our wineries, business leaders and citizens vehemently oppose. We implore you to act quickly.

Respectfully,

Richard Rainey, Justin Boyette, Louis Barruol
Forge Cellars
Hector, NY

JPV

December 8, 2014

The Honorable Andrew M. Cuomo
Governor of New York State
NYS State Capitol Building
Albany, NY 12224

Dear Governor Cuomo,

We looked around the world for the best location to develop our first joint winery project, bringing together know-how and prestige from two wine families from Northern California and the Mosel Valley, Germany, and chose the Finger Lakes. We extensively toured the region and fell in love with the soil and topography of an abandoned vineyard near the junction of Routes 79 and 414, just above Watkins Glen on the east side of Seneca Lake. There were no tax incentives offered to entice us to invest in the Finger Lakes. We were drawn by the opportunity to play a significant role in what we believe has the potential to become one of the most exciting wine regions in the world.

When we purchased the JP Vineyards site in 2013, we didn't believe the gas storage expansion would be allowed to proceed, given the importance of the rapidly expanding Finger Lakes wine industry. Beyond vines we have ordered for 2015 planting, we are considering holding off the further development of these vineyards and visitor center, a multi-million dollar project, until the question of gas storage expansion is resolved. We believe that the outcome of both the natural gas and LPG storage expansion struggle directly across the lake from our vineyards will have an extremely positive or severely negative impact on future Finger Lakes wine industry and tourism investments from around the world.

Sincerely,

Paul Hobbs

Johannes Selbach

JP Vineyards, LLC
3539 State Route 79, Burdett, NY 14818
Fax: 707.824.5843

ATTACHMENT B

New York State Department of Environmental Conservation

In the Matter of the Applications of	Application Number 8-4432-00085
FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	**AFFIDAVIT**

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF ONTARIO)

I, Timothy Jensen, swear or affirm:

1. My name is Timothy Jensen. I am an Associate Planner in the Ontario County Planning Department, a position which I have held for 1½ years. Prior to my current position, I worked as the Director of Development for the Town of Canandaigua, NY from 2009 to 2013. Prior to that, I was a Planner and then Senior Planner in the Ontario County Planning Department from 1999 to 2009.
2. In my 15 years in various positions with the Town of Canandaigua and Ontario County, I provided technical assistance to municipalities for a very wide range of land use planning and regulation issues.
3. Based upon my planning experience and knowledge of land use planning and regulation at the local and County levels, it is my position that Crestwood's proposed LPG storage facility (the "Proposed Project") raises heretofore unanswered questions regarding how the continued development of this category of industrial uses, especially those within

rural areas in close proximity to a regionally significant natural resource, conflicts with the growing regional priority placed on protection of water quality and community character.

4. Tourism: To a large extent the economy and community character of the Finger Lakes is based on a healthy natural environment and agriculture. This, in turn, fuels a growing tourism sector. Ontario County directs just under one million dollars each year to its Tourism Bureau (d.b.a. Finger Lakes Visitor Connection). In 2013, tourism accounted for approximately 6% of the employment in the region. Overall spending by visitors to the Finger Lakes has grown consistently since 2008 and, in 2013, reached an estimated $2.8 billion, the second highest of the 9 New York Regions outside of New York City and Long Island.

5. Water Quality Planning and Protection: The growing priority for protection of surface and ground waters is evident at the regional and State levels. Ontario County includes frontage on 5 of the 11 Finger Lakes. They serve as a drinking water source and are a key component of the local economy and quality of life. Several watershed protection groups have been formed and have been working diligently over the past few decades to protect these resources. These groups have been funded by several EPA and NYS grants to assess land use and development and implement strategies to protect the Finger Lakes. The Genesee Finger Lakes Regional Planning Council has also played an important role in this effort by providing technical support for review of local laws related to water quality. Water quality in Ontario County has, for the last several decades, been addressed at all levels of government as an issue of overriding importance.

6. It can be argued that the Proposed Project, by allowing intensification of a pre-existing industrial use in close proximity to Seneca Lake, directly undermines ongoing efforts to protect a critical natural resource that is the foundation of a growing sector of our economy. While the SEIS does include information about local noise and visual impacts, it is not clear that the real risks associated with this use have been weighed against the potential harm to the community character of the Finger Lakes Region and tourism.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Tim Jensen

Timothy Jensen

1/15/15

Date

Sworn to before me on January 15, 2015:

Linda Rae Frasca

Notary Public

LINDA RAE FRASCA
Notary Public, State of New York
Ontario County #01FR4820257
Commission Expires March 30, 2018

ATTACHMENT C

New York State Department of Environmental Conservation

In the Matter of the Applications of	Application Number 8-4432-00085
FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	**AFFIDAVIT**

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF ONTARIO)

I, Sage Gerling, swear or affirm:

1. My name is Sage Gerling. I am the Director of Neighborhood Initiatives for the City of Geneva (the "City"), a position that I have held for almost three years. Prior to my current position, I worked for five years as a consultant providing multiple New York State communities, including the City, with land planning and design services. I am an AICP certified planner and obtained Master of Regional Planning and Master of Landscape Architecture degrees from Cornell University. A copy of my Curriculum Vitae is annexed hereto as Exhibit A.

2. I manage the Office of Neighborhood Initiatives ("ONI"), which provides the City with place-based revitalization programs focused on implementing community and neighborhood development strategies. The community development strategies seek to forward planning efforts that strengthen the City's diverse resources and assets and position Geneva to be a model community. Neighborhood strategies seek to enhance the

competitiveness of the Geneva market through facilitation of neighbor-led programs and projects geared at boosting neighborhood pride, leveraging strategic partnerships, and creating a sense of place.

3. Based upon my planning experience and close knowledge of both regional and local development issues, I can state that Crestwood's proposed liquefied petroleum gas ("LPG") storage facility (the "Proposed Project") is incongruent with existing community character and land use planning goals for the City.

4. There are a number of specific concerns that the Proposed Project raises in this regard, including: (1) its inconsistency with and potential negative impacts on the trajectory of local and regional character and long term planning goals away from heavy industrial uses toward an identity as a center for agri-business and tourism; (2) its inconsistency with and potential negative impacts on careful local and regional planning efforts to protect and enhance the Seneca Lake waterfront; and (3) the potentially significant harms that industrial accidents associated with the facility could wreak on the character and land use goals of the City and the region.

5. Geneva is a major gateway for visitors coming to enjoy the Finger Lakes wine industry and its natural beauty including Seneca Lake. Since the 1950's, due in part to deliberate land use planning efforts, the City has shifted land uses along the lakefront from heavy industrial to recreational and tourism-related. In 1987, State Routes 5 and 20 relocated from the shores of Seneca Lake to the historic Cayuga-Seneca Canal alignment. This shift created a 60-acre City-owned site and allowed for the development of recreational and tourist amenities along the lakefront. Over a dozen studies since 1958 have recommended recreational and tourism amenities at the lakefront.

6. The City's 1997 Master Plan and Local Waterfront Revitalization Program (the "Plan") states that the lakefront serves as a catalyst for redevelopment of the City for economic, recreational and open space purposes, with particular emphasis on water-dependent and water-enhanced uses. Plan at II-14.[1] The Plan also includes targeted environmental resource protection recommendations to protect and enhance the lakeshore, such as limiting development on steep slopes along South Main Street that will negatively impact water quality; upgrading and protecting water quality of Castle and Marsh Creeks to uphold Seneca Lake water quality; and continuing shoreline stabilization along the lakefront. *Id.* at II-16. The Plan's recommendations also emphasize continuing a proactive tourism development program including water-dependent recreation. *Id.* at II-18.

7. The 2012 Geneva Waterfront Infrastructure Feasibility Study (the "Feasibility Study"), prepared with City and New York State Department of State ("NYSDOS") funds, outlines the design concept, construction effort, and cost estimates for six major waterfront enhancements including pier extensions for a marina breakwater, boardwalks, shoreline stabilization improvements, a new lakefront beach, habitat restoration, and pedestrian walking paths.[2]

8. Importantly, significant energy and funds have been invested to achieve the identified goals. Since 2013, the City of Geneva has taken action on the Feasibility Study by constructing Phase I, which involves shoreline revitalization and plantings, multi-use paths, jetty improvements, and a deck, and is currently undergoing design development for Phase II and schematic design for Phase III. The City is on schedule to construct

[1] *Available at* http://visitgenevany.com/sites/default/files/temp/neighborhood/Comp_plan/master%20plan.pdf.

[2] *Available at* http://bit.ly/1y1SMxf.

Phases II and III in Fall 2015. Committed City and NYSDOS funds (spent or designated) through Phase III total approximately $5 million. In addition, the City recently completed construction of a new Visitor and Event Center on the lakefront with an investment of $2.6 million raised from multiple New York State agencies.

9. The Proposed Project's heavy industrial use is inconsistent with the City's land use planning and actions as set forth above. The Proposed Project would create particular adverse impacts to the City's local character and planning goals and waterfront protection and enhancement efforts because of its proximity to the Lake and heavy industrial character. In addition, the risk of accidents associated with the facility (e.g., LPG railcar derailment and explosion in the City, or a catastrophic failure at the facility) would cause potential significant harm (specifically stigma) to the City's planning goals of retaining residents and attracting visitors.

10. Based on the foregoing, it is my opinion that the applicant has inadequately considered, much less addressed, the potential significant adverse impacts to community character presented by the Proposed Project.

11. I anticipate that I will be able to testify regarding the issues addressed in this affidavit in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Sage Gerling

1/15/15
Date

Sworn to before me on January 15, 2015:

Nancy A. Coluzzi
Notary Public

NANCY A. COLUZZI
Notary Public, State of New York
Qualified in Ontario County
No. 01CO6154377
My Commission Expires Oct. 23, 2018

EXHIBIT A

Sage B. Gerling, AICP, LEED AP
85 Maxwell Avenue
Geneva, New York, 14456
607-339-7729, beckettsage@gmail.com

EDUCATION/CERTIFICATIONS

American Institute of Certified Planners (AICP) — July 2009
U.S. Green Building Council (USGBC) LEED Certification (LEED AP) — August 2007
Master of Regional Planning — May 2007
Cornell University, Ithaca, NY
Master of Landscape Architecture — May 2007
Cornell University, Ithaca, NY
Concentration: Youth Participatory Research & Design
ASLA Award of Honor
Graduate in Alternative Design — May 2003
Archeworks, Chicago, Illinois
Alternative design school for socially & environmentally responsible projects
Bachelor of Arts in Cultural Anthropology and Advertising — May 1996
Southern Methodist University, Dallas, Texas

WORK HISTORY

Director of Neighborhood Initiatives, City of Geneva, Geneva, NY — Mar. 2012-Present
Community Planner/Landscape Designer at the Geneva Neighborhood Resource Center, czb, LLC and NeighborWorks Rochester, Geneva, NY — Jan. 2010-Mar. 2012
Community Planner/Landscape Designer, edr Companies, Rochester and Syracuse, NY — Feb. 2007-Dec. 2009
Group Facilitator & Assistant, Growing Up in New York City, Ithaca, New York — June 2005-Dec. 2006
Workplace Researcher, Haworth Intl., Holland, MI and Chicago, IL — Dec. 2000-Aug. 2003
Corporate Account Manager, Herman Miller, Los Angeles, CA — Oct. 1999-Dec. 2000
Photographer/Owner, Sage Ferguson Photography, Los Angeles, CA — July 1997-Jan. 2000

COMMUNITY/UNIVERSITY INVOLVEMENT

Board Member (Chairman, 2012-13), Boys & Girls Club of Geneva — April 2008-Dec. 2013
Operational Committee Chair, Geneva Community Center — Feb. 2010-Dec. 2013
Geneva Green Schools Initiative Organizer, Upstate NY US Green Building Council — Dec. 2007-May 2009
Cornell's Participatory Action Research Network Graduate Officer — Aug. 2003-May 2005

PROJECTS/PUBLICATIONS

- Project Manager, City of Geneva, *Brownfield Opportunity Area Study,* 2014, *Access Improvements to Seneca Lake Projects,* 2013-2015, *Comprehensive Plan,* 2015
- Co-Writer, Onondaga Community College, March 2009, *Sustainable Landscape Master Plan*
- Co-Writer, Town of Penfield, April 2009, *Bicycle Facilities Plan*
- Contributor, Village and Town of Cazenovia, Town of Marcy, 2008, *Comprehensive Plans*
- Contributor, Vancouver Working Group Discussion Papers for the World Urban Forum, April 2006, *The Youth Friendly City*
- Poster Presenter, EDRA Conference (Environmental Design Research Assoc.), May 2006, *Young People's Conflict, Contradiction and Comfort in Public Space: An Action Research Project in New York City*
- Graduate Thesis: *Clarence Stein Research: Design for Children in Sunnyside Gardens,* Fall 2005-2006
- Practitioner Profiles Project: *Using Participation in the Design Process*, Winter 2004
- Presenter, UT Austin ILASSA Conference, Feb. 2005, *The Power of Place: Brazil's Public Space as a Reflector of Social Inequalities,*
- Growing Up in New York City: An Action Research Project, Fall 2004-2006
- Organizer/Facilitator, Intergenerational Design Competition Conference, March 1, 2003
- Writer for IIDA's (International Interior Design Association), Magazine and Website, Fall 2002-Fall 2003: *Call-to-Action Articles for IIDA*
- Presenter, NeoCon Seminar, June 2002, *Using Measurement for Optimizing Open-plan Offices*

ATTACHMENT D

New York State Department of Environmental Conservation

In the Matter of the Applications of

Application Number
8-4432-00085

FINGER LAKES LPG STORAGE, LLC
For the Liquefied Petroleum Gas Storage Facility at Seneca Lake
for permits to construct and operate pursuant to the
Environmental Conservation Law

AFFIDAVIT

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF SCHUYLER)

I, Scott Gibson, swear or affirm:

1. I am the Deputy Mayor of the Village of Watkins Glen, Schuyler County, New York State. I have been Deputy Mayor for four (4) years and a resident of the Village for fourteen (14) years.
2. The Village of Watkins Glen sits on the southern end of Seneca Lake with the Town of Reading to the North, Town of Hector to the East, and Town of Dix to the South.
3. The Village of Watkins Glen borders Seneca Lake for approximately 1.75 miles. All Village residents, and many district customers from the Town of Reading and Town of Dix, obtain their drinking water from Seneca Lake and use the lake for a variety recreational of purposes.
4. There are approximately 1,950 full-time residents of the Village, and the lake plays an integral role in many people's decision to live here.

5. Watkins Glen is a tourist based economy and is highly sought after for its rich resources, including fishing, boating, swimming, hiking, camping, and other general recreational activities. The area is unique in that it experiences a wide swing in seasonal population influx. With an excess of 1.5 million that can visit during the peak tourist season, many come to Watkins Glen to enjoy the vast beauty of the area, to attend a race at Watkins Glen International (WGI), to visit the world renowned Watkins Glen Gorge, and to take advantage of the many recreational offerings that may be had on and around Seneca Lake. The Village of Watkins Glen is also known for several annual events including the Italian American Festival, the Cardboard Boat Regatta, and the Globally renowned Vintage Car Race, to name a few, which bring an untold number of thousands to each offering. Tourists also visit the rapidly multiplying local wineries that are scattered along the lake's eastern and western shores and many establishments are now offering boat-in eateries and other attractive fare. At 38 miles long, an average of 1.5 miles wide, and 618 feet at its deepest point, Seneca lake contains approximately 42,800 acres of surface area and is the lifeblood of our community.

6. There have been significant time, money, and long range planning efforts expended to date to bring Watkins Glen to where it is today. Once an industrial hub that waned with the disappearance of canal and lake transportation routes, the community of Watkins Glen has struggled to prosper ever since. Over the past decade alone, great strides have been made to reinvent our area into a tourist based economy to fill that void and we have been extremely successful in this venture and have great plans for its continued future. For example, our waterfront is rapidly changing and expanding with a newer 4-star hotel, lounge areas, picnicking, charter boating, eateries, and park areas just to name a few.

Local and state agencies have invested literally millions of dollars on improving the character of our community. Currently, the Village of Watkins Glen and the Village of Montour Falls are embarking on a brand new regional wastewater treatment plant as part of a larger economic development driver known as Project Seneca. Project Seneca is a state funded priority one plan that has the attention of the Governor and is on the short list for monetary grant and zero interest long term loan support. This is an unprecedented project in that two communities have agreed to conjoin municipal operations and embark on a $24.7M contract together. The environmental benefits are overwhelming as the project will decommission two 50+ year old non-compliant plants and remove them from their current location, which will open up further economic development opportunities along our waterfront.

7. Further, in 2012, the Village of Watkins Glen adopted a Comprehensive Plan that identifies its reliance on tourism and how to improve the character of the community to ensure its longevity. Several recent main street beautification grants have improved store front real estate and we have seen a vast influx of new and improved businesses along our corridor. Sales tax revenues have been steadily increasing over the past four years and there are several new projects in the works on how to improve our streetscape gateway approaches and to promote eco-tourism to take advantage of the beauty of our marsh lands and ornithology interests.

8. All of this progress comes at a price, of course, and we are vulnerable due to our limited infrastructure and reliance on the reputation of the Finger Lakes area as a clean and safe place to visit and recreate. For these reasons, the liquefied petroleum gas ("LPG") storage and distribution project proposed by Crestwood in the Town of Reading (the "Proposed

Project"), located only two (2) miles from our village border two and a quarter (2-1/4) miles from our downtown, is a threat to the Village's character and well-being. Because of these concerns, the Village Board passed a resolution opposing the project at its August 18, 2014 meeting.

9. Watkins Glen is at the intersection of two single lane state highways, and it is not uncommon for miles of bumper to bumper traffic to rule the day on a summer Saturday morning. Increased truck and rail traffic from the Proposed Project will undoubtedly snarl already overcrowded roadways and bring a heightened concern due to the increased exposure to explosive and flammable materials that will be transported over our busy streets several times more each day.

10. The mere perception that the Watkins Glen area is once again industrializing carries huge negative connotations for prospective investors looking to locate new and exciting tourist-based business ventures. Larger corporate style wineries who have already made that commitment have presented heartfelt public pleas detailing the very real possibility that those who are considering will simply look elsewhere. The size and scale of the Proposed Project would certainly have a direct negative impact on these plans and the future of our community.

11. Based on these facts, I do not believe the applicant has adequately considered the significant adverse impacts the Proposed Project would impose on the character of the Village and the larger region.

12. I anticipate that I will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Scott D. Gibson

1/15/15
Date

Sworn to before me on January 15, 2015:

Notary Public

DONNA J. BEARDSLEY
Notary Public, State of New York
No. 4763554
Qualified in Schuyler County
Commission Expires July 31, 2018

ATTACHMENT E

New York State Department of Environmental Conservation

In the Matter of the Applications of

Application Number 8-4432-00085

FINGER LAKES LPG STORAGE, LLC
For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law

AFFIDAVIT

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF ONTARIO)

I, Mark A. Venuti, swear or affirm:

1. I am the Supervisor of the Town of Geneva, Ontario County, New York State. I have been Town Supervisor for one year and a resident of the Town for 46 years.
2. The Town of Geneva surrounds the City of Geneva near the north end of Seneca Lake and is bordered by the Town of Waterloo, Seneca County, on the east, the Town of Phelps, Ontario County, on the north, the Town of Seneca, Ontario County, on the west, and the Town of Benton, Yates County, on the south.
3. The Town of Geneva borders Seneca Lake for approximately five miles, and many Town residents obtain their drinking water from Seneca Lake and use the lake for a variety of purposes.
4. There are approximately 3,300 residents of the Town and the lake plays an integral role in many people's decision to live here.

5. There are four wineries in the Town of Geneva, two micro-breweries, and many restaurants, hotels, and other commercial establishments. These businesses have increasingly come to define the character and daily life of the Town, and the Town has long recognized that the success of these businesses relies on the attractiveness and use of Seneca Lake to their clientele. Many of these businesses also draw water from the lake for drinking or other purposes.
6. The last community survey of Town residents was taken in 2006 as part of the Town's update of its Comprehensive Plan. In those surveys, preserving quality of life was seen as the greatest challenge facing the Town and it was clear that heavy industrial uses were decidedly inappropriate in the Town or larger region.
7. The Town is in the process of creating a new Comprehensive Plan and held community forums this past December. At those forums, preservation of the environment and the rural character of the Town, Seneca Lake, and Finger Lakes Wine Country were seen as paramount. The bucolic character of the town and region are vital to the growing tourism trade, and other spin-off businesses that help grow our local economy.
8. The liquefied petroleum gas ("LPG") storage and distribution project proposed by Crestwood in the Town of Reading (the "Proposed Project") is a threat to the Town of Geneva's character, development, and aspirations. Because of these concerns, the Town Board passed a resolution opposing the project at its February 11, 2014 meeting.
9. The Town of Geneva contracts with three volunteer fire departments for fire protection and emergency services: West Lake Road Fire Department, White Springs Fire Department, and North Side Fire Department. The Fire Chief of West Lake Road is Eric

Hansen, the Fire Chief of White Springs is Tim Higgins, and the Fire Chief of North Side is Dan Beckers.

10. I understand that, under the Proposed Project, LPG will be transported by pipeline and rail routes that will run along Seneca Lake and possibly through the Town of Geneva. I also understand that no draft permit conditions have been proposed by the Department of Environmental Conservation that would prohibit the use of truck transportation of LPG, which could also run through the Town of Geneva. I have discussed the Proposed Project with Fire Chief Eric Hansen, and he advised that his department has not been approached and consulted concerning the Proposed Project and has not undertaken any training specific to the hazards that would be presented by an accident at the facility or during transport. He stated he would have to consult the Hazardous Material Response Guide if an accident occurred for guidance on how to handle it. He also stated no one local department would be able to handle a tipped over tractor trailer truck or rail car or resulting fire on its own, but would need to call for assistance from other departments to contain and deal with the threats posed by an accident involving those quantities of hazardous material. He also stated that if there was a serious accident at the facility in the Town of Reading, his department could be called on to provide back-up to a department closer to the facility that responded to the facility. This would impose a significant burden on local responders and community resources.
11. I have also discussed this situation with the other Fire Chiefs and they agree with the statements of Chief Hansen.
12. Based on these facts, I do not believe the applicant has adequately considered the significant adverse impacts the Proposed Project would impose on the character of the

Town and the larger region, as well as on municipal resources, including emergency response.

13. I anticipate that I will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Mark A. Venuti

1-15-15

Date

Sworn to before me on January 15, 2015:

Notary Public

DENISE M. MULTER
Notary Public, State of New York
Yates County No. 01MU 5005576
Commission Expires Dec. 14, 2018

ATTACHMENT F

New York State Department of Environmental Conservation

In the Matter of the Applications of FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	Application Number 8-4432-00085 **AFFIDAVIT**

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF WASHINGTON)
) ss.:
COUNTY OF KING)

I, Richard B. Kuprewicz, swear or affirm:

1. I am president of Accufacts Inc., a firm that provides independent consulting services related to hydrocarbon pipeline energy infrastructure, both liquid and gas, especially regarding such infrastructure located in sensitive areas. The consulting services I provide include risk management, pipeline safety regulatory development, and incident investigations, as well as pipeline design, operation, maintenance and siting.
2. I have a BS in Chemical Engineering and a BS in Chemistry from the University of California – Davis, and have over forty years of experience in the energy business, including extensive field experience in production, refining, and transportation.
3. I have consulted for various local, state, and federal agencies, non-governmental organizations, the public, and pipeline industry on pipeline regulation, operation and design, and incident investigation.
4. I am currently serving as a member representing the public on the federal Liquid Pipeline Advisory Committee ("LPAC"), a technical committee established by Congress to advise

the United States Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA") on pipeline safety regulations. Committee members on the LPAC are appointed by the Secretary of Transportation.

5. I have also served for seven years as a member, including a term as its chairman, of the Washington State Citizens Committee on Pipeline Safety ("CCOPS"), an Advisory Committee established by the Washington State legislation following the terrible tragedy in Bellingham, Washington on June 10, 1999 related to a liquid pipeline rupture with loss of life. CCOPS's charter is to advise federal, state and local governments on regulatory matters related to pipeline safety, routing, construction, operation and maintenance. Positions to CCOPS are appointed by the Governor.

6. I have also served on various committees, representing the public, assembled to assist in the development of federal pipeline safety regulations related to such issues as gas and liquid transmission and gas distribution integrity management, and control room management that have been promulgated in federal regulations over the past decade or so.

7. I have authored numerous papers related to pipeline infrastructure and safety, including pipeline process safety management approaches and have testified to subcommittees in Congress concerning pipeline safety, such as pipeline integrity management. A copy of my full Curriculum Vitae is annexed hereto as Exhibit A.

8. I have had the opportunity to perform an initial review of pertinent materials in the record in this instant proceeding, and provide the following expert opinion on the basis of that review and my above-described experience.

Summary of Review and Conclusions

9. Based on my initial review, I conclude that the proposed Finger Lakes LPG Storage Facility ("Proposed Project") has not provided adequate or appropriate risk assessments related to this highly unique proposed LPG storage and/or transportation infrastructure project.

10. The safety risks of storing up to 2.1 million barrels of liquefied petroleum gas ("LPG") in underground salt caverns are substantially different and orders of magnitude greater than those associated with the storage of high pressure natural gas in the same underground salt caverns.

11. The consequences of a release of highly volatile liquids ("HVLs"), such as LPG, would be significantly greater than those associated with a release from a natural gas storage facility.

12. Storage of LPG in underground salt caverns presents much greater safety risks than those associated with LPG storage in aboveground facilities or those associated with LPG transportation, such as by trucks, railroad tank cars, or pipelines. Most significantly, aboveground LPG storage facilities do not carry the risk of releasing anywhere near the volume of inventory that is proposed to be stored under the Proposed Project.

13. The integrity of the salt caverns to safely prevent release of LPG is a critical path item in any risk assessment concerning the Proposed Project. I understand that others who have had more time to fully consider the applicant's risk assessment have concluded that it is extremely deficient in this critical regard.

14. I am further concerned that the Department of Environmental Conservation, which appears to be the agency chartered with primary jurisdiction over the safety of this

Proposed Project lacks the specific expertise required to conduct an appropriate safety review of this very unique proposal, or to ensure its safe operation.

15. Based on my review and knowledge of the nature of the Proposed Project, it is my opinion that state and local emergency response plans and emergency response personnel are not likely to be able to effectively handle a catastrophic release of stored LPG from salt caverns at the Proposed Project.

16. Because of the large inventory of LPG that would be stored at the Proposed Facility, the liability associated with a catastrophic failure of either or both of the salt domes would likely number in the hundreds of millions if not billions of dollars.

17. Based on the foregoing, it is my conclusion that the risk assessments are incomplete and inadequate to ensure the safe operation of the Proposed Project, and warrant further review and analysis at an adjudicatory hearing.

18. I anticipate that I will be available to testify regarding the issues addressed in this affidavit, and on the basis of my further review of the relevant record, in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Richard B. Kuprewicz
Richard B. Kuprewicz

1/15/2015
Date

Sworn to before me on January 15, 2015:

Notary Public

Redmond, Washington

Notary Public
State of Washington
CHARLES L SAUGET
MY COMMISSION EXPIRES
August 09, 2017

EXHIBIT A

Exhibit A

Curriculum Vitae.

Richard B. Kuprewicz

4643 192nd Dr. NE
Redmond, WA 98074

Tel: 425-836-4041 (Office)
E-mail: kuprewicz@comcast.net

Profile:

As president of Accufacts Inc., I specialize in gas and liquid pipeline investigation, auditing, risk management, siting, construction, design, operation, maintenance, training, SCADA, leak detection, management review, emergency response, and regulatory development and compliance. I have consulted for various local, state and federal agencies, NGOs, the public, and pipeline industry members on pipeline regulation, operation and design, with particular emphasis on operation in unusually sensitive areas of high population density or environmental sensitivity.

Employment:

Accufacts Inc. **1999 – Present**

Pipeline regulatory advisor, incident investigator, and expert witness on all matters related to gas and liquid pipeline siting, design, operation, maintenance, risk analysis, and management.

Position: President
Duties:
> Full business responsibility
> Technical Expert

Alaska Anvil Inc. **1993 – 1999**

Engineering, procurement, and construction (EPC) oversight for various clients on oil production facilities, refining, and transportation pipeline design/operations in Alaska.

Position: Process Team Leader
Duties:
> Led process engineers group
> Review process designs
> Perform hazard analysis
> HAZOP Team leader
> Assure regulatory compliance in pipeline and process safety management

ARCO Transportation Alaska, Inc. **1991 - 1993**

Oversight of Trans Alaska Pipeline System (TAPS) and other Alaska pipeline assets for Arco, after Exxon Valdez event.

Position: Senior Technical Advisor
Duties:
> Access to all Alaska operations with partial Arco ownership
> Review, analysis of major Alaska pipeline projects

ARCO Transportation Co. **1989 – 1991**

Responsible for strategic planning, design, government interface, and construction of new gas pipeline projects, as well as gas pipeline acquisition/conversions.

Position: Manager Gas Pipeline Projects
Duties:
> Project management
> Oil pipeline conversion to gas transmission
> New distribution pipeline installation
> Full turnkey responsibility for new gas transmission pipeline, including FERC filing

Four Corners Pipeline Co. 1985 – 1989

Managed operations of crude oil and product pipelines/terminals/berths/tank farms operating in western U.S., including regulatory compliance/emergency and spill response, and telecommunications and SCADA organizations supporting operations.

Position: Vice President and Manager of Operations
Duties:
> Full operational responsibility
> Major ship berth operations
> New acquisitions
> Several thousand miles of common carrier and private pipelines

Arco Product CQC Kiln 1985

Operations manager of new plant acquisition, including major cogeneration power generation, with full profit center responsibility.

Position: Plant Manager
Duties:
> Team building of new facility that had been failing
> Plant design modifications and troubleshooting
> Setting expense and capital budgets, including key gas supply negotiations
> Modification of steam plant, power generation, and environmental controls

Arco Products Co. 1981 - 1985

Operated Refined Product Blending, Storage and Handling Tank Farms, as well as Utility and Waste Water Treatment Operations for the third largest refinery on the west coast.

Position: Operations Manager of Process Services
Duties:
> Modernize refinery utilities and storage/blending operations
> Develop hydrocarbon product blends, including RFGs
> Modification of steam plants, power generation, and environmental controls
> Coordinated new major cogeneration installation, 400 MW plus

Arco Products Co. 1977 - 1981

Coordinated short and long-range operational and capital planning, and major expansion for two west coast refineries.

Position: Manager of Refinery Planning and Evaluation
Duties:
> Establish monthly refinery volumetric plans
> Develop 5-year refinery long range plans
> Perform economic analysis for refinery enhancements
> Issue authorization for capital/expense major expenditures

Arco Products Co. 1973 - 1977

Operating Supervisor and Process Engineer for various major refinery complexes.

Position: Operations Supervisor/Process Engineer
Duties:
> FCC Complex Supervisor
> Hydrocracker Complex Supervisor
> Process engineer throughout major integrated refinery improving process yield and energy efficiency

Qualifications:

Currently serving as a member representing the public on the federal Technical Hazardous Liquid Pipeline Safety Standards Committee (THLPSSC), a technical committee established by Congress to advise PHMSA on pipeline safety regulations.
Committee members are appointed by the Secretary of Transportation.

Served seven years, including position as its chairman, on the Washington State Citizens Committee on Pipeline Safety (CCOPS).
Positions are appointed by the governor of the state to advise federal, state, and local governments on regulatory matters related to pipeline safety, routing, construction, operation and maintenance.
Served on Executive subcommittee advising Congress and PHMSA on a report that culminated in new federal rules concerning Distribution Integrity Management Program (DIMP) gas distribution pipeline safety regulations.

As a representative of the public, advised the Office of Pipeline Safety on proposed new liquid and gas transmission pipeline integrity management rulemaking following the pipeline tragedies in Bellingham, Washington (1999) and Carlsbad, New Mexico (2000).

Member of Control Room Management committee assisting PHMSA on development of pipeline safety Control Room Management (CRM) regulations.

Certified and experienced HAZOP Team Leader associated with process safety management and application.

Education:

MBA (1976)	Pepperdine University, Los Angeles, CA
BS Chemical Engineering (1973)	University of California, Davis, CA
BS Chemistry (1973)	University of California, Davis, CA

Publications in the Public Domain:

1. "An Assessment of First Responder Readiness for Pipeline Emergencies in the State of Washington," prepared for the Office of the State Fire Marshall, by Hanson Engineers Inc., Elway Research Inc., and Accufacts Inc., and dated June 26, 2001.

2. "Preventing Pipeline Failures," prepared for the State of Washington Joint Legislative Audit and Review Committee ("JLARC"), by Richard B. Kuprewicz, President of Accufacts Inc., dated December 30, 2002.

3. "Pipelines - National Security and the Public's Right-to-Know," prepared for the Washington City and County Pipeline Safety Consortium, by Richard B. Kuprewicz, dated May 14, 2003.

4. "Preventing Pipeline Releases," prepared for the Washington City and County Pipeline Safety Consortium, by Richard B. Kuprewicz, dated July 22, 2003.

5. "Pipeline Integrity and Direct Assessment, A Layman's Perspective," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated November 18, 2004.

6. "Public Safety and FERC's LNG Spin, What Citizens Aren't Being Told," jointly authored by Richard B. Kuprewicz, President of Accufacts Inc., Clifford A. Goudey, Outreach Coordinator MIT Sea Grant College Program, and Carl M. Weimer, Executive Director Pipeline Safety Trust, dated May 14, 2005.

7. "A Simple Perspective on Excess Flow Valve Effectiveness in Gas Distribution System Service Lines," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated July 18, 2005.

8. "Observations on the Application of Smart Pigging on Transmission Pipelines," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated September 5, 2005.

9. "The Proposed Corrib Onshore System - An Independent Analysis," prepared for the Centre for Public Inquiry by Richard B. Kuprewicz, dated October 24, 2005.

10. "Observations on Sakhalin II Transmission Pipelines," prepared for The Wild Salmon Center by Richard B. Kuprewicz, dated February 24, 2006.

11. "Increasing MAOP on U.S. Gas Transmission Pipelines," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated March 31, 2006. This paper was also published in the June 26 and July 1, 2006 issues of the Oil & Gas Journal and in the December 2006 issue of the UK Global Pipeline Monthly magazines.

12. "An Independent Analysis of the Proposed Brunswick Pipeline Routes in Saint John, New Brunswick," prepared for the Friends of Rockwood Park, by Richard B. Kuprewicz, dated September 16, 2006.

13. "Commentary on the Risk Analysis for the Proposed Emera Brunswick Pipeline Through Saint John, NB," by Richard B. Kuprewicz, dated October 18, 2006.

14. "General Observations On the Myth of a Best International Pipeline Standard," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated March 31, 2007.

15. "Observations on Practical Leak Detection for Transmission Pipelines – An Experienced Perspective," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated August 30, 2007.

16. "Recommended Leak Detection Methods for the Keystone Pipeline in the Vicinity of the Fordville Aquifer," prepared for TransCanada Keystone L.P. by Richard B. Kuprewicz, President of Accufacts Inc., dated September 26, 2007.

17. "Increasing MOP on the Proposed Keystone XL 36-Inch Liquid Transmission Pipeline," prepared for the Pipeline Safety Trust by Richard B. Kuprewicz, dated February 6, 2009.

18. "Observations on Unified Command Drift River Fact Sheet No 1: Water Usage Options for the current Mt.

Redoubt Volcano threat to the Drift River Oil Terminal," prepared for Cook Inletkeeper by Richard B. Kuprewicz, dated April 3, 2009.

19. "Observations on the Keystone XL Oil Pipeline DEIS," prepared for Plains Justice by Richard B. Kuprewicz, dated April 10, 2010.

20. "PADD III & PADD II Refinery Options for Canadian Bitumen Oil and the Keystone XL Pipeline," prepared for the Natural Resources Defense Council (NRDC), by Richard B. Kuprewicz, dated June 29, 2010.

21. "The State of Natural Gas Pipelines in Fort Worth," prepared for the Fort Worth League of Neighborhoods by Richard B. Kuprewicz, President of Accufacts Inc., and Carl M. Weimer, Executive Director Pipeline Safety Trust, dated October, 2010.

22. "Accufacts' Independent Observations on the Chevron No. 2 Crude Oil Pipeline," prepared for the City of Salt Lake, Utah, by Richard B. Kuprewicz, dated January 30, 2011.

23. "Accufacts' Independent Analysis of New Proposed School Sites and Risks Associated with a Nearby HVL Pipeline," prepared for the Sylvania, Ohio School District, by Richard B. Kuprewicz, dated February 9, 2011.

24. "Accufacts' Report Concerning Issues Related to the 36---inch Natural Gas Pipeline and the Application of Appleview, LLC Premises: 7009 and 7010 River Road, North Bergen, NJ," prepared for the Galaxy Towers Condominium Association Inc., by Richard B. Kuprewicz, dated February 28, 2011.

25. "Prepared Testimony of Richard Kuprewicz Evaluating PG&E's Pipeline Safety Enhancement Plan," Submitted on behalf of The Utility Reform Network (TURN), by Richard Kuprewicz, Accufacts Inc., dated January 31, 2012.

26. "Evaluation of the Valve Automation Component of PG&E's Safety Enhancement Plan," extracted from full testimony submitted on behalf of The Utility Reform Network (TURN), by Richard Kuprewicz, Accufacts Inc., dated January 31, 2012, Extracted Report issued February 20, 2012.

27. "Accufacts' Perspective on Enbridge Filing to NEB for Modifications on Line 9 Reversal Phase I Project," prepared for Equiterre Canada, by Richard Kuprewicz, Accufacts Inc., dated April 23, 2012.

28. "Accufacts' Evaluation of Tennessee Gas Pipeline 300 Line Expansion Projects in PA & NJ," Prepared for the Delaware RiverKeeper Network, by Richard B. Kuprewicz, Accufacts Inc., dated June 27, 2012.

29. "Impact of an ONEOK NGL Pipeline Release in At---Risk Landslide and/or Sinkhole Karst Areas of Crook County, Wyoming," prepared for land owners, by Richard B. Kuprewicz, Accufacts Inc., and submitted to Crook County Commissioners, dated July 16, 2012.

30. "Impact of Processing Dilbit on the Proposed NPDES Permit for the BP Cherry Point Washington Refinery," prepared for the Puget Soundkeeper Alliance, by Richard B. Kuprewicz, Accufacts Inc., dated July 31, 2012.

31. "Analysis of SWG's Proposed Accelerated EVPP and P70VSP Replacement Plans, Public Utilities Commission of Nevada Docket Nos. 12---02019 and 12---04005," prepared for the State of Nevada Bureau of Consumer Protection, by Richard B. Kuprewicz, Accufacts Inc., dated August 17, 2012.

32. "Accufacts Inc. Most Probable Cause Findings of Three Oil Spills in Nigeria," prepared for Bohler Advocaten, by Richard B. Kuprewicz, Accufacts Inc., dated September 3, 2012.

33. "Observations on Proposed 12---inch NGL ONEOK Pipeline Route in Crook County Sensitive or Unstable Land Areas," prepared by Richard B. Kuprewicz, Accufacts Inc., dated September 13, 2012.

34. "Findings from Analysis of CEII Confidential Data Supplied to Accufacts Concerning the Millennium Pipeline Company L.L.C. Minisink Compressor Project Application to FERC, Docket No. CP11---515---000," prepared by Richard B. Kuprewicz, Accufacts Inc., for Minisink Residents for Environmental Preservation and Safety (MREPS), dated November 25, 2012.

35. "Supplemental Observations from Analysis of CEII Confidential Data Supplied to Accufacts Concerning Tennessee Gas Pipeline's Northeast Upgrade Project," prepared by Richard B. Kuprewicz, Accufacts Inc., for Delaware RiverKeeper Network, dated December 19, 2012.

36. "Report on Pipeline Safety for Enbridge's Line 9B Application to NEB," prepared by Richard B. Kuprewicz, Accufacts Inc., for Equiterre, dated August 5, 2013.

37. "Accufacts' Evaluation of Oil Spill Joint Investigation Visit Field Reporting Process for the Niger Delta Region of Nigeria," prepared for Amnesty International, September 30, 2013.

38. "Accufacts' Expert Report on ExxonMobil Pipeline Company Silvertip Pipeline Rupture of July 1, 2011 into the Yellowstone River at the Laurel Crossing," November 25, 2013.

39. "Accufacts Inc. Evaluation of Transco's 42-inch Skillman Loop submissions to FERC concerning the Princeton Ridge, NJ segment," prepared for the Princeton Ridge Coalition, dated June 26, 2014, and submitted to FERC Docket No. CP13-551.

40. Accufacts report "DTI Myersville Compressor Station and Dominion Cove Point Project Interlinks," prepared for Earthjustice, dated August 13, 2014, and submitted to FERC Docket No. CP13-113-000.

41. "Accufacts Inc. Report on EA Concerning the Princeton Ridge, NJ Segment of Transco's Leidy Southeast Expansion Project," prepared for the Princeton Ridge Coalition, dated September 3, 2014, and submitted to FERC Docket No. CP13-551.

42. Accufacts' "Evaluation of Actual Velocity Critical Issues Related to Transco's Leidy Expansion Project," prepared for Delaware Riverkeeper Network, dated September 8, 2014, and submitted to FERC Docket No. CP13-551.

43. "Accufacts' Report to Portland Water District on the Portland – Montreal Pipeline," with Appendix, prepared for the Portland, ME Water District, dated July 28, 1014.

ATTACHMENT G

New York State Department of Environmental Conservation

In the Matter of the Applications of	Application Number 8-4432-00085
FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	**AFFIDAVIT**

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF ONTARIO)

I, Mathew Horn, swear or affirm:

1. I am the City Manager of the City of Geneva, a position that I have held for 7 years. In my capacity as City Manager I oversee many day-to-day aspects of the City of Geneva, including city planning, budgeting, and the provision of public utilities.
2. Before preparing this affidavit, I consulted with the City of Geneva's Department of Public Works and with our water treatment plant operator, Mark Morabito, about the potential water quality issues presented by the proposed Finger Lakes Liquefied Petroleum Gas ("LPG") Storage Facility (the "Proposed Project"). I have also spoken to Dr. John Halfman about the conditions in Seneca Lake, and I have reviewed his 2014 paper *A 2014 Update on the Chloride Hydrogeochemistry in Seneca Lake* (*see* Affidavit of John Halfman, Ph.D., sworn to January 15, 2015, Exhibit B).

3. The City of Geneva, New York (pop. 12,940) operates a water treatment and distribution system to serve residents, as well as commercial and industrial operations in Geneva and neighboring communities. The system serves approximately 4,500 accounts, providing water to approximately 15,500 people in the City and Town of Geneva.

4. The primary treatment method used is microfilter technology, whereby water is drawn from Seneca Lake and passed through a series of microfilters designed to remove sediment. The water is then treated with a fluoride solution and pumped to an offsite storage tank, which pressurizes the distribution system. The plant is capable of producing approximately 4 million gallons per day ("GPD"), but typically produces less than 3 million GPD. An alternative treatment process is the use of legacy sand filter technology, which acts in a similar manner to remove sediments from lake water.

5. The City of Geneva has invested heavily in its water treatment capabilities. Water treatment costs are projected to be on the order of $550,000 for 2015. Additionally, the bulk of the $1.8 million in overhead and debt service costs the City currently has can be attributed to the operations and maintenance of, and capital investments in, the water treatment plant.

6. One of the City of Geneva's primary concerns about the Proposed Project is the possibility that water contamination would affect our ability to provide safe, potable water to those that rely on our water treatment plant. Dr. Halfman's research indicates that Seneca Lake already has significantly elevated salinity levels (currently around 75 mg/L of sodium and 122 mg/L of chloride). Given this information, I believe that an adverse event at this storage facility that resulted in an increased salinity in Seneca Lake – whether due to catastrophic failure of a storage cavern or long-term salt leaching –

would have a significant adverse impact on our ability to provide acceptable water treatment operations for our residents.

7. In the event of a significant salinity spike, the best option for sustained water production would be the installation of a reverse osmosis pre-treatment system to reduce salinity, followed by microfilter or sand filter treatment and fluoridation prior to distribution.

8. These adaptations would significantly increase the cost of providing water to City residents. The City of Geneva requested an estimate from the Pall Corporation, its water treatment technology vendor, and based on their knowledge of the Geneva treatment plant and the site they estimate the cost of a reverse-osmosis plant to be in the neighborhood of $18 million. Current treatment costs are a little less than ½ cent per gallon. A 2010 study by the Florida Department of Environmental Protection[1] identified the average cost to produce potable water from brackish sources is $3.00 to $3.50 a gallon – a cost 600 times as much as current treatment efforts.

9. Aside from potential costs, developing and constructing a water treatment facility capable of addressing a more saline Seneca Lake would take a significant amount of time. The current microfilter system took approximately 8 months to design, and an additional 8 months to permit and construct. Depending upon the intensity of the salinization, the City could be left without a viable drinking water solution for over a year. We are unaware of any temporary solution that could be developed that would meet the scale of demand served by the current water system.

10. Given these facts, if the Proposed Project is permitted, I would recommend that the City of Geneva begin designing and permitting a reverse osmosis desalinization solution so

[1] Florida Dept. of Envtl. Protection, Desalination in Florida: Technology, Implementation, and Environmental Issues; Division of Water Resource Management (Apr. 2010), *available at* http://www.dep.state.fl.us/water/docs/desalination-in-florida-report.pdf.

that the project could effectively begin construction at a moment's notice. The City should also explore solutions to deliver water on a temporary basis to support residential, industrial, and commercial needs. Undertaking either option would present a substantial cost to City taxpayers.

11. As such, I do not believe the applicant has adequately considered the potential significant adverse socioeconomic impacts presented in terms of the City's ability to ensure a consistent, safe and affordable source of drinking water.

12. I anticipate that I will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

Mathew Horn

1/15/2015

Date

Sworn to before me on January 15, 2015:

Nancy A. Coluzzi

Notary Public

NANCY A. COLUZZI
Notary Public, State of New York
Qualified in Ontario County
No. 01CO6154377
My Commission Expires Oct. 23, 2018

EXHIBIT A

Mathew D. Horn

312 William Street
Geneva, NY 14456
(315) 719-8249

Objective:
To provide high-quality, client-focused service delivery and project management through professional and responsible management practices

Relevant Work Experience
City Manager
City of Geneva, New York
Geneva, New York, July 2008-Present

The City of Geneva is a full-service municipality in the increasingly popular tourism and wine destination of the Finger Lakes Region of upstate New York. The region boasts incredible natural beauty, in addition to over 100 wineries and scores of other economically sustainable ventures from the tourism, agriculture, industrial and service sectors. As City Manager, I was responsible for the day to day management of 130 full time employees and a $20 million general fund and utilities budget.

Projects of Significance

- **Water and Wastewater Operational Enhancements:** Lead a multidisciplinary team of staff and consultants in the modernization of water and wastewater plant equipment and operational practices. Converted drinking water program from labor intensive sand and earth filters to mechanized membrane filtration treatment process. Reduced staff interaction and increased drinking water quality. Converted wastewater digestion process from anaerobic to aerobic model, reducing energy costs by 30% and reducing landfill dependency for after-product treatment by 75%.

- **Revenue Diversification:** Working with key partners in the engineering, legal, and finance sectors, developed innovative program for capturing revenues from non-taxable properties. The City of Geneva scores near the top in New York for properties off the tax rolls; including colleges, state-owned properties, and not-for-profits. Developed plan for assessing these properties for use of City facilities outside of the property tax program. Developed local legislation, coordinated funding plan, process-engineered implementation.

- **Neighborhood Revitalization:** Managed development of a grass-roots, market-driven revitalization effort for Geneva's eleven distinct neighborhoods. Developed neighborhood boundaries, provided oversight to market analysis and program development, hired and managed revitalization staff, provided oversight to ongoing revitalization efforts.

- **Collaborative Economic Development:** Coordinated the City's shift from a government and staff lead effort to a public-private partnership, engaging local not-for-profit and private sector partners to participate in business recruitment, retention, and expansion activities. Recruited economic partners, coordinated marketing activities, assisted in lead generation and management.

Director of Administrative Services
CH2MHill-OMI/City of Sandy Springs
Sandy Springs, GA, December 2006-July 2008

Incorporated in 2005, the City of Sandy Springs is Georgia's sixth largest municipality, with a population just under 90,000. The City provides most services through a public-private partnership with CH2MHill-OMI. Working under the direction of the Program Director, this position is responsible for strategic oversight and tactical management of the City's Accounting, Purchasing, Information Technology, Human Resources, Municipal Court, and Revenue Administration functions.

Projects of Significance

- **Municipal Court Restructuring:** Managed a multi-disciplinary team to completely redevelop the municipal court program, including the development of an administrative policies and procedures manual, standardizing all functions of the court. Developed job descriptions and a performance appraisal program. Implemented a tiered training program, which provides cross-training across functions of the division. Implemented bench and probation warrant program; clearing a one-year backlog of over 2,000 bench warrants and over 300 probation warrants.

- **Solid Waste Program Redevelopment:** Staffed a citizen committee to complete an overhaul of the City's solid waste collection ordinance. Closed significant loophole in the ordinance that prevented the City from collecting franchise fees on haulers collecting from multi-family developments. Developed cross-departmental program for enforcement of the franchise fee provision of the ordinance. Created tracking system to ensure prompt payment by haulers.

- **Performance Measurement Program:** Served as project coordinator for the City's participation in the International City Managers Association's performance measurement program. Coordinated collection efforts for key indicators of performance across departments. Served as the City's liaison to the Metropolitan Atlanta Performance Measurement Consortium. Additionally, provided oversight to the City's internal metrics program, including review of performance measures and recommendations for improvement to the program.

- **Revenue Enhancement Program:** Managed a multi-disciplinary team to address deficiencies in the City's business licensing program. Initial data provided from Fulton County yielded approximately 4,000 business license accounts. Utilizing cutting edge technology, standardized administration procedures, and heightened enforcement action, staff was able to nearly double the number of accounts in the City; yielding a $2,000,000 per year revenue windfall.

- **Vehicle Insurance Program Redevelopment:** Coordinated a cross-departmental team to restructure the program for addressing accidents involving City vehicles. At program inception, approximately 15% of the Police Department fleet was in some state of disrepair due to vehicle accidents. Utilizing financial analysis, innovative purchasing concepts, and process engineering, staff was able to quickly dispense with the backlog of damaged vehicles and clearly define a process for expeditiously repairing future damages.

Assistant City Manager
City of Beaufort, City Manager's Office
Beaufort, SC. February 2004-December 2006

Working with the City of Beaufort enhanced my public management skills through intense exposure to the inner-workings of a bustling municipality. Beaufort, population 12,500, is the County seat of the fastest growing county in South Carolina. The City operates under the Council-Manager form of government. During my tenure, I served as Chief of Operations, reporting directly to the City Manager while performing project management, providing staff support to Council-appointed boards and commissions, preparing reports and making presentations to Council, community groups, and outside consultants.

Projects of Significance:

- **Growth Management Strategy Development:** Managed a multi-disciplinary team to assess and make recommendations on major annexation proposals to the City. Developed cost modeling tools and project assessments to determine feasibility and impact on existing residential and commercial base. Utilized innovative growth management principles and development management tools to protect the City's financial posture, environmental assets, and transportation infrastructure.

- **Southside Park Development:** Staffed a citizen-based committee tasked with the redevelopment of the City's Southside Water Treatment Plant into a 40-acre regional park. Assisted the committee with design issues and conducted neighborhood meetings, surveys and other presentations. Prepared redevelopment report for City Council.

- **Bladen Street Streetscape Project:** Developed grant proposal and was awarded state transportation funds for the implementation of a streetscape project aimed at revitalizing the City's ailing Northwest

Quadrant neighborhood. The $450,000 redesign includes urban elements such as wider sidewalks, pedestrian-oriented street lamps, street furniture, on-street parking, and enhanced landscaping. Coordinated funding, administered grant funds, coordinated neighborhood presentations, and assisted in design.

- **Waterfront Park Wireless Hot Spot:** Coordinated the development of broadband wireless internet access as part of the City's $6.7 million renovation of Henry C. Chambers Waterfront Park. Through the implementation of a public-private partnership, this amenity was provided at no cost to taxpayers or end-users. Developed request for proposals, interviewed prospective providers, selected project consultant, overseeing implementation.

- **City/County Disaster Preparedness Plan:** Served on City and County Disaster Recovery Task Forces. Assisted in the development of plans providing for re-entry by essential staff, reinstitution of government services, damage assessment and demarcation, and re-entry by the general public following natural and other disasters. Provided research support, prepared plan components, coordinated training exercises.

- **Boundary Street Master Plan:** Assisted in the development of a master plan for the Boundary Street corridor; Beaufort's primary area of access from the mainland. The plan seeks to revitalize this area, transforming it from an underdeveloped corridor of scattered strip-type commercialization to an urban, pedestrian friendly environment. Prepared specifications for plan components, provided recommendations for the selection of project consultants, assisted in plan development and implementation.

- **Web-Based Procurement Solution:** Coordinated the development of a web-based procurement solution for the City; placing all procurement opportunities on the City's website, and providing electronic notification of bid opportunities to all registered vendors.

Economic Development Specialist
City of Staunton, Office of Economic Development
Staunton, VA. April 2001-February 2004

In Staunton, I was provided with the opportunity to excel in resource development for a small city. Staunton, population 24,000, operates under the Council-Manager form of government. In my tenure I reported to the Director of Economic Development and was responsible for the development of proposals for, and administration of, over $1.5 million in Federal, State, and private grant funding. Additionally, I executed marketing campaigns aimed at diversifying the City's tax base through business recruitment and retention, as well as managing several City and State incentive programs.

Projects of Significance:

- **Redevelopment of Stonewall Jackson Hotel:** Assisted in the redevelopment of an historic hotel property in the City's National Landmark downtown district. Through the implementation of a public-private partnership, this project received over $11 million in Federal, State, and private funding. The City's participation fostered the development of a 120-room luxury hotel and conference center property. Assisted in the development of project specifications, participated in selection of project partners, developed successful application for grant funding.

- **Redevelopment of Western State Hospital:** Assisted in the redevelopment of a seventy-acre state hospital property at the City's gateway. The property will be redeveloped utilizing a mixed-use concept with high-end residential, retail, restaurants, and civic spaces. Coordinated transfer of the property from the State to the City's Industrial Development Authority. Assisted in the development of project specifications and selection of project partners.

- **Resource Development for Local Cultural Attractions:** Coordinated the development of an alliance between local cultural groups, including the Woodrow Wilson Presidential Library and Shenandoah Shakespeare's Blackfriars Theatre, in order to more effectively target Federal funds. Utilizing intergovernmental liaisons, we were able to garner these groups nearly $900,000 in funding from the Federal government. Assisted in the selection of project consultants, developed grant application materials, administered grant funds.

- **Strategic Plan for Economic Development:** Assisted in the development of a Strategic Plan for Economic Development for the City. The plan provided an overview of current fiscal indicators of economic development performance, as well as an historical perspective as to how departmental activities have improved the City's tax and employment base. Performed research and analysis of financial data, developed impact analysis of potential economic development projects, assisted in goal setting and benchmarking.

Education:

- University of South Carolina, Columbia, SC
  Master of Business Administration (in progress)

- James Madison University, Harrisonburg, VA
  Bachelor of Science—Public Administration; Public Management Concentration, Political Science Minor

Professional Memberships and Activities:

- Chair, Jobs for Geneva Board of Directors
- Chair, Geneva Revolving Loan Fund
- President, Cornell Agriculture and Food Technology Park Board of Directors
- Director, Finger Lakes Municipal Health Insurance Trust
- Selected to CH2MHILL-OMI's Leadership Development Program (LEAD)
- Winner, Civitas Award for Business Support in Government, 2006

Availability:

With appropriate notice to current employer

ATTACHMENT H

New York State Department of Environmental Conservation

In the Matter of the Applications of

Application Number
8-4432-00085

FINGER LAKES LPG STORAGE, LLC
For the Liquefied Petroleum Gas Storage Facility at Seneca Lake
for permits to construct and operate pursuant to the
Environmental Conservation Law

AFFIDAVIT

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF SENECA)

I, James Bromka, swear or affirm:

1. I am the Chief Operator of the Village of Waterloo water treatment plant. I have held that position for 23 years, and I've been a resident of the Town of Romulus for 55 years. I have a degree/certification in Biological Sciences from SUC at Brockport, N.Y., which I received in 1976.
2. The Village of Waterloo water treatment plant draws from Seneca Lake to provide municipal water to the Village. That plant relies on diatomaceous earth filtration with chlorine dioxide primary disinfection and monochloramine secondary disinfection. We are planning on adding roughing filters along with advanced oxidation disinfection.
3. This system, even with the proposed addition, does not treat for sodium or chloride. In the event that Seneca Lake becomes significantly more saline, the Village of Waterloo would need to add reverse osmosis filters to remove the added sodium and chlorides.

4. This addition would be expensive and time-consuming. It would significantly increase water rates for our consumers, and would likely cost the Village $2 million in capital costs. It would also likely take no less than one year to complete, during which time the water treatment plant would not be providing acceptable potable water to the Village.
5. As such, I do not believe the applicant has adequately considered the potential significant adverse socioeconomic impacts presented in terms of the Village's ability to ensure a consistent, safe and affordable source of drinking water.
6. I anticipate that I will be available to testify regarding the issues addressed in this affidavit in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

James Bromka
James Bromka

1/16/2015
Date

Sworn to before me on January 16, 2015:

Allissa M Ansini (Robson)
Notary Public

ALLISSA M. ROBSON
Notary Public - State of New York
No. 01RO6136536
Qualified In Sene County
My Commission Expires November 7, 2017

ATTACHMENT I

New York State Department of Environmental Conservation

In the Matter of the Applications of	Application Number 8-4432-00085
FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	**AFFIDAVIT**

AFFIDAVIT IN SUPPORT OF THE SENECA LAKE COMMUNITIES' PETITION FOR FULL PARTY STATUS

STATE OF NEW YORK)
) ss.:
COUNTY OF ONTARIO)

I, John Halfman, Ph.D., swear or affirm:

1. I am a professor of geoliminology and hydrogeology at Hobart and William Smith Colleges in Geneva, New York. I have been a professor since 1988, and accepted a position at Hobart and William Smith Colleges in 1994. I am the Inaugural Finger Lakes Institute Endowed Chair in Environmental Studies at the Colleges. I have a doctorate in Geology from Duke University, awarded to me in 1987.
2. In my capacity as an expert on geoliminology and hydrogeology, I have studied the Finger Lakes for 2 decades. My work has often focused on Seneca Lake specifically. I have published numerous peer reviewed scientific articles and Finger Lakes Institute reports about Seneca Lake including Halfman, J.D., 2014, *A 2014 update on the chloride hydrogeochemistry in Seneca Lake*, New York. Finger Lakes Institute, Hobart and William Smith Colleges, 27 pg; Halfman, J.D., Meyer, S., Cleckner, L., Robertson, C.M. & D. Zorn., et al., 2012, *Seneca Lake Management Plan, Characterization and*

Subwatershed Evaluation, Hobart & William Smith Colleges, Finger Lakes Institute, Genesee/Finger Lakes Regional Planning Council, Southern Tier Central Regional Planning and Development Board, 155 pg; Halfman, J.D., 2011, *Water quality of Seneca Lake, New York: A 2011 Update (ver 2)*, Finger Lakes Institute, Hobart and William Smith Colleges, 41 pg; Halfman, J.D., C.M. Caiazza, R.J. Stewart, S.M. Opalka, and C.K. Morgan, 2006, *Major ion hydrogeochemical budgets and elevated chloride concentrations in Seneca Lake, New York*, Northeastern Geology and Environmental Sciences, v. 28, p. 324-333; Halfman, J.D., 2000, *Stratigraphy, sedimentology, and geochemistry of Seneca Lake, New York*, New York State Geological Association Annual Meeting, NYSGA Field Trip Guidebook, p. 27-38; Halfman, J.D., and many undergraduate students, 1999, *Seneca Lake Limnology and Water Quality Status.* Chapter 6A, Setting the Course for Seneca Lake – The State of the Seneca Lake Watershed, 28 p; Halfman, J.D., and many undergraduate students, 1999, *Seneca Lake Stream Water Quality*, Chapter 6B, Setting the Course for Seneca Lake - The State of the Seneca Lake Watershed, 16 p; and Halfman, J.D., and D.T. Herrick*, 1998, *Mass-movement and reworking of late glacial and postglacial sediments in northern Seneca Lake, New York.* Northeastern Geology and Environmental Sciences, v. 20, p. 227-241. A copy of my Curriculum Vitae is annexed hereto as Exhibit A.

3. I direct an ongoing monitoring program of Seneca and neighboring Finger Lakes under the aegis of the Finger Lakes Institute. Our surveys over the past 20 years indicate that Seneca Lake has comparatively high concentrations of both sodium and chloride relative to the other Finger Lakes. The most recent survey of Seneca Lake on October 25, 2014 showed that concentrations were 75 mg/L for sodium and 122 mg/L for chloride. This

concentration for sodium is above the New York State Department of Environmental Conservation and the United States Environmental Protection Agency drinking water advisory level of 20 mg/L.

4. The concentrations of chloride and sodium in Seneca Lake are up to 10 times greater than the concentrations detected in neighboring Finger Lakes. In contrast, the concentrations of other major ions like potassium, calcium, magnesium, and sulfate are more similar across the Finger Lakes.

5. I have also done computer modeling of Seneca Lake and how it would react to different stresses. Specifically, I modeled the behavior of the lake if it were to receive a large 'slug' of chloride. Those models indicate that it would take many generations—approximately 100 years—for Seneca Lake to flush out contaminants.

6. In December 2014, I authored an article about the elevated levels of chloride and sodium in Seneca Lake. That article is entitled *A 2014 Update on the Chloride Hydrogeochemistry in Seneca Lake, New York* (a copy of which is annexed hereto as Exhibit B). For that article, I reported on my surface and bottom water samples from Seneca Lake at a number of fixed sites, and my water samples from up to 17 streams in the Seneca Lake watershed periodically collected since 2000. I also reported on my samples from Honeoye, Canandaigua, Keuka, Cayuga, Owasco, Skaneateles, and Otisco Lakes since 2005. These data were augmented with data from published literature dating back to 1963 and with chloride data for Seneca, Cayuga, Hemlock, Canadice, and Skaneateles Lakes for the past 100 years.

7. For the article, I examined the potential sources for the high concentrations of sodium and chloride in Seneca Lake. I determined that modern-day stream inputs of chloride and

sodium alone cannot explain the modern-day concentrations found in Seneca Lake, assuming steady-state, equilibrium conditions. This is unusual because stream inputs support the concentrations of those ions in other Finger Lakes.

8. Salt mines located at the southern end of Seneca Lake are permitted to discharge sodium and chloride directly into the lake. However, adding the reported mine waste discharges to the stream inputs still does not result in enough salt to support the current concentrations in Seneca Lake, assuming steady-state, equilibrium conditions. Explaining the sodium and chloride in Seneca Lake requires another major source of those ions. That source would need to supply 32,000 metric tons of sodium and 54,000 metric tons of chloride a year, if the lake was in steady state.

9. Wing et al (1995) and Halfman et al. (2006) hypothesized this additional source to be groundwater flow interacting with underground salt deposits assuming steady state, equilibrium conditions. Seneca Lake is the deepest of the Finger Lakes, intersecting with halite deposits under the lake, and so the hypothesized source is groundwater flow from those deposits. These are the same deposits mined by the nearby salt mines and, therefore, the same salt deposits that contain the abandoned caverns to be used by the proposed LPG storage facility.

10. My research shows that the source has either changed, or changed in intensity, over time, complicating this hypothesis. Data on chloride in Seneca Lake over the last century shows that concentrations began rising in the early 1900s, peaked at over 180 mg/L in the mid-1960s and 1970s, and have slowly declined from this peak to the present. This significant change indicates non-steady-state, non-equilibrium conditions – the source of Cl has not been constant over time.

11. The early 20th century increase in chloride concentrations coincides with the beginning of solution mining operations at the southern end of Seneca Lake. The first wells at the US Salt site were drilled in 1893. The chloride peak in the 1960s and 1970s also coincides with historical storage of gas in the abandoned salt caverns at issue here and waste disposal issues into Seneca Lake at another, now abandoned, salt mine in Himrod, NY. However, the Himrod mine waste issues post-date the 1960s initial rise in chloride concentrations. This raises a significant question: does solution mining and/or gas storage in these caverns influence chloride and sodium levels in Seneca Lake?

12. As an expert in the hydrogeochemistry of Seneca Lake, it is my opinion that sufficient information is not publically available to answer this question. Specifically, groundwater pressure gradients and permeability of the Salina and neighboring rock formations are unavailable, as are data sufficient to investigate the correlations between mining and/or storage activity in these salt caverns and concentrations of sodium and chloride in the lake.

13. There is a simple experiment the applicant could conduct to help answer this question. I recommend that Finger Lakes LPG Storage, LLC perform year-long pressure tests on any proposed cavern while a third party concurrently monitors Seneca Lake for chloride and sodium concentrations. Given Seneca Lake's preexisting high concentrations of salt and its role as a drinking water source for surrounding communities, examining this possibility is crucial to determining whether this site is suitable for gas storage. This is an issue that should be considered in an adjudicatory hearing on the proposed application.

14. I anticipate that I will be available to testify regarding the issues addressed in this affidavit, and on the basis of my further review of the relevant record, in an adjudicatory hearing in the above captioned matter, should one be scheduled.

I SWEAR OR AFFIRM THAT THE ABOVE IS TRUE AND CORRECT TO THE BEST OF MY INFORMATION, KNOWLEDGE, AND BELIEF,

John Halfman, Ph.D.

1/15/2015
Date

Sworn to before me on January 15, 2015:

Notary Public

TABATHA E. SPINNER
NOTARY PUBLIC, State of New York
Qualified in Seneca Co. No. 01SP6052163
My Commission Expires Dec. 11, 2018

EXHIBIT A

Exhibit A

John David Halfman

Professor, Department of Geoscience & Environmental Studies Program
Inaugural Finger Lakes Institute Endowed Chair in Environmental Studies
Hobart and William Smith Colleges
Geneva, New York 14456
Office Phone: (315) 781 - 3918
e-mail: Halfman@hws.edu - Web Site: http://people.hws.edu/Halfman
Revised: 1/15/2015

Personal Information:

Born:	November 9, 1956; Concord, Massachusetts.
Family:	Married: Barbara; 3 children: Samuel, Camille and Marie.
Hobbies:	Woodworking, hiking, biking, sailing, canoeing, kayaking and flying.

Education:

1984-1987	Duke University, Durham, NC.	Ph.D., Geology.
1980-1982	University of Minnesota, Minneapolis, MN.	M.S., Geology and Geophysics.
1975-1978	University of Miami, Coral Gables, FL.	B.S., Geology magna cum laude.
1971-1975	Lexington High School, Lexington, MA.	

Professional Research, Teaching and Community Service Positions:

2014-present	Research Scientist, Finger Lakes Institute, Hobart and William Smith Colleges.
2006-present	Professor, Department of Geoscience & Environmental Studies Program, Hobart and William Smith Colleges, Geneva, NY 14456.
2005-present	Board of Advisors, Great Lakes Research Consortium.
2011-2014	Finger Lakes Institute Endowed Chair in Environmental Studies, Hobart and William Smith Colleges, Geneva, NY, 14456.
2010-2014	Chair, Environmental Studies Program, Hobart and William Smith Colleges, Geneva, NY, 14456.
2008-2010	Chair, Department of Geosciences, Hobart and William Smith Colleges, Geneva, NY 14456.
2002-2011	Research Scientist, Finger Lakes Institute, Hobart and William Smith Colleges.
2002-2008	Vice President, Executive Committee, Seneca Lake Pure Waters Association.
2001-2008	Executive Committee & Board of Directors, Seneca Lake Pure Waters Association.
2000-2006	Associate Professor, Department of Geoscience, Hobart and William Smith Colleges, Geneva, NY.
1999-2005	Director, Environmental Studies Program, Hobart & William Smith Colleges, Geneva, NY
1996-2005	Oversight & Educational Committees, Seneca Lake Area Partners in Five Counties, a Watershed Management and Protection Alliance.
1995-2008	Board of Directors, Seneca Lake Pure Waters Association, A Citizen Watchdog Group.
1994-2000	Assistant Professor, Department of Geoscience, Hobart & William Smith Colleges, Geneva, NY.
1991-1994	Assistant Professor, Department of Civil Engineering and Geological Sciences, University of Notre Dame, Notre Dame, IN.
1988-1991	Assistant Professor, Department of Earth Sciences, University of Notre Dame, Notre Dame, IN.
1988-1988	Lynde and Harry Bradley Foundation Research Fellow, Duke University Marine Laboratory, Beaufort, NC (January - August).
1984-1987	Research and Teaching Assistant, Department of Geology, Duke University, Durham and Beaufort Campuses, NC.
1984-1984	Field Associate, Project PROBE, Duke University. Collection of multifold and high-resolution seismic data, and piston cores on Lake Turkana, Kenya. (August - December).
1983-1983	Lecturer, FORTRAN Programming, Mathematical Sciences Department, University of Minnesota, Duluth, MN (Fall Semester).
1980-1983	Research Assistant, Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN.
1979-1980	Research Associate, Stable Isotope and Radiocarbon Geochronology Laboratories, Department of Geology, University of Miami, Coral Gables, FL.
1977-1978	Teaching Assistant, Tutor and Peer Advisor, U. of Miami, Coral Gables, FL.

Courses Taught:

Hobart and William Smith Colleges:

Env-110 Energy – an interdisciplinary course on energy for environmental studies students

Exhibit A **John David Halfman**

Env-170 The Fluid Earth
Env-301 The Group Senior Integrative Experience
Geo-130 Oceanography
Geo-190 Geoscience and the Environment
Geo-330 Limnology
FSem-139 Global Change 1st YR Seminar
Env-191 Introductory Environmental Science
Env-200 Environmental Science
Geo-140/200 Environmental Geology
Geo-210 Environmental Hydrology
Geo-460 Senior Seminar
BiDis-201 Environmental Science

University of Notre Dame:

Undergraduate: Physical Geology, Environmental Geology, Geology Colloquium, Field Methods, Regional Field Trip, Directed Readings. Graduate: Geolimnology, Paleoclimatology.

Field Experience:

2006-present Nutrient loading & lake/watershed interactions in the Owasco Watershed, *JB Snow*.
2005-present New York Finger Lakes, Limnological, Hydrogeochemical & Sedimentological Studies, *JB Snow*.
2001-2002 Lake Ontario Benthic Storm & *Dreissena* and *Diporeia* lake floor distribution study, R/V *Kaho*.
1999-2002 Eastern Lake Ontario Sands Transport Study, HWS *William Scandling* (formerly the Explorer).
1996-2000 Zurich Bog - Groundwater Flow and Hydrogeochemistry of Wetlands.
1995-present Seneca and other Finger Lakes, High-Resolution Geophysical Studies, HWS Scandling & Others.
1995-present Seneca Lake, Geochemical Tracers of Sedimentation Processes.
1995-present Seneca Watershed, Limnology and Surface Hydrogeology Study.
1994-present Limnological Impact of Zebra Mussels in Seneca Lake.
1995 Lake Malawi, East Africa, Deltaic Sedimentation Processes, RV *Ndunduma*.
1994 NC Continental Shelf, Underwater Vibrocoring, RV *Cape Hatteras*.
1993 Univ. of Notre Dame Environmental Research Center, Land-O-Lakes, WI.
1992 Lake Malawi, East Africa, Deltaic Sedimentation Processes, RV *Timba*.
1990 Lake Turkana, Kenya, Paleoclimatic Expedition.
1988 Lake Malawi, East Africa, Sediment Trap Expedition.
1984 Lake Turkana, Kenya, Sedimentology/Geophysics RV *Halcyon* & *Nyanja*.
1984 Blake Outer Ridge, Atlantic Ocean, Sedimentology, RV *Cape Hatteras*.
1983 Lake Tanganyika, East Africa, Geophysics, RV *Nyanja*.
1982 Lake Superior, Suspended Sediments Study, RV *Viking*.
1981 Lake Superior, Sedimentology/Geophysics, RV *Laurentian*.
1980 Lake Superior, Sedimentology/Geophysics, RV *Roger Simons*.

Professional Society Memberships:

American Association for the Advancement of Science
American Society of Limnology and Oceanography
National Association of Geology Teachers
New York State Federation of Lakes Association, Inc.
American Geophysical Union
Geological Society of America
Council on Undergraduate Research
Great Lakes Research Consortium

Teaching and Community Service Awards:

2004 Hobart and William Smith Colleges – Faculty Community Service Award.
2002 Seneca Lake Watershed Steward Award, Seneca Lake Pure Waters Association.
2002 Seneca Lake Watershed Protector Award, Seneca Lake Pure Waters Association.
1993 Nominated for Outstanding Teaching Award, University of Notre Dame.

Research, Teaching and Community Service Grants:

Pending Cayuga County Legislation, $20,500 for one year. 2015 Owasco Lake & Stream Monitoring Proposal.
Pending Emerson Foundation, Co-PI with Stina Bridgeman, $10,000 for one year, 2014 Owasco Lake Monitoring Buoy Proposal.
Pending Cayuga County Soil & Water, Co-PI with John Vaughn, $15,000, 2014 BMP Monitoring & Assessment Subcontract.
2015 NYSERDA, Co-PI with Lisa Cleckner, $164,894 for 18 months, Mercury dynamics in Finger Lakes Fish and Invertebrates.
2014 Owasco Lake Watershed Association, $2,000 for one year. Support budget cuts to 2014 Owasco Lake & Stream Monitoring Proposal.
2014 Cayuga County Legislation, $20,500 for one year. 2014 Owasco Lake & Stream Monitoring Proposal.
2013 Cayuga County Legislation, $25,500 for one year. 2013 Owasco Lake & Stream Monitoring Proposal.

2012 Cayuga County Legislation, $26,700 for one year. 2012 Owasco Lake & Stream Monitoring Proposal.
2011 Owasco Watershed Lake Association, $15,000 for one year. Owasco Lake Instrumentation Proposal.
2011 Anonymous Foundation $500,000 for 5 years. Equipping the Introductory Course Sequences in the Natural Sciences.
2011 DE French & SW Metcalf Foundations via Owasco Lake Watershed Association. $15,000 for 1 year. Owasco Stream Instrumentation Proposal.
2010 Seneca Lake Pure Watersheds Association. $4,500 for 1 year. Seneca Lake Water Quality. SLPWA got awards from Freshwaters Futures Association and Ontario County for this work.
2010 New York State - Dept of State: $62,950 for 3 years. The Seneca Lake Watershed Management Plan. Collaborators: Finger Lakes Institute, Genesee/Finger Lakes Regional Planning Council and Southern Tier Central Regional Planning & Development Board.
2010 Seneca Lake Pure Watersheds Association. $2,000 for 1 year. Seneca Lake Water Quality.
2010 Owasco Lake Watershed Association. $3,000 for 1 year. Water quality in Owasco Lake.
2009 Owasco Lake Watershed Association. $4,000 for 1 year. Water quality in Dutch Hollow Creek.
2007 JB Snow Foundation. $15,000 for one year. A water quality study of the seven central Finger Lakes: A proposal to the J.B. Snow Foundation.
2007 Park Foundation. $20,000 for two years. A water quality study of Cayuga Lake: A proposal to the Park Foundation.
2006 New York State. $225,000 for 1 year. Water Quality Analysis of Owasco Lake.
2006 New York State. $100,000 for one year. Educational Outreach at the Finger Lakes Institute.
2006 Emerson Foundation. $25,000 for 18 months. Water quality Analysis of Owasco Lake.
2006 Andrew W. Mellon Foundation. $200,000 for three years. Science at the Finger Lakes Institute. Hire post-doctoral scholar and expand the science research objectives of the Institute.
2006 NSF-ATE, $899,000 for three years (5/06-4/09). Co-PIs with Jim MaKinster, Nancy Trautmann, et al. The Finger Lakes GIT Ahead Project: Creating Career Paths for Geospatial Technology Professionals Through Teacher Enhancement and Student Engagement.
2005 Booth Ferris Foundation, JP Morgan Chase Bank. $150,000 for one year. Capital Support for the Finger Lakes Institute.
2005 Lisa Kloman. $1,000 gift to add to the Kloman Environmental Research endowment.
2005 Triad Foundation. $300,000 for 3 year. The Finger Lakes Institute.
2005 New York State Member Item – Senator Michael Nozzolio. $100,000 for 1 year. Development of the Finger Lakes Institute's Educational Outreach and Economic Development Programs.
2005 Andrew W. Mellon Foundation. $300,000 for 3 years. Support of the Environmental Studies Program at Hobart and William Smith Colleges – Development of the Finger Lakes Institute.
2004 Great Lakes Aquatic Habitat Network & Fund. $17,000 for 1 year. Seneca Lake watershed community environmental awareness: Town of Torrey, Yates County.
2004 Institute for the Application of Geospatial Technology. $13,500 for 1 year. Bathymetric Survey of Owasco Lake. As part of a NASA Grant to IAGT, Preserving the Finger Lakes for the Future.
2004 Keck Consortium Research Proposal. $51,990 for 2 years. The Finger Lakes, NY: Natural "Beakers" for Investigating Environmental and Climatic Change from the Holocene to "Anthropocene".
2004 NSF-MRI, Major Research Instrumentation, EAR-04-20576, $152,153 for 1 year. Co-PIs Tara Curtin and Leah Joseph. Acquisition of an elemental analyzer, particle-size analyzer, and KappaBridge to investigate, the origin of rhythmites in the Finger Lakes of New York.
2004 US Department of HHS – Congressman Walsh. $250,000. Capital Equipment and Infrastructure Support for the Finger Lakes Institute.
2003 Triad Foundation. $100,000 for 1 year. The Finger Lakes Institute. Includes a $50,000 match from New York State.
2003 New York State Member Item – Senator Michael Nozzolio. $20,000 for 1 year. Initiation of the Finger Lakes Institute's Educational Outreach Program.
2003 John Ben Snow Foundation, $20,000 for 1 year. Acquisition of a pontoon boat (*JB Snow*) for Finger Lake Institute activities.
2002 New York State Legislature – Senator Michael Nozzolio. $1,000,000. Initiation of the Finger Lakes Institute at Hobart and William Smith Colleges.
2002 NYS-Department of Environmental Conservation, M-010015, $18,000 for 2 years. Subcontract from Seneca Lake Pure Waters Association. Wastewater Management Initiative in the Seneca Lake Watershed.
2002 The Patchett Foundation, $15,000 for 12 months. Matching funds to upgrade the X-Ray Diffractometer.
2001 NSF-MRI, Major Research Instrumentation, EAR 01-16078, $99,771 for 24 months. Co-PI, D. Brooks McKinney. Acquisition of an Ion Chromatograph and X-Ray Diffractometer to support watershed modeling, Seneca Lake, New York.

2001 Tripp Foundation, $9,500 for 14 months. The source of nitrates to selected streams within the Seneca Lake Watershed.

2001 US-EPA, GL2000-26, $24,234 for 2 years. Co-PI, Dawn Dittman, United States Geological Survey, Tunison Laboratory of Aquatic Science. Influence of physical factors and exotics on *Diporeia.*

2000 Andrew W. Mellon Foundation, $400,215 for 36 months. Proposal in Support of Environmental Studies at Hobart and William Smith Colleges.

2000 The Nature Conservancy, $2,500 for 12 months. Monitoring Water Levels of Sandy Pond.

2000 John Ben Snow Foundation, $15,000 for 12 months. Matching funds for the NSF CCLI Award.

1999 Upper Susquehanna Coalition and U.S. Fish and Wildlife Service, $700 for 6 months. Beta testing an inexpensive data logger.

1999 NSF-DUE-CCLI-EMD, DUE 99-50544, $75,850 for 30 months. Co-PI's, D.B. McKinney & J.B. Vaughn, An Inexpensive Data Logger Designed to Record Analog Signals in Hydrology and Computer Architecture.

1999 Bergen Swamp Preservation Society. $500 for Spring Term. Hydrogeochemistry of Zurich Bog – Course Curricular Improvement Funds.

1998 EPA Environmental Educational Funds, $9,000 for one year. Herbicide and pesticide awareness in the Finger Lakes: Curriculum improvements and community outreach. Co-PI Owen Priest.

1998 The Nature Conservancy, $28,675 for one year. co-PI's Woodrow, Ahrnsbrak, Singer, et al., Eastern Lake Ontario sand transport study.

1997 Merck Company Foundation & American Association for the Advancement of Science (AAAS) Award for Undergraduate Science Research. $20,000 per year. PI's Walter Bowyer & Joel Kerlan. Groundwater interconnections at Zurich Bog, New York.

1997 Hobart & William Smith Colleges Faculty Research Award. $1,200 for one year. Developing inexpensive recording stream gauges to investigate the hydrology of Seneca Lake. Co-PI, D. Brooks McKinney.

1995 NSF - STI-94 13384, Academic Research Facilities, NSF. $108,678 for 5 years. Acquisition of a high-resolution seismic reflection system which utilizes chirp technology and side scan sonar. Co-PI's Don Woodrow, Charlie McClennen, et al.

1994 Energy Research Clearing House, (Oil Company Consortium) Co-PI Chris Scholz, Sublacustrine Fans and Deep-Water Sands in Lakes Malawi.

1993 Lilly Endowment, Inc., Summer Stipend for the Development of New Courses, $5,000, Practical Environmental Geology and the Liberal Arts Major.

1992 NSF - REU Supplement for ATM 91-05842-01, $3,500 for 12 months, NSF research experience for undergraduates supplement.

1991 NSF Research Grant, ATM 91-05842, $50,000 for 24 months, High-Resolution Paleoclimatic Studies on Lake Turkana, Kenya.

1991 Jesse H. Jones Faculty Research Equipment Fund Program for 1990-91, $17,230 for 1 year, Acquisition of a Conductivity, Temperature, Turbidity, and Depth Profiler.

1991 Jesse H. Jones Faculty Research Fund Program for 1990-91, $9,610 for 1 year, High-Resolution Analysis for Cyclic Climatic Change During the Past 9,000 Years, Lake Superior.

1990 NSF Equipment Grant, OCE 90-01930, $29,200 for 1 year, Acquisition of an Electronic Particle Size Analyzer.

1989 NSF Research Grant, ATM 89-03649, $52,485 for 1 year, Stratigraphic and Geochronologic Controls on Sedimentation in Lake Turkana, Kenya.

1988 Lynde and Harry Bradley Foundation Research Fellowship.

Research Interests:

Geolimnology, Hydrogeochemistry, Paleoclimatology and Sedimentology.

Topics of current and proposed research interests include the limnology, hydrogeochemistry and sedimentology of lakes through the collection and analysis of limnological and hydrogeochemical data from lakes and streams, CTD water column profiles, sediment cores and high-resolution (1-kHz) seismic profiles. Current projects focus on the hydrogeochemical impact of zebra and quagga mussels, watershed/lake major ion hydrogeochemistry, and the impact of nutrient loading from the watershed on the Finger Lakes of central and western New York. Funding originates from private foundation, state and federal sources.

Publications in Refereed Journals and Refereed Symposia: *student co-authors

Zhu, B., J.D. Halfman, Christine Mayer, and L.G. Rudstam, submitted, Effects of dreissenid mussels on nitrogen and phosphorus cycling in the Finger Lakes: Linking laboratory results with field observations.

Exhibit A **John David Halfman**

Brown, M.E., T.M. Curtin, C.J. Gallagher* and **J.D. Halfman**, 2012, Historic nutrient loading and recent species invasions cause shifts in zooplankton demography and water quality in two Finger Lakes (New York, USA). J of Paleolimnology. 48: 623-639.

Halfman, J.D., C.M. Caiazza*, R.J. Stewart*, S.M. Opalka*, and C.K. Morgan*. 2006., Major ion hydrogeochemical budgets and elevated chloride concentrations in Seneca Lake, New York. Northeastern Geology and Environmental Sciences, v. 28, p. 324-333.

Halfman, J.D., D.E. Dittman, R.W. Owens, and M.D. Etherington*, 2006. Storm induced redistribution of deepwater sediments in Lake Ontario. J of Great Lakes Research. 32: 348-360.

Riley*, T.C., T.A. Endreny, and **J.D. Halfman**, 2006, Monitoring soil moisture and water table height with a low-cost data logger. Computers and Geoscience. 32: 135-140.

Vollmer, M.K, H.A. Bootsma, R.E. Hecky, G. Patterson, **J.D. Halfman**, J.M. Edmond, D.H. Eccles, & R.F. Weiss, 2005, Deep-Water Warming Trend in Lake Malawi, East Africa. Limnology & Oceanography. 50: 727-732.

Eyles, N., M Doughty, J.I. Boyce, H.T. Mullins, **J.D. Halfman** and B. Koseogulu*, 2002, Acoustic architecture of ice-contacted glaciolacustrine sediments deformed during zonal stagnation of the Laurentide Ice Sheet; Mazinaw Lake, Ontario, Canada. Sedimentary Geology. 157: 133-151.

Halfman, J.D., S.M. Baldwin*, J.P. Rumpf* and M.B. Giancarlo*, 2001, The impact of the zebra mussel (Dreissena polymorpha) on the limnology, geochemistry and sedimentology of Seneca Lake, New York. Wagenet, L.P., D.A. Eckhardt, N.G. Hairston, D.E. Karig, and R. Yager, eds., A Symposium on the Environmental Research in the Cayuga Lake Watershed. October 12, 1999. Natural Resource, Agriculture and Engineering Service (NRAES), Cooperative Extension, Cornell University. P. 154-166.

Mullins, H.T., and **J.D. Halfman**, 2001. High-resolution deglacial and post glacial seismic stratigraphy of Owasco Lake, New York: Evidence for mid-Holocene environmental change. Quaternary Research. 55: 322-331.

Dedrick*, R.R., **J.D. Halfman** & D.B. McKinney, 2000. An inexpensive, microprocessor-based, data logging system. Computers and Geoscience. 26: 1059-1066.

Eyles, N., J.I. Boyce*, **J.D. Halfman**, and B. Koseoglu*, 2000. Seismic-stratigraphy of Waterton Lake, a sediment starved glaciated basin in the Rocky Mountains of Alberta, Canada and Montana, USA. Sedimentary Geology. 130: 283-311.

Halfman, J.D., and D.T. Herrick*, 1998, Mass-movement and reworking of late glacial and postglacial sediments in northern Seneca Lake, New York. Northeastern Geology and Environmental Sciences, 20: 227-241.

Halfman, J.D., 1996, CTD-transmissometer profiles from Lakes Malawi and Turkana. In: Johnson, T.C. and E. Odada, eds., The Limnology, Climatology and Paleoclimatology of the East African Lakes. Gordon and Breach Scientific Publishers. p. 169-182.

Wüest, A., G. Piepke and **J.D. Halfman**, 1996, Combined effects of dissolved solids and temperature on the density stratification of Lake Malawi. In: Johnson, T.C. and E. Odada, eds., The Limnology, Climatology and Paleoclimatology of the East African Lakes. Gordon and Breach Scientific Publishers. p. 183-204.

Halfman, J.D., T.C. Johnson and B.P. Finney, 1994, New AMS dates, stratigraphic correlations and decadal climatic cycles for the past 4 ka at Lake Turkana, Kenya. Palaeogeography, Palaeoclimatology, Palaeoecology, 111: 83-98.

Halfman, J.D., 1993, Water column characteristics from modern CTD data, Lake Malawi, Africa. Journal of Great Lakes Research, 19: 512-520.

Halfman, J.D. and C.A. Scholz, 1993, Suspended sediments in Lake Malawi, Africa: A reconnaissance study. Journal of Great Lakes Research, 19: 449-511.

Halfman, J.D., D.F. Jacobson*, C.M. Cannella*, K.A. Haberyan and B.P. Finney, 1992, Fossil diatoms and the mid to late Holocene paleolimnology of Lake Turkana, Kenya: A reconnaissance study. Journal of Paleolimnology, 7: 23-35.

Halfman, J.D., 1992, Review of *Principles, Methods and Applications of Particle Size Analysis*, J.P.M. Syvitski (ed.) Cambridge University Press. Journal of Paleolimnology. 7: 257-258.

Johnson, T.C., **J.D. Halfman** and W.J. Showers, 1991, Paleoclimate of the past 4000 years at Lake Turkana, Kenya, based on isotopic composition of authigenic calcite. Palaeogeography, Palaeoclimatology, Palaeoecology, 85: 189-198.

Halfman, J.D. and P.J. Hearty, 1990, Cyclical sedimentation in Lake Turkana, Kenya. In: Lacustrine basin exploration: Case studies and modern analogs, American Association of Petroleum Geologists Memoir # 50, B.J. Katz (ed.) p. 187-196.

Halfman, J.D., T.C. Johnson, W.J. Showers and G.S. Lister, 1989, Authigenic low-Mg calcite in Lake Turkana, Kenya. Journal of African Earth Sciences, 8: 533-540.

Halfman, J.D. and T.C. Johnson, 1988, The laminations in Lake Turkana, and the climatic implications. El Nino in the Ancient Record (ELNAR) Circular, 5: 1-2.

Halfman, J.D. and T.C. Johnson, 1988, High-resolution record of cyclic climatic change during the past 4 Ka from Lake Turkana, Kenya. Geology, 16: 496-500.

Exhibit A **John David Halfman**

Johnson, T.C., **J.D. Halfman**, B.R. Rosendahl and G.S. Lister, 1987, Climatic and tectonic effects on sedimentation in a rift-valley lake: Evidence from high-resolution seismic profiles, Lake Turkana, Kenya. Geological Society of America, Bulletin, 98: 439-447.

Halfman, J.D. and T.C. Johnson, 1984, The sediment texture of contourites in Lake Superior. In: Fine-grained sediments: Deep-water processes and facies, The Geological Society Special Publication, Blackwell Scientific Publications, D.A.V. Stow and D.J.W. Piper (eds.) p. 293-307.

Johnson, T.C., **J.D. Halfman**, W.H. Busch and R.D. Flood, 1984, Effects of bottom currents and fish on sedimentation in a deep-water, lacustrine environment. Geological Society of America, Bulletin, 95: 1425-1436.

Halfman, J.D. and T.C. Johnson, 1984, Enhanced atmospheric circulation over North America during the early Holocene. Science, 224: 61-63.

Ph.D. and Master's Theses:

Ph.D. Duke University, Durham, NC, 1987, High-resolution Sedimentology and Paleoclimatology of Lake Turkana, Kenya. Advisor: Thomas C. Johnson

M.S. University of Minnesota, Minneapolis, MN, 1982, Textural Analysis of Lacustrine Contourites. Advisor: Thomas C. Johnson

Other Publications & Reports: *student co-authors

Halfman, J.D., G. Moralez, K. Coughlin, & N Andrzejczyk, 2014. Owasco Lake, New York: Water Quality & Nutrient Sources, 2014 Findings. Finger Lakes Institute, Hobart and William Smith Colleges. 45 pg.

Halfman, J.D., 2014. A 2014 update to the chloride hydrogeochemistry in Seneca Lake, New York. Finger Lakes Institute, Hobart and William Smith Colleges. 27 pg.

Halfman, J.D., A Cole*, G Moralez* & T Goldstoff*, 2013. Owasco Lake, New York: Water quality and Nutrient Sources, 2013 Findings. Finger Lakes Institute, Hobart and William Smith Colleges. 41 pg

Halfman, J.D., E. Black*, L. Carver Dionne*, C. Ellis* and P. Hackett*, 2012. Owasco Lake, New York: Water quality and nutrient sources, a 2012 update. Finger Lakes Institute, Hobart and William Smith Colleges. 42 pg.

Halfman, J.D., D. Zorn, C. Roberson, L Cleckner and S. Meyer, 2012. Seneca Lake Watershed Management Plan: Characterization and Evaluation. 139 pg.

Halfman, J.D., 2011. Water quality of Seneca Lake, New York: A 2011 Update. Finger Lakes Institute, Hobart and William Smith Colleges. 40 pg.

Halfman, J.D., E.G. Cummings* and M.M. Stewart*, 2011. Owasco Lake, New York: Water quality and nutrient sources, a 2011 update. Finger Lakes Institute, Hobart and William Smith Colleges. 44 pg.

Halfman, J.D., and K.O. O'Neill*, 2010. Water quality and nutrient sources in the Owasco Lake watershed: A 2010 Update. Finger Lakes Institute, Hobart and William Smith Colleges. 22 pg.

Watkins*, J., L. Rudstam, E. Mills, M. Leopold, D. Dittman & **J.D. Halfman**, 2010. The benthic community of Owasco Lake as an indicator of lake ecosystem health. In: Halfman, J.D., M.E. Balyszak and S.A. Meyer (eds.), A 2007 Water Quality Study of Owasco Lake, New York. Finger Lakes Institute, Hobart and William Smith Colleges. 20 pg.

Halfman, J.D., and P. Basnet*, 2009. Bottom water phosphates and suspended sediments in southern Cayuga Lake, New York. Finger Lakes Institute, Hobart and William Smith Colleges. 21 pg.

Halfman, J.D., and K. O'Neill*, 2009. Water quality of the Finger Lakes, New York: 2005 – 2008. Finger Lakes Institute, Hobart and William Smith Colleges. 33 pg.

Halfman, J.D., T.F. Ware*, and K.A. O'Neill*. 2008. The 2007 Progress Report: Phosphate and suspended sediment distribution and potential sources to southern Cayuga Lake. Finger Lakes Institute, Hobart and William Smith Colleges. 9 pg.

Halfman, J.D., E.S. Brown*, T.F. Ware*, K.A. O'Neill*, C.K. Franklin* and R.E. Dye*, 2008. Owasco Lake, New York: Water Quality and Nutrient Sources. In: Halfman, J.D., M.E. Balyszak and S.A. Meyer (eds.), A 2007 Water Quality Study of Owasco Lake, New York. Finger Lakes Institute, Hobart and William Smith Colleges. 37 pg.

Halfman, J.D., and C.K. Franklin*, 2008. Water Quality of Seneca Lake, New York: A 2007 Update. Finger Lakes Institute, Hobart and William Smith Colleges. 28 pg.

Halfman, J.D., B.L. Holler*, and H.M. Philip*, 2006. A preliminary water quality study of Owasco Lake, NY, and its watershed. Finger Lakes Institute, Hobart and William Smith Colleges. 26 pg.

Halfman, J.D., and K. F. Bush*, 2006. A preliminary water quality study of selected Finger Lakes, New York. Finger Lakes Institute, Hobart and William Smith Colleges. 15 pg.

Halfman, J.D., I West*, T.M. Hintz*, and B.A. Beckingham* and many other undergraduate students, 2006. Water Quality and Pollution Sources to the Keuka Outlet, 2003-2005. Report to the Torrey Ad-Hoc Water Quality Committee. 12 pg text, 13 pg data & figures.

Wood*, D.A., and **J.D. Halfman,** 2005. High-resolution, seismic reflection survey of the upper sediments in Otsego Lake, New York. SUNY Oneonta Biological Field Station Annual Report.

Dittman, D.E., **Halfman, J.D.**, and Owens, R.W. 2005. Influence of Exotics and Physical Sedimentological Factors on *Diporeia*. Final Project Report USEPA.

Halfman, J.D., D. Wood*, and S. Strong*, 2004. Bathymetric Survey of Owasco Lake for the Institute for the Application of Geospatial Technology (IAGT), Auburn, New York. In-House Report, Finger Lakes Institute, Hobart and William Smith Colleges.

Halfman, J.D., 2003. Water Quality Data: Seneca Lake and Selected Tributaries. Report to New York State Department of Environmental Conservation (NYS-DEC). 31 pg.

Halfman, J.D., J.M. Ryan, and J. MaKinster, 2002. The Finger Lakes Institute Strategic Plan.

Halfman, J.D., 2002. The Finger Lakes Institute and Hobart and William Smith Colleges. New York Glaciogram, v. 37, p. 12.

Joseph, L. and **J.D. Halfman**, 2001. Mid-Holocene Climate Transition. New York Glaciogram. v. 36, p. 15.

Halfman, J.D. and D.B. McKinney, 2001. Trouble Shooting the HWS Data Logger. 7 p.

Halfman, J.D. and D.B. McKinney, 2001. The HWS Data Logger Software Manual. 18 p.

Halfman, J.D., and D.B. McKinney, 2001. The HWS Data Logger Construction Manual. 24 p.

Halfman, J.D. and S. Alderman*, 2001. The Seneca Lake Salt Investigation Continues. Lake Watch: A Newsletter of the Seneca Lake Pure Waters Association.

Halfman, J.D., 2001, Two Things of Importance. New York Glaciogram. v. 36, p. 7.

Halfman, J.D., 2000, Stratigraphy, sedimentology, and geochemistry of Seneca Lake, New York. New York State Geological Association Annual Meeting. NYSGA Field Trip Guidebook. p. 27-38.

Halfman, J.D., and D.L. Woodrow, 1997, Stratigraphy, sedimentology, and geochemistry of Seneca Lake, New York. New York State Geological Association Annual Meeting. NYSGA Field Trip Guidebook.

Halfman, J.D., 1997, The sediments and chemistry of Seneca Lake. In: The National Association of Geoscience Teachers Eastern Section Annual Meeting - Field Trip Guidebook, May 8 - 11, 1997, Chapter 2.

Halfman, J.D., and many undergraduate students, 1999, Seneca Lake Limnology and Water Quality Status. Chapter 6A, Setting the Course for Seneca Lake – The State of the Seneca Lake Watershed, 1999.

Halfman, J.D., and many undergraduate students, 1999, Seneca Lake Stream Water Quality. Chapter 6B, Setting the Course for Seneca Lake – The State of the Seneca Lake Watershed, 1999.

Abstracts for Symposia, Conferences & Workshops: *student co-authors

Halfman, J.D., 2014, Land Use Controls on Stream and Lake Dissolved Silica Concentrations: A Case Study from the Finger Lakes, Central New York State, USA. American Geophysical Union Fall Meeting.

Invited talk: **Halfman, J.D.**, 2014. Nutrient sources, variability and their water quality impacts: A case study from the Finger Lakes of Central New York. Sam Houston State University Seminar Series.

Cole*, A., Moralez*, G., and **J.D. Halfman**, 2013. Precipitation induced nutrient loading variability between two tributaries in the Owasco Lake Watershed, Central New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 45: p. 97.

Halfman, J.D., 2013. Finger Lakes Water Quality. Greentopia Futures Summit, Rochester, 9/11/2013.

George*, M., **J.D. Halfman**, and J.C. Cornwell, 2013. A preliminary investigation of bacterial respiration in the Finger Lakes of central New York, USA. 2013 Aquatic Sciences Meeting, American Society for the Sciences of Limnology and Oceanography.

Halfman, J.D., 2013. Century and decade-scale major ion and water clarity fluctuations in Seneca Lake, the largest Finger Lake of central New York, USA. 2013 Aquatic Sciences Meeting, American Society for the Sciences of Limnology and Oceanography.

Ellis* C.J., and **J.D. Halfman**, 2012. Comparison of two tributaries to Owasco Lake, New York, from 2011 to 2012. Geological Society of America Annual Meeting Abstracts with Programs, v. 44: p. 436.

Black*, E.D. and **J.D. Halfman**, 2012. A two-year comparison of nutrient fluxes in Dutch Hollow Brooks, Owasco Watershed, central New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 44: p. 579.

Carver Dionne*, L and **J.D. Halfman**, 2012. Segment analysis of Castle Creek, a small urban & agricultural watershed, Geneva, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 44: p. 564-565.

Halfman, J.D., E.G. Cummings*, and M.M Stewart*, 2011. Comparative Limnology of the eight eastern Finger Lakes: A 2011 update. 7th Annual Finger Lakes Research Conference Abstract Volume, 2011, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

John David Halfman

Halfman, J.D., E.G. Cummings*, and M.M Stewart*, 2011. Nutrient Loading in the Seneca and Owasco Watersheds. 7th Annual Finger Lakes Research Conference Abstract Volume, 2011, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Stewart*, M. and **Halfman, J.D.**, 2011. Identification of Nutrient Sources in Two Owasco Lake Tributaries. Geological Society of America Annual Meeting Abstracts with Programs, v. 43: p. 465.

Halfman, J.D., E. Cummings* and L. Carver Dionne*, 2010. Comparative Limnology of the eastern Finger Lakes: 2005 – 2010. 6th Annual Finger Lakes Research Conference Abstract Volume. 2010, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Halfman, J.D., E. Cummings* and L. Carver Dionne*, 2010. Water quality degradation in Seneca Lake, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 42: p. 60-61.

Hoering*, K. and **J.D. Halfman**, 2010. Precipitation, Nutrient Loading and Water Quality trends in the Finger Lakes of New York. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 42, p. 181.

Rocchio*, A.. and **J.D. Halfman**, 2010. Honeoye Lake, New York: The Anomalous Finger Lake. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 42, p. 183-184.

invited **Halfman, J.D.**, 2009. Comparative Limnology of the eastern Finger Lakes: 2005 – 2009. Finger Lakes Watershed Representatives Meeting. Dec 10, 2009.

Halfman, J.D., K.A. Hoering, and A.M. Rocchio, 2009. Comparative Limnology of the eastern Finger Lakes: 2005 – 2009. 5th Annual Finger Lakes Research Conference Abstract Volume. 2009, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

invited **Halfman, J.D.**, 2009. Comparative Limnology of the eastern Finger Lakes: 2005 – 2009. New York State Environmental Lawyers Keynote Address. November, 2009.

Halfman, J.D., and many undergraduate students, 2009. The Finger Lakes, An ideal natural laboratory for research, education and outreach. Workshop on Techniques for Evaluating Water Resources in the Finger Lakes. 11/13/2009. Conference sponsored by US Geological Survey, Finger Lakes – Lake Ontario Watershed Protection Alliance, and Finger Lakes Institute.

Halfman, J.D., K. O'Neill*, S. Bridgeman, W. Van Steen*, and M. Brown, 2009. Seneca Lake, an ideal natural laboratory for research, education and outreach. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 41, p. xx.

O'Neill*, K. and **J.D. Halfman**, 2009. The Finger Lakes of New York: An Ideal Natural Laboratory for Research, Education and Outreach. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 41, p. xx.

Abbott*, A., **J.D. Halfman** and M. Bothner, 2009. Inferring Regional and Local Sources of Mercury to the Sediments of Seneca Lake, New York. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 41, p. xx.

Halfman, J.D., K.A. O'Neill, K.A. Hoering, P. Basnet, and S.E. Georgian, 2008. Comparative Limnology of the eastern Finger Lakes: 2005 – 2008. 4th Annual Finger Lakes Research Conference Abstract Volume. 2008, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Basnet, P., and **J.D. Halfman**, 2008. Sources for Bottom Water Phosphates and Suspended Sediments in Southern Cayuga Lake, New York. 4th Annual Finger Lakes Research Conference Abstract Volume. 2008, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Georgian, S.E., and **J.D. Halfman**, 2008, Comparison of Methods to Determine Algal Concentrations in Freshwater Lakes. American Geophysical Union Annual Fall Meeting Abstracts with Programs.

Hoering, K.A., and **J.D. Halfman**, 2008. 2008 Water Quality Analysis of Otisco Lake, New York. American Geophysical Union Annual Fall Meeting Abstracts with Programs.

O'Neill, K.A. and **J.D. Halfman**, 2008, Water Quality of Eight Finger Lakes, New York: Changes from 2005 Through 2008. American Geophysical Union Annual Fall Meeting Abstracts with Programs.

Basnet, P., and **J.D. Halfman**, 2008. Sources for Bottom Water Phosphates and Suspended Sediments in Southern Cayuga Lake, New York. American Geophysical Union Annual Fall Meeting Abstracts with Programs.

Halfman, J.D., E.S. Brown*, R.E. Dye*, C.K. Franklin*, K.A. O'Neill*, and T.F. Ware*, 2007, Comparative limnology of Honeoye, Canandaigua, Keuka, Seneca, Cayuga, Owasco, and Skaneateles Lakes. 3rd Annual Finger Lakes Research Conference Abstract Volume. 2007, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Halfman, J.D., K.A. O'Neill*, T.F. Ware*, 2007, Potential sources for hypolimnetic nutrients and suspended sediments in southern Cayuga Lake, New York. American Geophysical Union Annual Fall Meeting Abstracts with Programs. GC32-0938.

Brown*, E.S. and **J.D. Halfman**, 2007, What happened to our Lake? Nutrient loading in Owasco Lake and its watershed. Geological Society of America Annual Meeting Abstracts with Programs, v. 39, p. 217.

Dye*, R.E., and **J.D. Halfman**, 2007, Decreasing salinity in Seneca Lake, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 39, p. 217.

Franklin*, C.K., and **J.D. Halfman**, 2007, A decade of increasing productivity in the Seneca Lake watershed. Geological Society of America Annual Meeting Abstracts with Programs, v. 39, p. 217-218.

Holler*, B.L., Philip*, H.M., and **J.D. Halfman**, 2007, Water Quality of Owasco Lake, central New York: The 2006 Lake Survey. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 39, p. 100.

Philip*, H.M., Holler*, B.L., and **J.D. Halfman**, 2007, Water Quality of Owasco Lake, central New York: The 2006 Watershed Survey. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 39, p. 100.

Halfman, J.D., 2006, Seneca Lake, An Ideal Natural Laboratory for Research, Education and Outreach. Geological Society of America Annual Meeting Abstracts with Programs, v. 38, p. 30.

Sukeforth*, R.L., and **J.D. Halfman**, 2006, Are winter deicing applications the primary source of chloride to the Finger Lakes of central and western New York? Geological Society of America Annual Meeting Abstracts with Programs, v. 38, p. 136.

Brown*, C.A., and **J.D. Halfman**, 2006, Seasonal Distribution of Plankton Species among seven Finger Lakes in New York State. Geological Society of America Annual Meeting Abstracts with Programs, v. 38, p. 137.

Kinnevey*, C.E., and **J.D. Halfman**, 2006, Water Quality Analysis in the Seneca Lake Watershed, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 38, p. 136.

Petrick*, B., T.M. Curtin, **J.D. Halfman**, R.F. Aspinwall and D.I.Lyons, 2006, A sediment record of major storm events from Keuka Lake, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 38, p. 82.

Halfman, John D., R.L. Sukeforth*, B. Holler*, C. Kinnevey*, and C. Brown*, 2006, Comparative Limnology of Honeoye, Canandaigua, Keuka, Seneca, Cayuga, Owasco, and Skaneateles Lakes – 2005 & 2006. 2nd Annual Finger Lakes Research Conference Abstract Volume. October 14, 2006, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Lyons*, D.I., T.M. Curtin, **J.D. Halfman**, R. Gaines, and K.K. Nichols, 2006. Getting to the bottom of it: Holocene climate change in Keuka Lake based on sediment cores. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 38, p. 29.

Sukeforth*, R.L., K.L Parrinello*, and **J.D. Halfman**, 2006, Are historical chloride data inconsistent with saline groundwater intrusions in Seneca Lake, New York? Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 38, p. 82.

Bush*, K.F., and **J.D. Halfman**, 2006, Water quality analyses and watershed protection in the Finger Lakes, New York. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 38, p. 81.

Halfman, J.D., 2005. Finger Lakes Comparative Limnology – 2005. Rochester Academy of Sciences Annual Research Symposium. Finger Lakes Community College.

Morgan*, C.K., T.M. Curtin, W. Darden*, **J.D. Halfman**, and H. Woodson*, 2005. Reflections on Mud: Holocene Climate Variability Recorded by Laminated Sediments in Canandaigua Lake, NY. American Geophysical Union Annual Fall Meeting Abstracts with Programs, PP33B-1570.

Halfman, J.D., Bush*, K.F., Sukeforth*, R.L., and I.D. West*, 2005. Comparative Limnology of Honeoye, Canandaigua, Keuka, Seneca, Cayuga, Owasco, and Skaneateles Lakes – 2005. 1st Annual Finger Lakes Research Conference Abstract Volume. October 8, 2005, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Aspinwall*, R.F., T.M. Curtin, **J.D. Halfman**, D. Lyons*, B. Petrick*, and L. Hafner*, 2005. Seismic stratigraphy and depositional architecture of Holocene sediment in Keuka Lake, NY. 1st Annual Finger Lakes Research Conference Abstract Volume. October 8, 2005, Finger Lakes Institute, Hobart and William Smith Colleges, Geneva, NY.

Aspinwall*, R.F., T.M. Curtin, **J.D. Halfman**, D. Lyons*, B. Petrick*, and L. Hafner*, 2005. Seismic stratigraphy and depositional architecture of Holocene sediment in Keuka Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 364.

West*, I.D., and **J.D. Halfman**, 2005. When bacteria attack: Keuka Outlet, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 352.

Bush*, K.F., and **J.D. Halfman**, 2005. Water Quality Analysis of the Finger Lakes, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 352.

Sukeforth*, R.L., and **J.D. Halfman**. 2005. Spatial and temporal trends in major ion concentrations from the Finger Lakes, NY. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 37, p. 62.

Exhibit A **John David Halfman**

Bush*, K.F., and **J.D. Halfman**, 2005. Water quality analysis and sources of total coliform and *E. coli* bacteria in the Seneca Lake, NY watershed. Geological Society America Northeast Regional Annual Meeting Abstracts with Programs, v. 37, p. 62.

Morgan*, C.K., **J.D. Halfman**, 2004. Preliminary hydrogeochemical budgets for Seneca Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 36, p. 493.

Wood*, D.A., **J.D. Halfman**, 2004. A practical, trailerable limnological research vessel for the Finger Lakes Institute. Geological Society of America Annual Meeting Abstracts with Programs, v. 36, p. 285.

Riina*, J.W., **J.D. Halfman**, 2004. A hydrogeochemical study of a water retention pond, Odell's Pond. Geological Society of America Annual Meeting Abstracts with Programs, v. 36, p. 493.

Hintz*, T.M. and **J.D. Halfman**, 2004. Bacterial and Nutrient Water Quality Survey of the Keuka Outlet, Seneca Lake Watershed, NY. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 36, p. 24.

Kostick*, S.R. and **J.D. Halfman**, 2003. The impact of large precipitation events on nutrient runoff to Seneca Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 145.

Beckingham*, B.A. and **J.D. Halfman**, 2003. Preliminary inspection of water quality using total Coliform and E. coli bacteria in the Seneca Lake watershed, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 145.

Opalka*, S.M. and **J.D. Halfman**, 2003. A preliminary calcium budget for Seneca Lake, NY: Fluvial inputs and probably removal mechanisms. Geological Society of America Annual Meeting Abstracts with Programs, v. 37, p. 145.

Halfman, J.D., L.H. Joseph, M.J. Nicolo*, and T.M. Curtin, 2003. An abrupt mid-Holocene climatic event: Seismic Imaging and sedimentological evidence from Seneca Lake, central New York State. The Third International Limnogeology Congress Abstract Volume, 3/29-4/2, Tucson, AZ, p. 106.

Dittman, D.E., **J.D. Halfman**, and R.W. Owens, 2003. Investigation of physical factors and the distribution of the deepwater amphipod *Diporia*. 46th Annual Conference International Association for Great Lakes Research & 10th World Lakes Conference, Chicago, IL.

Walker*, A.E., **J.D. Halfman**, and D.E. Dittman, 2002. Sedimentological controls on the distribution of *Diporeia* and *Dreissena* species in Lake Ontario. Geological Society of America Annual Meeting Abstracts with Programs, v. 34, p. 258.

Stewart*, R.J., **J.D. Halfman**, 2002. Assessing the role of watershed area and landuse on nutrient and suspended sediment flux to Seneca Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 34, p. 258.

Caiazza*, C.M., and **J.D. Halfman**, 2002. Intrusion of saline groundwater into Seneca Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 34, p. 258.

McKinney, D.B., and **J.D. Halfman**, 2002. A new 12-bit/16K version of the Hobart and William Smith Datalogger – Better resolution and more data! Geological Society of America Annual Meeting Abstracts with Programs, v. 34, p. 418.

Etherington*, M.D., **J.D. Halfman**, and D.E. Dittman, 2002. Influence of sedimentological factors on the distribution of Diporeia and Dreissena species in Lake Ontario. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 34, p. A31.

Bowser*, L.P., and **J.D. Halfman**, 2002. Nitrate loading in the Seneca Lake Watershed. Geological Society of America Northeast Regional Annual Meeting Abstracts with Programs, v. 34, p. A31.

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Baldwin*, S.M., **J.D. Halfman**, and A.S. Cohen, 2001. A comparison of chlorophyll-a patchiness in Kigoma Bay, Lake Tanganyika, Africa, and Seneca Lake, New York. Geological Society of America Annual Meeting Abstracts with Programs, v. 33, p. A365.

Nicolo*, M.J., L.H. Joseph, & **J.D. Halfman**, 2001. Environmental system transition at the mid-Holocene hypsithermal: Evidence from Seneca Lake, NY. Geological Society of America Annual Meeting Abstracts with Programs, v. 33, A23.

Invited Presentation: **Halfman, J.D.**, 2001. The Limnology and Water Quality of Seneca Lake and Its Tributaries. The 18th Annual Conference of the New York State Federation of Lake Associations. White Eagle Conference Center, Hamilton, NY, May 4-6.

Woodrow, D.L., **J.D. Halfman**, and C.E. McClennen, 2001. Results from the 2000 Eastern Lake Ontario Sand Transport Study: Vibra cores, side scan sonar and lake level. International Association of Great Lakes Research Annual Meeting.

Riley*, T.C. and **J.D. Halfman**, 2001, The HWS Data Logger and Hydrological Field Studies. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 33, p. A21-22.

Nicolo*, M.J., L.H. Joseph & **J.D. Halfman,** 2001, Climate transition during the Mid-Holocene: Evidence from the sediment of Seneca Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 33, p. A69.

Halfman, J.D, 2000, Lake Levels in Lake Ontario: Eastern Lake Ontario Sand Transport Study Report. Eastern Lake Ontario Sand Transport Advisory Committee Meeting, SUNY, ESF. November 11, 2000.

Halfman, J.D, 2000, An inexpensive data logger to remotely record stream stage, temperature and other environmental variables. New York State Geological Association Annual Meeting. Oct. 1, 2000. Workshop on HWS Data Logger for meeting.

Halfman, J.D, 2000, Stratigraphy, sedimentology, and geochemistry of Seneca Lake, New York. New York State Geological Association Annual Meeting. Sept. 30, 2000. Field trip on Seneca Lake for meeting.

Halfman, J.D., 2000. Long-term limnological changes in Seneca Lake. Seneca Lake Watershed Agricultural Environmental Management. Landre, Peter, ed., Yates County Cornell Cooperative Extension. pg. 13-16.

Halfman, J.D., D.B. McKinney, J.P. Rumpf*, S.M. Baldwin* and T.C. Riley*. 2000. Application of the HWS Data Logger to Hydrological Studies. Geological Society of America Annual Meeting Abstracts with Programs, v. 32, p. 287.

Baldwin*, S.M., **J.D. Halfman**, A.S. Cohen and P.D. Plisnier. 2000. A preliminary investigation of chlorophyll-a patchiness in Kigoma Bay, Lake Tanganyika, Africa. American Geophysical Union Annual Fall Meeting Abstracts with Programs, v. 81, p. F466.

Halfman, J.D., S.M. Baldwin*, and T.C. Riley*. 2000. The HWS Data Logger and Hydrological Studies. American Geophysical Union Annual Fall Meeting Abstracts with Programs, v. 81, p. F486.

Baldwin*, S.M. and **J.D. Halfman.** 2000. Atrazine in the Seneca Lake Watershed – An update on our Findings in 2000. Lake Watch: A Newsletter of the Seneca Lake Pure Waters Association.

Halfman, J.D., 2000. An inexpensive data logger to remotely record stream stage, temperature and other environmental variables. A workshop for the NYSGA Conference, Hobart and William Smith Colleges, Geneva, NY. October 1, 2000.

Halfman, J.D., 2000. Sediments and Geochemistry of Seneca Lake. Field Trip for the NYSGA Conference, Hobart and William Smith Colleges, Geneva, NY. Sept 30, 2000.

Invited Presetation: **Halfman, J.D.,** 2000. Water Quality and Limnology of the Seneca Lake Watershed, An Overview. A Watershed Summit for Municipal Government Representatives. Dresden, August 22, 2000.

Halfman, J.D., 2000. Recording lake levels in North Pond, eastern Lake Ontario. The Nature Conservancy Progress Report. June 9, 2000.

Halfman, J.D., 2000. Streams, lakes, bogs, data loggers and mud, a little bit of everything. New York Glaciogram. v. 35.

Invited Presentation: Baldwin, S.M.* and **J.D. Halfman,** 2000. The Limnology and Water Quality of Seneca Lake and Its Tributaries. The 17th Annual Conference of the New York State Federation of Lake Associations. White Eagle Conference Center, Hamilton, NY, May 5-7.

Woodrow, D.L, W.F. Ahrnsbrak, **J.D. Halfman**, C.E. McClennen, and J.K. Singer, 2000. Eastern Lake Ontario Sand Transport Study (ELOSTS): Further Developments 1999/2000. The International Association for Great Lakes Research Annual Meeting.

Invited Presentation: **Halfman, J.D.,** 2000. Limnology and Water Quality of Seneca Lake and its Tributaries. 17th Annual New York State Federation of Lake Associations Conference, Hamilton, NY, May 5-7, 2000.

Invited Presentation: **Halfman, J.D.,** 2000. An abrupt climatic transition during the mid-Holocene: Evidence from high-resolution seismic profiles and sediment cores in Seneca Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-32.

Invited Presentation: Mullins, H.T., and **J.D. Halfman,** 2000. High-resolution seismic reflection evidence for mid-Holocene climate change: Owasco Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-61.

Halfman, J.D., C.M. McSweeney*, and S.M. Baldwin*, 2000. Atrazine in the Seneca Lake Watershed – An Update on our Findings. Lake Watch: A Newsletter of the Seneca Lake Pure Waters Association.

Flusche, M.A.* and **J.D. Halfman**, 2000. Hydrogeochemistry of the northern sedge mat at Zurich Bog, Lyons, NY. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-17.

Rumpf, J.P.*, **J.D. Halfman** and D.B. McKinney, 2000. Development and testing of an inexpensive data logger and its application to hydrological studies. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-70-71.

Baldwin, S.M., J.C. McSweeney, and **J.D. Halfman**, 2000. The concentration and sources of atrazine in Seneca Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-4.

Freeman, J.W., D.L. Woodrow, & **J.D. Halfman**, 2000. Areal variation in acid precipitation: Central New York and northern Pennsylvania. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 32, p. A-18.

Invited Presentation: **Halfman, J.D.,** 1999. The hydrogeochemistry of Zurich Bog. An update on our recent findings. Bergen Swamp Preservation Society Annual Meeting. Rochester, NY.

Halfman, J.D., & the 1999 Hydrogeology Class*, 1999, Hydrochemical research at the northern floating sedge mat, Zurich Bog. 15 p. Bergen Swamp Preservation Society.

Halfman, J.D., and many other undergraduates*, 1999, Zebra mussel impact on Seneca Lake, New York. 8th annual conference on the Finger Lakes – Lake Ontario Watershed Protection Alliance.

Baldwin, S.M.*, 1999, The concentration and sources of atrazine in Seneca Lake, New York. 8th annual conference on the Finger Lakes – Lake Ontario Watershed Protection Alliance.

Invited Presentation: **Halfman, J.D.**, S.M. Baldwin*, J.P. Rumpf*, and M.B. Giancarlo*, 1999, The impact of the zebra mussel (Dreissena polymorpha) on the hydrogeochemistry of Seneca Lake, New York. A symposium on the environmental research in the Cayuga Lake Watershed. USGS, Ithaca & Cornell U. Center for the Environment. Oct. 12, 1999.

Baldwin, S.M.*, 1999, The concentration and sources of atrazine in Seneca Lake, New York. A symposium on the environmental research in the Cayuga Lake Watershed. USGS, Ithaca & Cornell U. Center for the Environment. Oct. 12, 1999.

Halfman, J.D., D.B. McKinney, R.R. Dedrick*, J.B. Vaughn, 1999, Recent improvements to an inexpensive, small, self-contained data logger. Geological Society of America Annual Meeting Abstracts with Programs, v. 31, p. 350.

Halfman, J.D., 1999, Atrazine in Seneca Lake. Lake Watch, Newsletter of the Seneca Lake Pure Waters Association.

Tara Spitzer*, 1999, Hog Farming. Lake Watch, A Newsletter of the Seneca Lake Pure Waters Association.

Kate Hamontree*, 1999, Seneca Lake Zebra Mussels (Parts I, II, III). Lake Watch, A Newsletter of the Seneca Lake Pure Waters Association.

Halfman, J. D. and many other undergraduate students, 1998, Seneca Lake Limnology – An update on our current understanding – December 1998. Seneca Lake Pure Waters Association and Seneca Lake Area Partners in Five Counties in-house report.

Halfman, J.D., H. Mullins and J. Desloges, 1998, High-resolution seismic reflection and GPR surveys of glaciated lake basin infills. N. Eyles, B. Koseoglu, J. Boyce. Geological Society of America Annual Meeting Abstracts with Programs, v. 30, p. 137.

Hammontree*, K.E. Maloney*, J.J. Christensen*, **J.D. Halfman**, 1998, Limnology and Geochemistry of Seneca Lake, New York: The impact of the zebra mussel, *Dreissena polymorpha*. Geological Society of America Annual Meeting Abstracts with Programs, v. 30, p. 180.

Invited Presentation: K.E. Maloney*, **J.D. Halfman** and many others*, 1998, Zebra Mussel impact on the limnology of Seneca Lake. New York State Federation of Lake Associations 15th Annual Meeting, Hamilton, NY.

Dedrick*, R.R., **J.D. Halfman**, D.B. McKinney, 1998, An inexpensive, small, submersible, recording stream gauge. Design, tests and application to the Seneca Lake Watershed. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 30, p. 13.

Maloney*, K.E., **J.D. Halfman** and many others, 1998, The impact of the zebra mussel, *Dreissena polymorpha*, on the biogeochemistry of Seneca Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 30, p. 60.

Sardella*, T.P., S.A. Jones* and **J.D. Halfman**, 1998, Preliminary Hydrogeochemistry of Zurich Bog, north of Lyons, New York. Groundwater impact on the plant species. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 30, p. 72.

Halfman, J.D. and A. Fetterman*, 1998, Preliminary analysis of high-resolution (2-12 kHz) reflection seismic profiles from Otsego Lake, New York. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 30, p. 23.

Halfman, J.D., T Sardella*, and S Jones*, 1997, Hydrogeochemistry of Zurich Bog. Progress Report. Bergen Swamp Preservation Society.

Halfman, J.D., T Sardella*, and S Jones*, 1997, Hydrogeochemistry of Zurich Bog. Bergen Swamp Preservation Society's Swamp News, 40: 3-4.

Halfman, J. D., K.E. Maloney* and many others, 1997, Seneca Lake Limnology – A Report on our current understanding. Seneca Lake Pure Waters Association and Seneca Lake Area Partners in Five Counties in-house report.

Halfman, J.D., D. Herrick*, N Ciszkowski*, and M. Potter*, 1997, Potential paleoclimatic proxies gleaned from Seneca Lake. New York Glaciogram. 32(2) pg 7.

Halfman, J.D., and numerous undergraduates, 1997, Research Programs at Hobart and William Smith Colleges. 6th Annual Conference of the Finger Lakes – Lake Ontario Watershed Protection Alliance..

Halfman, J.D., and M. Potter*, 1997, A lake-floor scarp at a water depth of 20 meters in Seneca Lake, New York. Was the lake a closed basin in the past? Geological Society of America Annual Meeting Abstracts with Programs.

Halfman, J.D. and D.L. Woodrow, 1997, Stratigraphy, Sedimentology and Geochemistry of Seneca Lake, New York. New York State Geological Association Field Trip Guide, 69th Annual Meeting. New York State Geological Association Annual Field Trip Meeting.

Participant 1997. Reforming Earth and Planetary Science Curricula: What Works? A Project Kaleidoscope Workshop, Whitman College.

Halfman, J.D., 1997, Recent research at Seneca Lake. Christian A. Johnson Foundation Lunchtime Seminar Series, Hobart and William Smith Colleges.

Halfman, J.D., D.T. Herrick*, 1996, Truncation and downslope reworking of varved sediments in Seneca Lake, NY, interpreted from high-resolution (1-12 kHz) seismic profiles. Geological Society of America Annual Meeting Abstracts with Programs.

Ciszkowski*, N.A., **J.D. Halfman**, W.J. Bowyer, 1996, Chemical analysis of glacial and post-glacial sediments of Seneca Lake and its paleoclimatic implications. Undergraduate Research Symposium, Rochester Section of the American Chemical Society Spring Meeting.

Herrick*, D.T., **J.D. Halfman**, 1996, Modern sedimentation processes interpreted from high-resolution (1-kHz) seismic profiles from the northern portion of Seneca Lake. Geological Society of America Northeastern Regional Meeting Abstracts with Programs, v. 28, 64.

Ciszkowski*, N.A., **J.D. Halfman**, W.J. Bowyer, 1996, ICP elemental analysis of Seneca Lake sediments - a paleoclimatic proxy for the Holocene. Geological Society of America Northeastern Regional Meeting, v. 28, p. 45.

1996 Innovative approaches to teaching earth and planetary science - participant. A Project Kaleidoscope Workshop, Franklin and Marshall College.

Halfman, J.D., 1995, Water column dynamics in Lake Malawi: Results of CTD profiling. Lake Malawi Deep Water Sands and Sub-Lacustrine Fan Study, 1995 Sponsor's Meeting.

Halfman, J.D., 1995, Climatic change: Evidence from Lake Turkana, Africa. Department of Geology Seminar Series, Syracuse University, Syracuse, New York.

Ciszkowski*, W.J. Boywer, **J.D. Halfman**, 1995, ICP elemental analysis of Seneca and Cayuga Lake sediments in the study of paleoclimatic indicators. Rochester Academy of Sciences Annual Meeting.

King, J.W., Peck, J.A., Johnson, T.C., **J.D. Halfman**, 1995, The uses of environmental magnetism in paleoclimatic studies of rift lake sediments. Geological Society of America Annual Meeting Abstracts with Programs.

Halfman, J.D. and C.A. Scholz, 1995, Water-Column profiles of conductivity, temperature, dissolved oxygen, pH and turbidity from Lake Malawi (Nyasa), Africa. Geological Society of America Annual Meeting.

Acquisto*, N.L., D.L. Woodrow, **J.D. Halfman**, M.R. Wing, 1995, The impact of the zebra mussel, *Dreissena polymorpha* within Seneca Lake. Geological Society of America Northeastern Regional Meeting Abstracts with Programs.

Halfman, J.D., 1994, Lacustrine sediments as archives of ecological change. US Forest Service and US Environmental Protection Agency Conference on Ecological Classifications and Research, University of Notre Dame, Notre Dame, IN.

Donovan, P., **J.D. Halfman**, J.-F. Gaillard and K.A. Gray, 1993, Collection and characterization of colloids in lakes with diverse chemistries. 16th Midwest Environmental Chemistry Workshop, University of Notre Dame, Notre Dame, IN.

1993 International Symposium on the Limnology, Climatology and Paleoclimatology of the East African Lakes. Jinja, Uganda.

1993 Session Chair, Sediments, 16th Midwest Environmental Chemistry Workshop, Participant, University of Notre Dame, Notre Dame, IN.

1993 Workshop on the In Situ Research using Submersibles and Advanced Underwater Technology in Large Lake Systems. Participant, NOAA National Undersea Research Program.

1993 Coordinated Joint Oceanographic Institutions, Inc. Distinguished Lecture Series at Notre Dame. Roger Larsen, U of Rhode Island.

1992 Paleoclimatic Signals Preserved in Lake Sediments. Department of Civil Engineering and Geological Sciences, University of Notre Dame, Notre Dame, IN.

1992 Coordinated American Association of Petroleum Geologist's Distinguished Lecture Series at Notre Dame. Shea Penland, Louisiana State University.

1991 Paleoclimatology at Lake Turkana, Kenya. Department of Geology, Bowling Green State University, Bowling Green, OH.

1991 Coordinated Charles Edison Lecture Series, University of Notre Dame. Dr. Stephen H. Schneider, National Center for Atmospheric Research, Boulder, CO.

1990 Geological Society of America Penrose Conference on Large Lakes and Their Stratigraphic Record.
1988 American Association of Petroleum Geologists Research Conference on Lacustrine Exploration: Case Studies and Modern Analogs.
1987 Paleoclimatology at Lake Turkana, Kenya. Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY.
Over 20 abstracts presented at national meetings during my stay at Notre Dame

Professional Service:

NSF Review Panelist:
- Major Research Instrumentation Development (MRI) Proposals. 2002 panel.
- Course, Curriculum and Laboratory Improvement (CCLI) Proposals. 2001 panel.

Reviewed Articles:
- Geology; Palaeo^3; Global & Planet. Change; J. of Paleolimn.; Deep-Sea Res.; J. of Great Lakes Res., Sedimentology.

Reviewer Grant Proposals:
- NSF, NOAA, National Geographic Society, American Chemical Society – Petroleum Research Fund.

Coordinator for Best Student Paper Awards:
- Annual Finger Lakes Research Conference, 2005, 2006, 2007.
- North-Central Geological Society of America Annual Meeting

Undergraduate Research: Summer Research, Honors & Independent Study Projects:

Summer Science Undergraduate Researcher Program – Advised or Co-Advised

2014 Genny Moralez, Nikki Andrzejczyk, Katherine Coughlin
2013 Ali Cole, Genny Moralez & Tyler Goldstoff
2012 Laura Carver Dionne, Carli Ellis, Ethan Black, Phillip Hackett
2011 Emily Cummings, Maggie Stewart, Abby Kent, Lucia Melara
2010 Laura Carver Dionne, Emily Cummings
2009 Katherine Hoering, Andrea Rocchio, Kerry O'Neill
2008 Kerry O'Neill, Prabi Basnet, Samuel Georgian, Katherine Hoering
2007 Tara Ware, Evan Brown, Rachael Dye, Casey Franklin, Kerry O'Neil
2006 Rachel Sukeforth, Clancy Brown, Christina Kinnevey, Brittany Holler
2005 Katie Bush, Rachel Sukeforth, Ian West + Co-Advised 9 Keck Students.
2004 John Riina, Douglas Wood, Katie Bush, Clare Morgan
2003 Suzie Opalka, Barbara Beckingham, & Sarah Kostick (Smith College)
2002 Rob Stewart, Cathy Caiazza, & Annie Walker
2001 Sandy Baldwin, Lindsay Bowser, & Laura Calabrese
2000 Sandy Baldwin, Scott Alderman, Natalie Sabuda, & Derith Hart
1999 Jon Rump, Sandy Baldwin, & MaryBeth Giancarlo
1998 Kate Hammontree
1997 Mellisa Potter, Tom Sardell, & Sarah Jones (incoming first year STEM enhancement experience)
1995 Nancy Ciszkowski

Honors Projects – Advised or Co-Advised

Bush, Kathleen, 2006. A Preliminary Study of Water Quality and Water Quality Protection in the Finger Lakes. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 65 pg.

Hintz, Tana, 2004. Water quality survey and policy for the Keuka Outlet. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 52 pg. Co-Advisor: Jim Ryan.

Baldwin, Sandra M., 2002. The effect of meteorological events on chlorophyll-a concentrations. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 39 pg.

Bowser, Lindsey Paige, 2002. Nitrate loading in the Seneca Lake Watershed: Is Hog farming having an effect? Undergraduate Honors Thesis, Hobart and William Smith Colleges. 45 pg.

Etherington, Margaret D., 2002. Influence of sedimentological factors on the distribution of *Diporeia* and *Dreissena* species in Lake Ontario. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 59 pg.

Nicolo, Micah J., 2001. Environmental transition at the end of the Mid-Holocene Hypsithermal: Evidence from the sediment of Seneca Lake. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 54 pg. Co-Advisor: Leah Joseph, Environmental Studies.

Riley, Timothy, C. 2001. Application of the HWS Data Logger to hydrological studies. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 58 pg.

Flusche, Mark A., 2000. The hydrogeochemistry of the northern sedge mat at Zurich Bog, Lyons, NY. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 67 pg. High Honors.
Rumpf, Jon P., 2000. Development of an underwater housing design for use with the HWS Data Logger system. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 104 pg.
McSweeney, Jennifer C.(Cory), 1999. The concentration and source of atrazine in Seneca Lake, New York. Undergraduate Honors Thesis, Hobart and William Smith Colleges. 37 pg.
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Independent Study or Independent Senior Integrative Experience Projects – Advised or Co-Advised

2013 – 2014
- Nutrient loading variability between the Owasco Inlet and Dutch Hollow Brook in the Owasco Lake watershed. Ali Cole
- Nutrient and suspended sediment loading down the Keuka Outlet. Carly Ellis & Willy Weimer
- Hydrogeochemistry of seeps in the Hubbard Brook Research Area. Carly Ellis

2012-2013
- Benthic Ecology & Art, Laura Carver-Dionne
- Nitrogen a preliminary investigation of Finger Lakes ecosystem health, Mary (Molly) George

2011-2012
- Septic Systems in the Owasco Watershed, Emily Cummings and Maggie Stewart
- Rainfall variability in the Finger Lakes Region, Kevin Guay
- Plastic Trash in the Oceans, Jonathan Meyers
- Nutrient Loading from Castle, Wilson, Kashong & Keuka Outlet, Emily Thurston

2010-2011
- Nutrient Loading from Castle, Wilson, Kashong & Keuka Outlet, Laura Carver Dionne
- Major Ions of the Finger Lakes, Samantha Lesser & Brittany Simon
- Sarah Bates & Jacob Schreiber

2009-2010
- Nutrient Loading from Castle, Wilson, Kashong & Keuka Outlet, Laura Carver Dionne & Katherine Perri
- Precipitation, Nutrient Loading & Water Quality in the Finger Lakes, Katherine Hoering
- GIS Hydrological Modules in Honeoye Watershed, Ryan Whitehouse
- Monitoring Castle, Wilson, & Kashong Creeks with AquaTroll Sensors, Katherine Premo & Kaitlyn Van Nostrand
- Nutrient loading from Castle, Wilson, & Kashong Creeks, Kaitlyn Van Nostrand
- Thinking Outside the Sink, Water use at HWS, Kerry O'Neill
- Landforms, K-12 Case Study, Alison Rodman

2008-2009
- Invasive Plant Species – Bryan Harris
- Water Use on the HWS Campus; A drive towards Sustainability – Kerry O'Neill
- Mercury in Seneca Lake Sediments – April Abbott

2007-2008 – A sabbatical year.
- A decade of increasing productivity in the Seneca Lake Watershed, Casey Franklin.
- Water Quality in Owasco Lake Watershed, Evan Brown.
- A comparison of Finger Lakes Water Quality, Robert Gugliuzzo.
- Phosphates in Cayuga Lake Bottom Waters, Tara Ware.

2006-2007
- Nutrient loading of Owasco Lake, Heather Philip.
- Environmental history, myths and other Stories from the north country of New Hampshire, Michelle Dodge.
- Fisheries of Seneca Lake, Steven Dwyer.

2005-2006
- 100 years of increasing salt in the Finger Lakes, Rachel Sukeforth & Kathryn Parrinello.
- Seasonality in Stream Major Ion Concentrations, Nicole Dudley, Kathryn Warner, Heather Philip.
- Public Access to the Finger Lakes, Emily Corcione.
- Water Quality of the Finger Lakes. Kathleen Bush.

Sustainable Living and Modern House Designs. Gill Carr.
Alternative Energy Sources and the Finger Lakes Environment. Ryan Williams.
Hazardous Waste and Environmental Justice in the Finger Lakes Region. Courtney Wilson.

2004-2005

Evaluation Water Quality in the Finger Lakes. Marissa Madej.
Land use in the Finger Lakes Region. Laura Evans.
E. coli and Total Coliform Bacteria in the Finger Lakes. Kate Bush.
Policy Issues in the Finger Lakes. Meredith Trainor.
Introductory GIS. Caitlin Rogers, Lisa White, Alyssa Carlson, Katie Clifford.
High Resolution Seismic Profiles from Keuka Lake. Linda Hafner.
High Resolution Seismic Profiles from Otsego Lake. Doug Wood.
High Resolution Geochemical Variability in Seneca Lake & Wilson Creek. Phil Place.
Odell's Pond Hydrogeochemistry (year long project). John Riina.
K-6 Educational Outreach for the Finger Lakes Institute. Kate Kana.
Finger Lake Hydrogeochemistry. Rachel Sukeforth.

2003-2004

Odell's Pond Hydrogeochemistry. John Riina, Colby Moore & Emily LaDuka.
Environmental Ethics in Patagonia. Ted Wilson.
Introductory GIS. Elizabeth Reed.
Water quality survey of the Keuka Outlet. Tana Hintz.
Westport River Watershed Alliance Internship. Nicole Vance.
The impact of invasive species on the fisheries of Seneca and the Great Lakes. Colby Moore.

2002-2003 Academic Year (On Sabbatical)

Fecal Coliform bacteria in the Seneca Lake Watershed. Jennifer McDonald.
Phase II Storm water regulations. Brad Griffith.
Stream bank erosion in the Seneca Lake Watershed. Pat Hennessey.
Regulation and Monitoring of Water Resources, Falmouth, Cape Cod, MA. Sonya Smith.
Science on Seneca Teacher Modules. Gail Reynolds working with Tara Curtin.
Seneca Lake Bottom Water Salinity over the past Decade. Emily LaDuca.
Plankton Diversity and Distribution in Seneca Lake. Ted Wilson.
Salinity diffusion fluxes through the sediment in Seneca Lake, Rob Stewart.
Demographic trends in the Seneca Lake Watershed 1990 –2000, Victoria Henderson.

2001-2002 Academic Year

American foreign policy regarding the acquisition of oil. Colin Hayes.
The distribution of chemical and other spills in the Seneca Lake Watershed. Tom Williamson.
Drilling for Natural Gas in the Finger Lakes National Forest. Laura Calabrese.
Biological indicators of aquatic pollution – A biological field guide. Molly Etherington.
Should we clean up Onondaga Lake? Caroline Miller.
Hydrology of Wilson Creek, NY. Andrew Dibble.
GIS Applications in Watershed Hydrology. Sandra Baldwin.
Hydrogeochemistry of Wilson Creek, NY. Meghan Zarnetske.
Pesticides in the Seneca Lake Watershed. Sebastian Mineo.
Drilling for Gas in the Finger Lakes National Forest. Thomas Williamson.
Reducing SO_2 Emissions at Greenidge Coal Power Plant. Trevor Rees & Jason Yehle
Environmental Justice in Geneva, NY. Amy Dundas.

2000-2001 Academic Year

The sodium budget for Seneca Lake. Scott Alderman.
Geoscience in secondary education II. JR Anderson.
Save the Seeds. Natalie Sabuda.
Zebra Mussel impact on Sport Fisheries. Rob Gould.
Wetland Delineation Methods. Rob Gould
Onondaga Lake Cleanup. Bryan Gallacher
Seneca Lake Watershed Planning. Monifa Samad, Meghan Carty.
GIS and Hydrological Applications. Alderman, Hart, Riley.

1999-2000 Academic Year

Recording stream stage – tests of an inexpensive data logger. Tim Riley.
Geoscience in secondary education. JR Anderson
Zebra Mussels – a present update. Scott Alderman.
The hydrochemistry of selected streams in the Seneca Lake Watershed. Sandy Baldwin

Sand sheets and the sedimentology of eastern Lake Ontario, Ben Hobbs. Co-Advisor – Don Woodrow.
Limnology of Seneca and selected Adirondack Lakes. Alderman, Baldwin, Driscoll, Giancarlo, Hart, Nicolo, Riley, Rumpf, Vandemoer.
The pH of rainfall in central New York. Jay Freeman.

1998-1999 Academic Year
Geochemical signals of climate change. Laura Cotton.
Pig Farms in the Seneca Lake Watershed. Honors Project, Tara Spitzer. (continues into Fall '99).
Stream quality and landuse connections, Jon Rumpf, Cory McSweeney.
Limnology of Seneca Lake. Alroy, Dominick, Farr, LeBoutillier, Vandemoer.
Pictorial view of environmental concerns. Amy Woodland.
Recycling in Ontario County. Amy Collins.

1997-1998 Academic Year
GIS integration into Environmental Geology Laboratories, Ben Hobbs.
Roadside Erosion in the Seneca Watershed, Ellen Lauterbach.
Limnology of Hanley Property Lakes, Katie Maloney, Katie Morse and Allie Burke.
Calcium Budget for Seneca Lake, Jay Christensen and Nate Kranes.
Limnology of Seneca Lake. Maloney, Farnung, Christensen, Went, Kranes.
Limnology of Seneca Lake – An Educational / Public Policy Primer. Katie Maloney.
Zurich Bog Hydrogeochemistry, Tom Sardella & Sarah Jones.
Seismic Reflection Profiles, Southern Seneca Lake, Melissa Potter.

1996-1997 Academic Year
GIS and Seismic Reflection Data. Bob Dedrick & Chuck Mayers.
A Web Site for Science on Seneca. Chuck Mayers.
Environmental Impact of Guardian Glass Factory Plant, Geneva NY. B. Walsh.
Watershed Analysis and Management, Seneca Lake II, P. Bass & M. Dodson.
Urban Development of Seneca Lake through photography. Poly Gibbins-Neff.
Limnology of Seneca Lake, Zurich Bog, Odell Pond & Hanley Preserve Ponds Herrick, Bass, Dedrick, Fiori, Lamana, Nuzzo, Prout, Pulver, Maloney, Gibbons-Neff, Babaian, Bond, Lesniak, Sardella.
Seismic Facies Analysis - Northern Seneca Lake, Jeff Butts.
Low dissolved oxygen concentrations in Maine Lakes, Matt Sicchio.

1995-1996 Academic Year
Seismic Reflection Profiles, Northern Seneca Lake, Damian Herrick.
Basin Hydrology: A Data-Base Approach, Seneca Lake, Shawn Skelly.
Turbidity Plumes, Seneca Lake, D. Bozzuto & Jennifer McKnight.
Zebra Mussel Population Densities, Seneca Lake, Ethan Prout.
Composting Sewage Sludge, Geneva Facility, Alex MacArthur.
Watershed Analysis and Management, Seneca Lake, P. Bass, S. Firth & M. Dodson.

1994-1995 Academic Year
Kashong Creek Watershed Management, John Muhlfeld.
Limnological Impact of Zebra Mussels, Nadine Acquisto & David Cohn.
Zebra Mussels, Scientific Controls & Economic Implications, David Tuveson.
Geochemical Signals of Sedimentation, Seneca Lake, D. Herrick & S. Skelly.
Sediment Processes offshore of Kashong Creek, D. Bozzuto & Jennifer McKnight.
Environmental Water Chemistry of Kashong Creek, Sean Delaney.

Web Site Development at Hobart and William Smith's Web Site.
Finger Lakes Institute Site
Department of Geoscience Site
Environmental Studies Site
HWS Scandling (Explorer) Site
Science On Seneca – High School Outreach Site
Information Technology & Communications took over the upkeep of these sites a few years back.

Recent Additions to Halfman's Professional & Research Interests Web Site
Finger Lakes Limnological Results Site

EXHIBIT B

Exhibit B

A 2014 Update on the Chloride Hydrogeochemistry in Seneca Lake, New York.

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12/10/2014

Introduction:

Seneca Lake is the largest of the 11, elongated, north-south trending, Finger Lakes in central and western New York State (Fig. 1). It has a volume, surface area, watershed area, and maximum depth of 15.5 km^3, 175 km^2, 1,621 km^2 (including Keuka watershed), and 188 m, respectively (Mullins et al., 1996). The lake basins were formed by glacial meltwaters eroding and deepening former stream valleys underneath the retreating Pleistocene Ice Sheet cutting into the Paleozoic sedimentary rocks approximately 10,000 years ago. Each basin was subsequently filled with a thick deposit of glacial tills and a thin veneer of pro-glacial lake clays. Basins not completely filled with sediment (e.g., Tully Valley), were subsequently filled with water and slowly accumulating postglacial muds. Seneca Lake is classified as a Class AA water resource by the New York State Department of Environmental Conservation (NYS DEC), except for a few locations along the shore (http://www.dec.ny.gov/regs/4592.html, Halfman et al., 2012). It supplies drinking water to approximately 100,000 people in the surrounding communities.

Berg (1963) and Schaffner and Oglesby (1978) noted that chloride concentrations were significantly larger in Seneca Lake, and to a lesser extent in Cayuga Lake, than the other Finger Lakes. Wing et al. (1995) argued that the elevated chloride concentrations required an extra source of chloride beyond the measured fluvial fluxes to the lake. They expanded and substantiated arguments by Berg (1963) and Ahrnsbrak (1975), and hypothesized that the extra source of chloride originated from the Silurian beds of commercial grade rock salt (Halite) some 450 to 600 m below the lake's surface. Measured concentration gradients in the sediment pore waters indicated that chloride diffuses into the lake from the lake floor.

Seismic reflection profiles revealed an extensive thickness of glacial till that filled half of the basin down to the bedrock floor under Seneca Lake. The bedrock floor is deep enough to intersect the Silurian beds of rock salt (Mullins and Hinchey, 1989, and Mullins et al., 1996). The most likely location for this intersection is not well defined, but projected to be located under the northern portion of the lake based on a uniform 1° southerly dip of the bedrock and the depth profile of the basin's bedrock floor. Wing et al. (1995) hypothesized that this connection provided an avenue for brine to migrate from these rock salt beds into these two lakes, and not the other Finger Lakes (Fig. 2).

Exhibit B

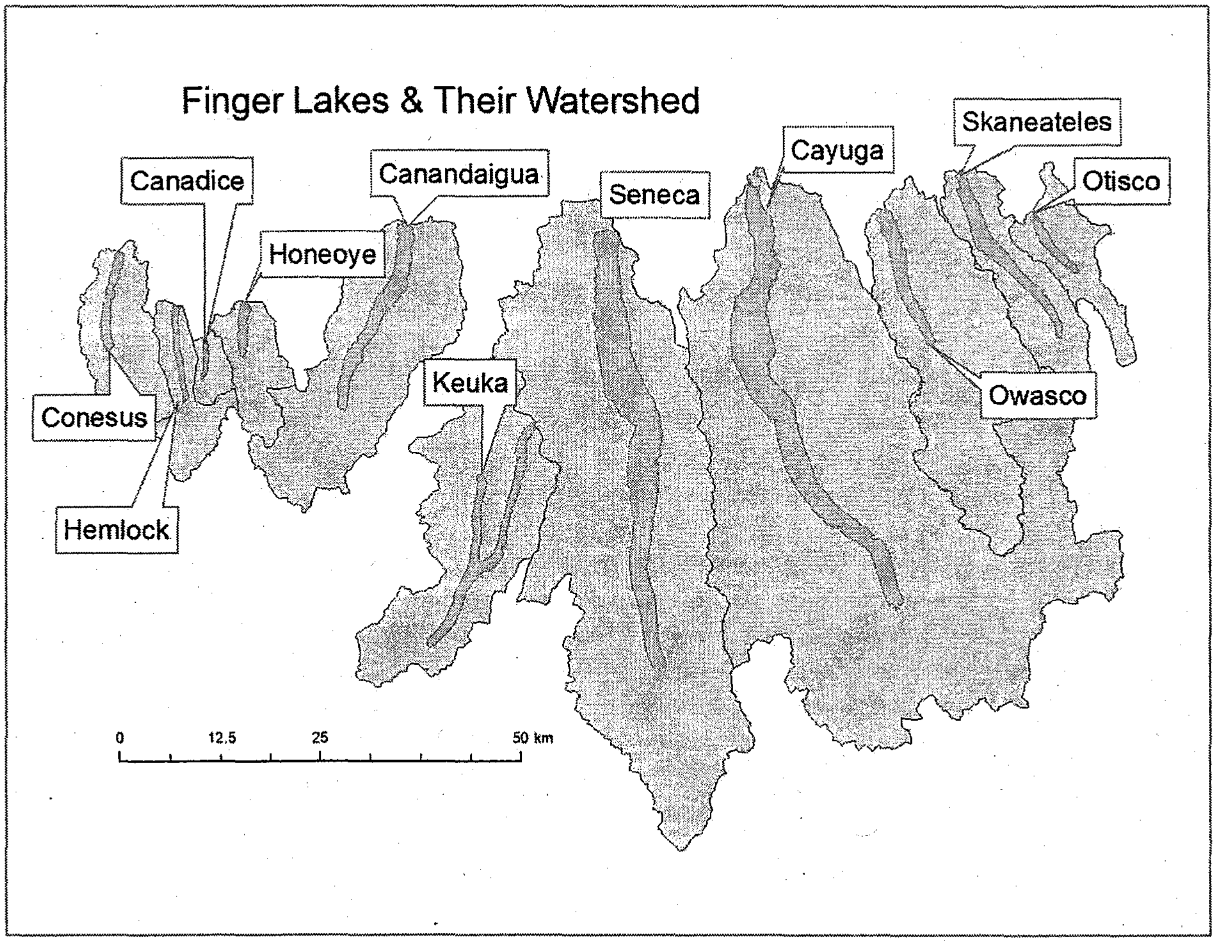

Fig. 1. The Finger Lakes & their watersheds.

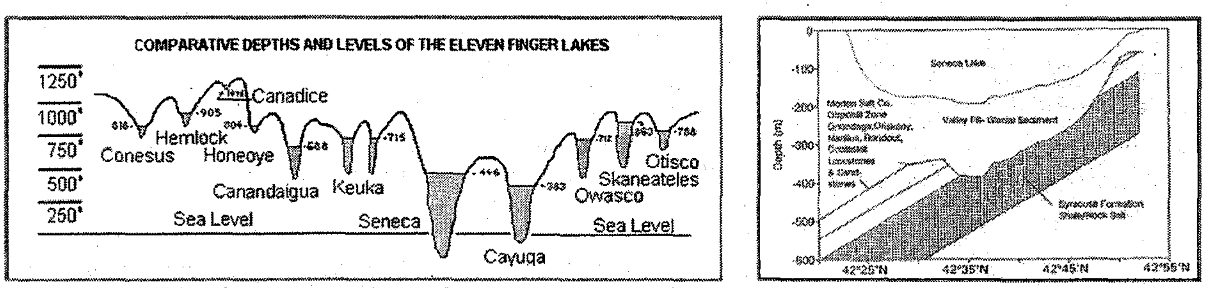

Fig. 2. The depths of the Finger Lakes and connections to the Silurian rock-salts under Seneca Lake (modified from Wing et al., 1995).

Callinan (2001) offered an alternative hypothesis. He noted a decline in sodium concentration since the 1970s to the late 1990s in Seneca Lake and speculated that the decline may reflect changes in analytical accuracy and precision, and/or a decline in the discharge of brine water waste from the salt mines located near Watkins Glen along the southern shores of Seneca and Cayuga Lakes. However, Wing et al. (1995) calculated that the presumed 3,500 kg/day discharge of chloride to Seneca Lake by the mines would only increase chloride concentrations by a few mg/L in Seneca Lake. Thus, an extra groundwater source of chloride was still necessary to explain the larger concentration in Seneca Lake.

Exhibit B

Halfman et al. (2006) expanded the major ion investigation of Seneca Lake to include all of the major ions: chloride, sulfate, sodium, potassium, calcium and magnesium. No horizontal spatial-scale trends in major ion concentrations were observed in the well-mixed lake. Vertically, the epilimnion (surface waters) was slightly less saline than the hypolimnion (bottom water). Mass-balance calculations subdivided the major ions into three populations. Chloride, sodium, and to a lesser extent sulfate, were up to four times greater in the lake than the streams (Cl^- 140 *vs.* 33 mg/L, Na^+ 80 *vs.* 20 mg/L, SO_4^{2-} 40 *vs.* 30 mg/L, respectively). Thus, these ions required another source to attain the concentration detected in the lake. Conversely, calcium and magnesium were more concentrated in the streams than the lake and required a mechanism to remove a portion of these ions from the lake (Ca^{2+} 60 *vs.* 42 mg/L, Mg^{2+} 17 *vs.* 11 mg/L, respectively). Finally, the fluvial flux of potassium was at equilibrium with the lake. The mean molar ratio of chloride and sodium for all the analyses was nearly 1:1, suggesting a common Halite (NaCl) source for these two ions. All of these observations were consistent with a substantial groundwater source to explain the elevated concentration detected in the modern lake.

Steady-state conditions are crucial, if Seneca Lake is to remain a potable drinking water supply for nearly 100,000 people in the region. The EPA's total dissolved salt (TDS) drinking water advisory concentration is 500 mg/L, and 250 mg/L for chloride (EPA 822-S-12-001, 2012). The drinking water advisory concentration for sodium is between 30 and 60 mg/L, and the threshold is lowered to 20 mg/L for those on low-salt diets (<500 mg/day) and newborn infants (EPA 822-R-03-006, 2003). NYS DEC regulations use the 250 mg/L limit for chloride and 20 mg/L for sodium as drinking water guidelines (http://www.dec.ny.gov/regs/4590.html). Thus, any increase in the current chloride (122/128 mg/L, surface/bottom) and/or sodium concentrations (75/79 mg/L) for the lake would be a concern, as sodium already exceeds its 20 mg/L drinking advisory limit. This report updates the major ion hydrogeochemistry of Seneca Lake focusing on the chloride data collected and discovered since the earlier publications.

Methods:

Since 2000, surface water samples for major ion analysis were routinely filtered through a 0.45 µm HA Millipore or 0.45 µm glass fiber filters at four lake sites (1-4) located at the northern end of the lake as part of the Finger Lakes Institute's monitoring program of Seneca Lake (Fig. 3). Bottom water samples, approximately 1 to 5 m above the lake floor, weather permitting, were collected at the two deeper, mid-lake sites, 1 & 3, and processed in an identical manner. When funding was available, surface and bottom samples were collected from at least five additional sites that follow a mid-lake transect down the central axis of the lake (one or more full-lake cruises occurred during 1989, 1999, 2011 and 2014). A state-of-the-art SeaBird SBE-25 CTD (conductivity, temperature and depth profiler) water column profile of temperature, specific conductance (proportional to salinity), pH, dissolved oxygen, fluorescence (chlorophyll indicating algal abundance), turbidity, and PAR (light availability) was also collected at each site along with other limnological parameters. The SBE-25 replaced a SeaBird SBE-19 in 2006. Water samples were also collected and analyzed from up to 17 streams in the Seneca Lake watershed focusing on base-flow and not rain/runoff event samples. Sample frequency of each stream varied from once or twice a year in the late spring to weekly samples throughout the year

Exhibit B

in selected subwatersheds during the 1999 to 2014 monitoring program depending on the availability of funds.

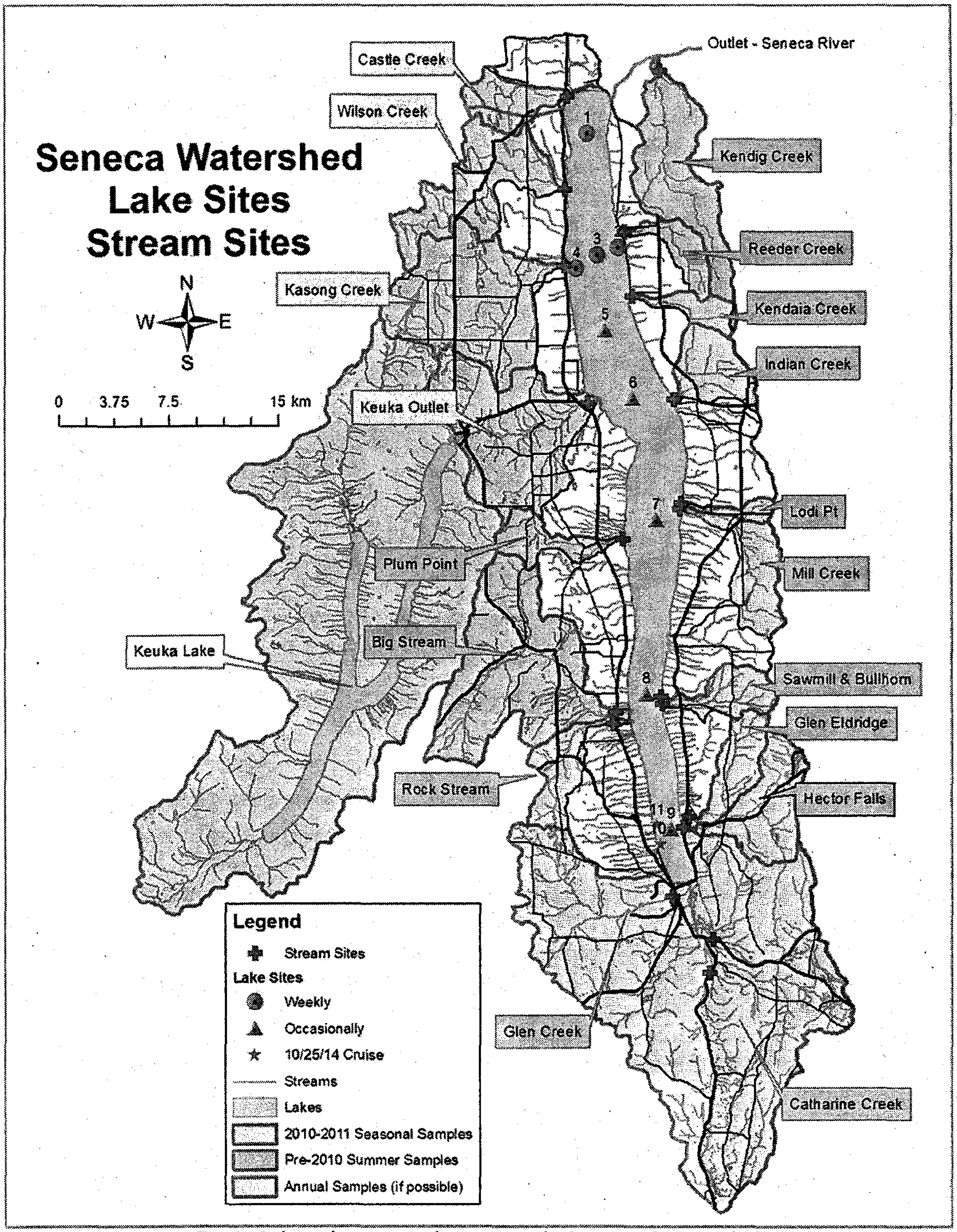

Fig. 3. Lake and stream site locations in the Seneca Lake watershed.

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The filtrate was saved in pre-rinsed Nalgene bottles and typically stored at 4°C until analysis for major anions (chloride, sulfate) and cations (sodium, potassium, magnesium and calcium) by Ion Chromatograph (IC, Dionex DX-120). The IC protocol uses a standard anion column (AS14) and bicarbonate eluent for anions, and a standard cation column (CS12A) and methane-sulfonic acid eluent for the cations. The accuracy, measured by the mean difference between the result from analyzing samples and their known concentrations during each run, typically averaged less than 1 mg/L, and precision, measured by the standard deviation of three or more runs of the same sample, averaged 0.2 mg/L. Before 2000, and on subsequent checks in the field, chloride was analyzed by a silver nitrate titration using a potassium chromate indicator (LaMotte PSC-DR). All water samples were analyzed for total alkalinity (primarily bicarbonate ion, HCO_3^-) by titration with sulfuric acid using a phenolphthalein and bromocresol green/methyl red indicator in the field (LaMotte WAT-MP-DR). Both titration techniques revealed an average precision of 4 mg/L. The average difference in the anion/cation charge balance was 0.5 meq/L, approximately 10% of the total charge, and deviations were probably due to the less precise alkalinity data.

In addition to the work on Seneca Lake, monthly surface and bottom water samples and CTD casts were also collected from a minimum of two sites during the May to October field season in Honeoye, Canandaigua, Keuka, Cayuga, Owasco, Skaneateles and Otisco Lakes starting in 2005 (Fig. 1) These samples were processed in an identical manner. This dataset was augmented with data from the literature (Berg, 1963, Schaffner and Ogelby, 1978, Wing et al., 1995, Callinan, 2001, Halfman et al., 2006), and are all graphically presented below.

Century-scale chloride data were also discovered for Seneca, Cayuga, Hemlock & Canadice, and Skaneateles Lakes. These data are reproduced with permissions from the Hemlock Water Quality Laboratory for the City of Rochester, Oneonta County Water Authority for the City of Syracuse, and Glenn Jolly, USGS, Reston (Jolly, 2005, Jolly, 2006, Jolly, 2012, Sukerfort & Halfman, 2005, 2006, Sukerfort et al., 2006). All of these lakes supply water to neighboring communities, e.g., Geneva, Ithaca, Rochester & Syracuse, and water providers measure chloride and other potential contaminants in the water to ensure the conveyance of potable drinking water. The century-scale data are a challenge to find as they are typically buried within water quality reports that may or may not have been archived, and reporting regulations changed over time. I am grateful for the hard work by Glenn Jolly, who dug through Cornell's archives for the Seneca Lake, Cayuga Lake, Fall Creek and Keuka Outlet data. I am also grateful to the Hemlock Water Quality Laboratory and the Oneonta County Water Authority for their data that they gave to me and/or my students (e.g., Sukerforth).

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Results & Discussion:

Lake Concentrations: The salinity of Seneca Lake is still dominated by chloride, sodium and bicarbonate ions (Table 1. Fig. 4). The mean major ion concentrations in the lake, averaging the 2000 through 2013 data, are 128 for Cl (as Cl), 77 for Na (as Na) and 105 mg/L for bicarbonate (as $CaCO_3$) for a total dissolved solids concentration of 390 mg/L. These chloride and sodium concentrations equate to 1.98 million and 1.19 million metric tons of Cl and Na, respectively, dissolved in Seneca Lake (assuming a lake volume of 15.5 km^3). A significant event must happen to change the concentration of chloride or sodium in Seneca Lake. For example, instantaneously adding 100,000 metric tons of chloride to the entire, well-mixed, lake will only increase the chloride concentration from 128 to 135 mg/L (Table 2). Over 1 million tons must be added to increase the lake's concentration to 190 mg/L. Conversely, adding 50 cm of rain to the lake will only decrease the epilimnetic chloride concentration of 128 to 125 mg/L assuming an epilimnetic thickness of 30 meters, a lake surface area of 175 km^2 and no inputs from streams. The epilimnetic chloride concentrations decrease to 120 mg/L, assuming 40% of the precipitation over land enters stream runoff and eventually the lake, and this event-based runoff dilutes the stream mean major ion concentrations by 40%. However, these percentages require additional verification to more accurately represent these parameters in the Seneca Lake watershed. Please note: These relatively sudden changes, when not sustained over time, will only impact the lake concentration for a few decades because concentrations will exponentially return back to its original equilibrium concentration in time (50 to 100 years in Seneca Lake).

Table 1. Mean major ion concentrations in the Seneca Lake watershed (2000-2013 data).

	Chloride (mg/L)			Sulfate (mg/L)			Sodium (mg/L)			Potassium (mg/L)			Calcium (mg/L)			Magnesium (mg/L)		
Lake Sites	Average	StDev	N	Average	StDev	N	Average	StDev	N	Average	StDev	N	Average	StDev	N	Average	StDev	N
Site 1S	128.0	7.5	242	34.4	3.5	240	77.0	4.4	243	3.6	1.4	242	38.8	3.3	242	11.1	1.0	242
Site 2S	127.4	7.5	224	34.4	3.0	222	76.5	4.3	222	3.6	1.4	222	39.0	3.0	221	11.1	1.0	221
Site 3S	126.9	7.0	223	34.3	2.9	221	76.1	4.8	224	3.6	2.0	224	38.9	3.0	223	11.1	1.3	223
Site 4S	127.7	7.9	233	34.6	3.3	231	76.6	4.6	231	3.5	1.6	232	39.1	3.1	231	11.1	1.0	230
Site 1B	128.2	7.3	239	34.5	3.2	237	77.0	4.6	238	3.7	1.4	237	39.7	3.1	237	11.1	1.0	237
Site 3B	130.2	7.2	225	35.0	3.0	223	78.4	4.5	223	3.6	1.4	224	40.7	2.5	222	11.1	1.0	222
Stream Sites																		
Glen	14.6	3.3	7	21.0	16.0	7	11.7	2.7	7	1.9	0.5	7	38.0	3.9	7	9.1	3.2	7
Rock Stream	35.0	13.8	13	20.4	16.4	13	21.3	8.3	12	3.0	1.4	12	40.2	19.0	12	13.1	11.0	12
Big Stream	39.6	11.1	43	23.3	9.5	43	23.1	6.2	41	2.8	1.0	41	48.9	7.4	41	13.2	3.5	41
Plum Pt.	77.1	31.7	43	39.3	12.5	43	39.6	16.5	40	3.5	1.5	40	56.6	14.1	40	16.4	3.8	40
Keuka	33.8	12.9	124	26.5	7.7	124	19.8	6.8	122	3.5	1.5	122	42.1	11.8	122	13.0	5.5	122
Kashong	45.7	11.8	118	33.9	9.4	118	23.4	6.1	113	4.5	2.3	114	71.6	20.4	112	24.8	8.9	113
Wilson	55.3	17.6	110	36.0	13.1	110	28.6	8.0	109	5.3	1.7	108	82.4	17.9	110	25.8	6.1	110
Castle	148.0	113.2	71	35.5	12.0	72	80.8	50.7	71	4.6	1.5	72	79.7	19.3	72	23.8	6.7	72
Kendig	38.1	9.8	40	41.5	12.0	40	21.5	11.1	38	3.2	1.1	38	70.2	20.5	38	21.5	7.5	38
Reeder	45.0	20.2	52	41.2	12.4	52	31.9	12.6	52	3.7	3.7	52	81.9	20.7	52	17.0	5.5	52
Kendaia	36.1	19.7	11	35.9	17.9	11	23.5	13.0	11	3.3	1.8	11	70.8	20.8	11	14.8	5.3	11
Indian	35.2	17.3	11	40.7	19.7	11	16.5	5.2	11	2.8	1.2	11	72.8	10.3	11	17.8	5.6	11
Lodi Pt.	48.5	23.5	3	29.1	17.4	3	34.0	4.9	3	4.1	1.0	3	66.4	38.6	3	19.5	4.3	3
Mill Cr	7.6	2.3	8	17.6	8.4	8	8.8	2.3	6	1.9	0.8	7	31.0	17.7	7	8.2	4.7	7
Bullhorn	40.4	11.9	9	31.8	17.3	9	22.3	5.8	9	3.0	1.5	9	62.9	9.1	9	13.1	4.7	9
Sawmill	18.1	13.1	13	23.3	14.2	13	13.9	7.4	11	2.5	1.6	11	53.4	26.2	11	11.5	6.0	11
Glen Eld.	12.3	4.0	12	21.0	14.0	12	8.5	2.3	11	1.9	1.0	11	44.7	12.8	11	9.4	3.8	11
Hector Falls	18.2	3.3	11	15.1	12.2	11	12.8	3.1	11	1.9	1.2	11	43.3	5.6	11	9.9	3.3	11
Catharine	29.4	10.1	17	13.9	2.7	17	22.1	5.2	17	3.8	1.2	17	49.7	11.5	17	12.8	3.6	17
Average Lake	128.1	7.4	231.0	34.5	3.1	229.0	76.9	4.5	230.2	3.6	1.5	230.2	39.4	3.0	229.3	11.1	1.1	229.2
St Dev Lake	1.1	0.3	8.2	0.3	0.2	8.2	0.8	0.2	8.8	0.0	0.2	8.2	0.7	0.3	8.8	0.0	0.1	8.8
Maximum Lake	130.2	7.9	242.0	35.0	3.5	240.0	78.4	4.8	243.0	3.7	2.0	242.0	40.7	3.3	242.0	11.1	1.3	242.0
Minimum Lake	126.9	7.0	223.0	34.3	2.9	221.0	76.1	4.3	222.0	3.5	1.4	222.0	38.8	2.5	221.0	11.1	1.0	221.0
Average Stream	40.9	18.4	37.7	28.8	12.9	37.7	24.4	9.4	36.6	3.2	1.4	36.7	58.2	16.2	36.7	15.5	5.4	36.7
St Dev Streams	30.8	24.1	40.0	9.2	4.2	40.0	16.0	10.7	39.3	1.0	0.7	39.3	16.2	8.1	39.3	5.4	2.0	39.4
Maximum Streams	148.0	113.2	124.0	41.5	19.7	124.0	80.8	50.7	122.0	5.3	3.7	122.0	82.4	38.6	122.0	25.8	11.0	122.0
Minimum Streams	7.6	2.3	3.0	13.9	2.7	3.0	8.5	2.3	3.0	1.9	0.5	3.0	31.0	3.9	3.0	8.2	3.2	3.0

Exhibit B

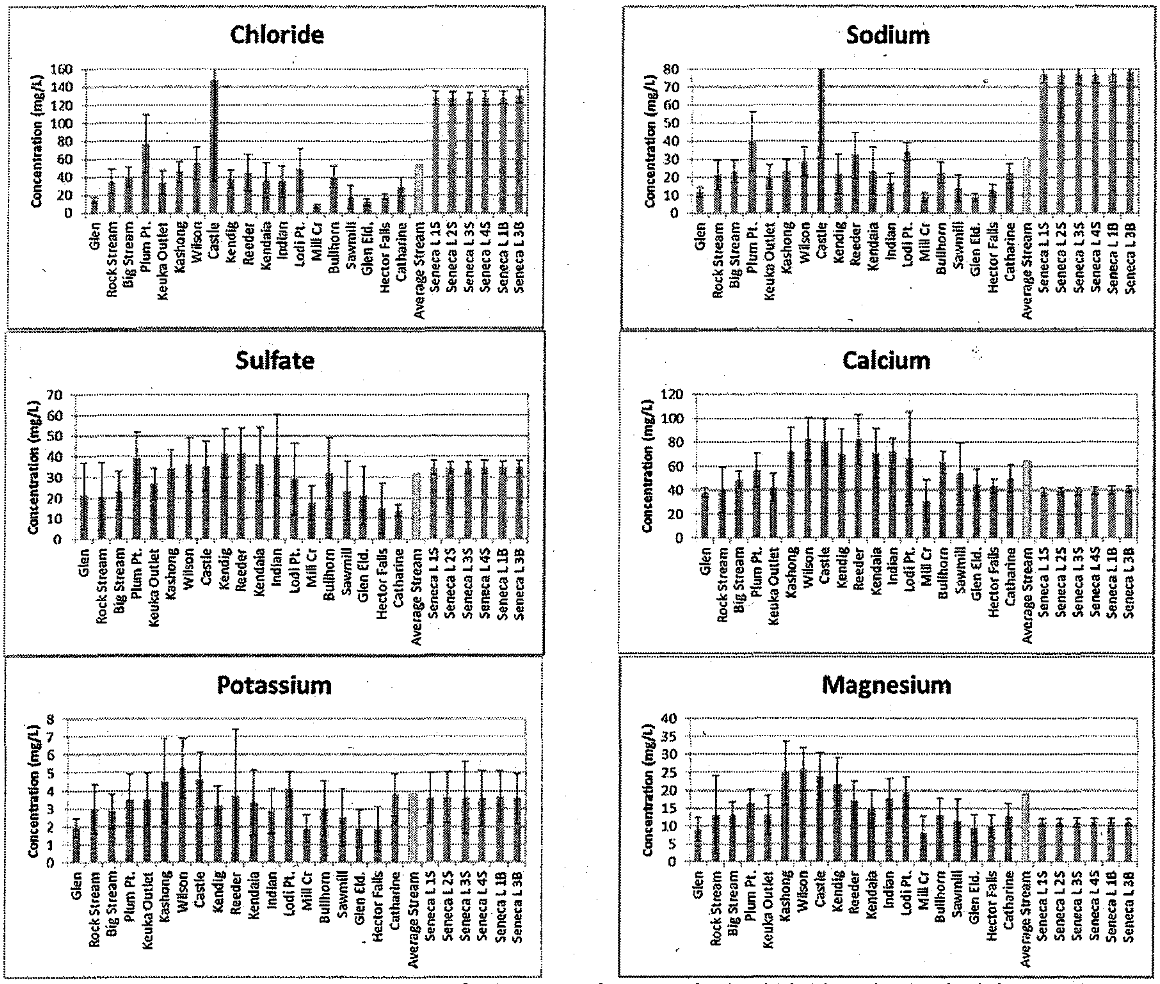


Fig. 4. Mean major ion concentrations in the Seneca Lake watershed (2000-2013 data). The lake samples are highlighted in orange, stream samples in blue and the mean stream value in light blue. The error bars are the 1 σ deviation about the mean for each site.

Calcium (as Ca, 39 mg/L), sulfate (as SO_4, 34 mg/L), magnesium (as Mg, 11 mg/L) provide the bulk of the remaining major ions in the lake with minor amounts of potassium (as K, 4 mg/L). The total dissolved solids (TDS) concentration in Seneca Lake of 390 mg/L is larger than the mean TDS of 235 mg/L for other Finger Lakes (240 mg/L), but all are below the drinking water advisory level of 500 mg/L and 100 times less saline than sea water (35,000 mg/L). These concentrations are typically slightly smaller than those reported in Wing et al. (1995) and Halfman et al. (2006).

Samples from a recent full-lake cruise on October 25, 2014 were also run for sodium, chloride and specific conductance at both Halfman's research lab and a commercial lab, Community Science Institute, Inc. (Table 3, see appendix). Each lab reported slightly different values, with the CSI lab results slightly larger than Halfman's lab. The mean difference between the two labs was 7 mg/L for Cl, 5 ppm for Na, and 22 μS/cm for specific conductance. The differences may reflect different analytical techniques. The on-site specific conductance data measured by a hand-held probe (Oakton CON 410 Series) aboard the ship was 11 μS/cm smaller

Exhibit B

than that measured by the CTD. A CTD value was estimated by averaging all data within the upper 10 m and lowest 10 m in each cast for comparison to the surface and bottom water samples. This methodology may have induced the reported difference. Please note: These differences are small, are focused on a small range of data, and most importantly, are always proportional. The best correction is between Halfman's on-site specific conductance results and the CTD ($r^2 = 0.99$). Thus, any conclusions based on one data set should be mimicked by data from the other lab. This report focuses on the IC results from Halfman's lab due to its known precision and accuracy and more importantly, for comparison to Halfman's earlier data from Seneca and the neighboring Finger Lakes.

Table 2. Chloride concentrations after inputs of chloride and rainfall.

Entire Lake Chloride Concentrations with One Time Slug of Chloride

	Original & Resulting Lake Concentration (mg/L)						
Cl Load (tons)	100	120	128	140	160	180	200
1,000	100	120	128	140	160	180	200
10,000	101	121	129	141	161	181	201
100,000	106	126	134	146	166	186	206
1,000,000	165	185	193	205	225	245	265

Epilimnion Chloride Concentrations with One Time Slug of Chloride

	Original & Resulting Lake Concentration (mg/L)						
Cl Load (tons)	100	120	128	140	160	180	200
1000	100	120	128	140	160	180	200
10000	102	122	130	142	162	182	202
100000	119	139	147	159	179	199	219
1000000	290	310	318	330	350	370	390

Epilimnion Chloride Concentrations with Rain

	Original & Resulting Lake Concentration (mg/L)						
Rain (cm)	100	120	128	140	160	180	200
10	100	120	128	140	159	179	199
20	99	119	127	139	159	179	199
30	99	119	127	139	158	178	198
40	99	118	126	138	158	178	197
50	98	118	126	138	157	177	197
60	98	118	125	137	157	176	196

Epilimnion Chloride Concentrations with Rain and Runoff

	Original & Resulting Lake Concentration (mg/L)						
Rain (cm)	100	120	128	140	160	180	200
10	99	119	127	138	158	178	198
20	98	117	125	137	156	176	195
30	97	116	124	135	154	174	193
40	96	115	122	134	153	172	190
50	95	114	121	132	151	170	188
60	94	112	120	131	149	168	186

Mean chloride, sodium and to a lesser extent sulfate concentrations in Seneca Lake were three or more times larger than those from Honeoye, Canandaigua, Keuka, Cayuga, Owasco, Skaneateles and Otisco Lakes (Table 4, Fig. 5). The other major ions reveal similar concentrations between all the sampled Finger Lakes. This pattern is consistent with the earlier results and still suggests that Seneca Lake has a unique additional source for its chloride and sodium ion concentrations.

Table 4. Mean major ion concentrations in the Finger Lakes region (2005-2013 data).

	Chloride	Sulfate	Sodium	Potassium	Magnesium	Calcium	Alkaninty
Lake	Cl mg/L	SO4 mg/L	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	CaCO3 mg/L
Seneca	126.4	32.7	75.7	4.4	11.4	38.3	105.0
Honeoye	19.5	9.0	14.9	3.1	7.3	23.1	99.6
Canandaigua	31.6	19.2	21.1	3.9	11.9	39.0	140.4
Keuka	23.2	18.9	15.7	3.8	10.1	30.2	111.5
Cayuga	40.8	27.0	26.9	4.4	11.4	40.9	130.8
Owasco	17.1	10.9	13.9	3.5	9.2	40.0	146.4
Skaneateles	13.7	12.8	10.5	2.9	8.0	35.6	125.3
Otisco	29.6	12.8	20.9	3.5	11.3	42.0	147.3

Exhibit B

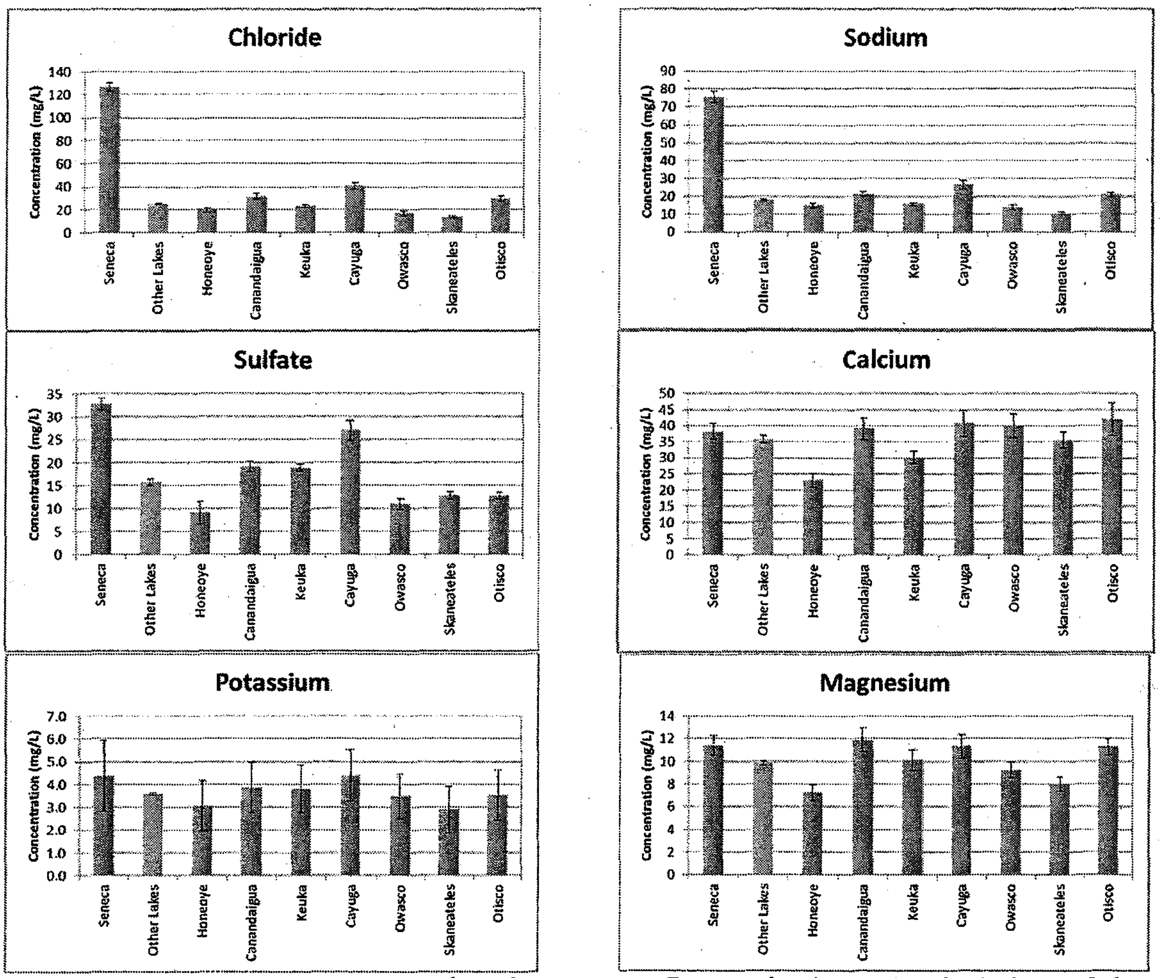


Fig. 5. Mean major ion concentrations in the eight easternmost Finger Lakes (2005-2013 data). Seneca Lake is highlighted in orange, and the mean concentration for all the other Finger Lakes is highlighted in green. The error bars are the 1 σ deviation about the mean for each lake.

Within Seneca Lake, surface lake concentrations revealed minimal (< 1 mg/L) spatial variability, especially within the northern end of the lake (Fig. 4). The occasional entire lake cruises also revealed similar uniformity over the lake's surface and thus indicates that the epilimnion is well-mixed by waves and surface currents. Base flow stream inputs are also quickly homogenized into the lake. Lake concentrations were consistently measured as close as 10 to 100 m from the stream mouth, except during the largest flood events, and highlights the relatively small inputs by streams compared to the quantity of ions in and volume of the lake. The data also revealed slightly larger concentrations with increasing depth in the water column with a maximum increase in chloride and sodium concentrations between the surface and bottom water samples of 15 and 10 mg/L, respectively, at the deepest sites (7 & 8) offshore of Lodi Point. Chloride, sodium and sulfate explained 85 to 90% of the increase in concentrations along the deepest lake floor. The lake-wide surface uniformity and slightly elevated concentrations at the deepest depths is consistent with the earlier results. Samples collected offshore of the US Salt outfalls near Watkins Glen on the 10/25/2014 cruise did not reveal any significant spatial changes. In conclusion, input of saline or fresh water to Seneca Lake is apparently quickly

Exhibit B

mixed throughout the lake. Significant "issues" along the southern shores will impact lake water at the northern end. It implies that we all share the same lake.

Seneca Lake CTD specific conductance (proportional to salinity) profiles from 10/25/2014 revealed a similar uniformity across the epilimnion (Fig. 6). Vertically, two notable increases in salinity were detected, an increase in salinity from the well-mixed epilimnion to the hypolimnion, and another increase in salinity from the lower hypolimnion to the lake floor at only at the deepest sites offshore of Lodi Point (Sites 7 & 8). Please Note: Internal seiche activity forced the shallower thermocline depths, and boundary between the epilimnion and hypolimnion, towards the southern end of the lake.

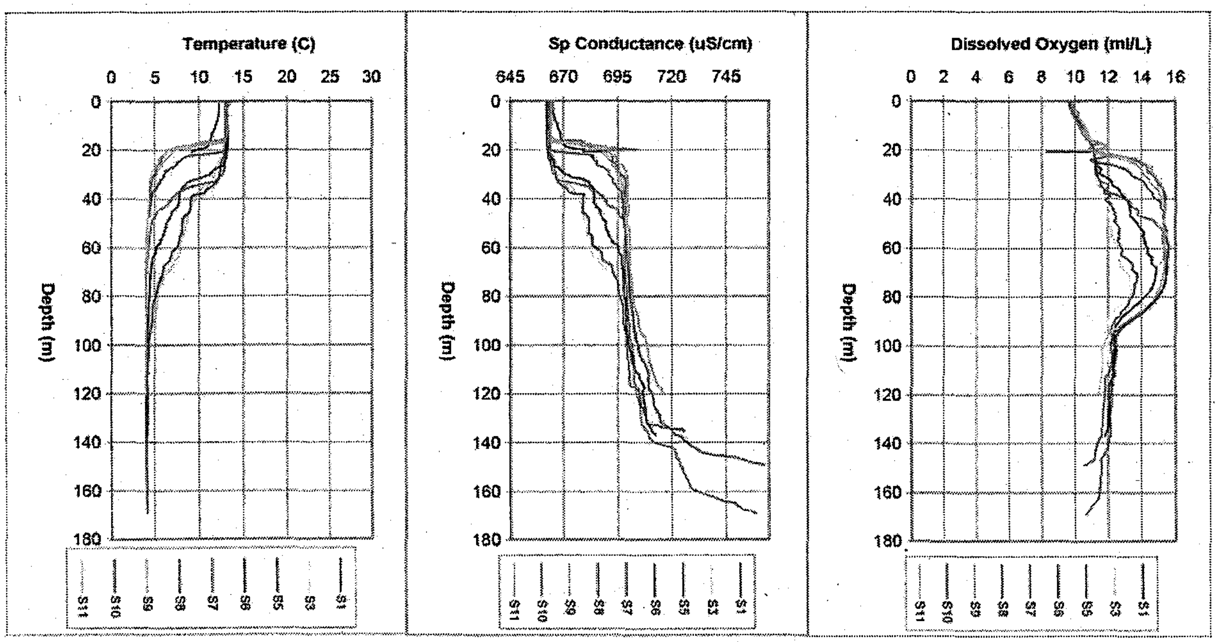


Fig. 6. CTD temperature, specific conductance, and dissolved oxygen profiles from the 10/25/2014 full-lake cruise.

A systematic seasonal decrease in epilimnetic (surface water) salinities by approximately 50 μS/cm (~20 mg/L) occurred each year during the stratified summer seasons. The CTD profiles revealed uniform concentrations with water depth during the isothermal spring. With the onset of thermal stratification, the epilimnion salinity increasingly decreased through the summer season (Fig. 7). This concentration difference would dissipate during the breakdown of the thermal stratification in the fall. The epilimnetic decrease in salinity during summer stratification is interpreted to reflect the dilution of the epilimnion by less saline rainfall and surface runoff. The seasonal decrease is consistent with adding ~50 cm of rain to the lake. However, other unknown factors may come into play because the year-to-year decrease does not correlate with seasonal or annual rainfall totals from Geneva, NY assuming Geneva rainfall is representative of the entire watershed. Specific conductance in the hypolimnion remained relatively constant each year, except in the deepest portions of the lake. This uniformity is counter to earlier statements made by Wing and his coauthors (1995), but is consistent with the data presented in their manuscript. Subsequent mixing due to the fall – spring overturn yields a salinity somewhere between the end of summer epilimnion and hypolimnion concentrations. It is proportionally closer to the hypolimnion salinity because the hypolimnion is approximately

Exhibit B

twice as large as the typical epilimnion (~10 vs 5 km^3, respectively). Finally, the observed multiyear decrease and uniformity is counter to a significant source of salts from the lake floor.

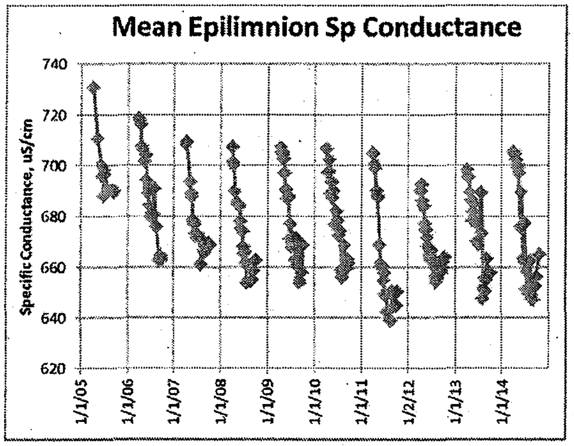


Fig. 7. Daily mean epilimnetic specific conductance data (2005-2014 data).

The salinity in the deepest water typically increases by ~50 µS/cm above an otherwise relatively uniform salinity throughout the hypolimnion. The lake floor increase, when observed, is consistent with the measured increase in TDS. The increase in salinity starts approximately 30 to 40 meters above the lake floor and progressively increases towards the lake floor. Data are not available to determine if this lake floor increase dissipates during overturn. I believe that it dissipates each year, because overturn clearly overcomes a similar late fall salinity gradient between the epilimnion and hypolimnion, and the density differences across both salinity gradients are similar and very small (0.0002 g/cm^3). In comparison, the change in density from the epilimnion to the hypolimnion due to a temperature difference of 18°C (early summer) is ten times larger, 0.002 g/cm^3.

A number of mechanisms can create the increase in salinity near the lake floor. The accumulation of ions could be from the natural biogeochemical decomposition of organic matter at or near the sediment-water interface, and is consistent with the observed slight decrease in dissolved oxygen concentrations and increase in bicarbonate species. The ions could also result from the accumulation of occasional inputs of saline water to the lake, either through natural seeps or human-induced inputs. Its greater density and gravity would transport and maintain the layer at the deepest depths in the lake over time. It is impossible to estimate the volume of this layer without more accurate bathymetric maps of the lake floor. However, I suspect that the amount of chloride in this layer was too small in this layer to reflect the quantity of groundwater chloride required to achieve the hypothesized groundwater flux of chloride to the lake (Wing et al., 1995, Halfman et al., 2006). Also, the available specific conductance profiles have not revealed increasing salinities in either the epilimnion or hypolimnion over time. Perhaps groundwater inputs have recently ceased.

Stream Concentrations: Stream mean major ion concentrations were dominated by bicarbonate (180 mg/L as $CaCO_3$), calcium (64 mg/L as Ca), chloride (62 mg/L as Cl), sulfate (36 mg/L as SO_4), sodium (35 mg/L as Na), magnesium (21 mg/L as Mg), and finally potassium (4 mg/L as K). The stream concentrations were more variable between streams (± 24.1 mg/L for Cl) and over time in any one stream than the lake sites (± 7.4 mg/L for Cl, Table 1, Fig. 4). For example, subwatershed mean chloride concentrations were largest in Castle (148 mg/L) and Plum Point (77 mg/L) Creeks and smallest in Mill Creek (7 mg/L) with no systematic change across the watershed. Sodium concentrations paralleled the chloride trends.

Exhibit B

In a comparison of Castle, Wilson, Kashong, Plum Point, Big Stream and Catharine Creeks, the watershed road density correlated to their mean chloride concentrations ($r^2 = 0.9$). Presumably streams with more roads per unit area received more road de-icing salts. Castle Creek drains the City of Geneva. Its large chloride concentrations and large variability in concentrations is interpreted to reflect its urban subwatershed. Plum Point drains an abandoned salt mine (Morton-Himrod Site) which had, when active, working salt piles and brine ponds. It also drains the watershed with the second largest road density. Both issues probably contributed to its larger chloride concentrations.

Calcium, magnesium, alkalinity, and sulfate concentrations were progressively larger towards the northern end of the Seneca Lake watershed. The trend parallels the distribution of limestone bedrock in the watershed and more importantly, more limestone in the glacial tills and soils underlying these watersheds.

Temporal variability in the major ion concentrations in each stream is large as well. For example, the range in chloride concentrations was up to 600 mg/L in Castle Creek, but was under 100 mg/L in the other creeks with adequate data. The variability was mostly attributed to sampling during and just after the application of road de-icing salts and storm events. De-icing salts enter the streams after the snow and ice melts. In contrast, storm events and the associated surface runoff would dilute the base-flow/groundwater contributions of the major ion population.

The differences between the lake and streams concentrations in Seneca Lake still differentiate the major ions into three groups: (1) chloride, sodium and sulfate, (2) calcium and magnesium, and (3) potassium. The concentration of chloride, sodium, and to a lesser extent sulfate are much larger in the lake than the streams. Whereas as calcium and magnesium concentrations are much smaller in the lake than the streams, and potassium concentrations are relatively uniform, ie., means are within 1 standard deviation, across the watershed. To quantify these differences and investigate the potential additional sources and sinks for the first two groups of ions beyond the modern day fluvial inputs, ion flux and mass balance calculations were performed (after Harte, 1988, Halfman et al., 2006). The mass balance calculations assumed equilibrium, steady-state conditions, i.e., the stream and lake concentrations, fluxes of each ion into and out of the lake, and fluxes of water into and out of the lake, were constant over time.

Ion Fluxes:

Fluxes for each ion from each subwatershed were calculated using the following equation:

$$Fluvial\ Flux\ In_{ion} = SC_{ion} \times Q_{inflow}$$

Where:
$Fluvial\ Flux\ In_{ion}$ is flux of each ion to the lake by each subwatershed (mtons/year),
SC_{ion} is the mean stream concentration of each ion in each subwatershed (mg/L), and
Q_{inflow} is the annual runoff of water from each subwatershed to the lake (m^3/year).

Mean ion concentrations were used, recognizing this value will be high because it is primarily base-flow data. For any subwatershed without major ion data, the average of the mean concentrations from the two nearest neighboring subwatersheds was used to preserve the spatial variability in the major ion concentrations observed across the entire watershed. The stream flow for each subwatershed was assumed proportional to the total inflow to the lake (863 x 10^6 m^3/yr) by subwatershed area. The total flux for each ion to the lake was therefore the sum of the individual fluxes from each subwatershed (Table 5).

The flux of any ion from the lake was calculated:

$Flux\ Out_{ion} = LC_{ion}\ x\ Q_{outflow}$

Where:

$Flux\ Out_{ion}$ is the flux of each ion out of the lake (mtons/year),

LC_{ion} is the mean lake concentration for each ion (mg/L), and

$Q_{outflow}$ is the annual flow of water through the outlet (760 x 10^6 m^3/year).

The unknown or extra flux to balance the mass budget was calculated:

$Extra\ Flux_{ion} = Fluvial\ Flux\ In_{ion} - Flux\ Out_{ion}$.

Where:

$Extra\ Flux_{ion}$ is the required flux of each ion to balance the budget (mtons/year).

Finally, the theoretical; lake concentration based on these fluxes were calculated:

$Lake_{Conc} = (Flux_{ion} / Q_{out})\ x\ 1\ x\ 10^6$.

Where:

$Lake_{Conc}$ is the theoretical ion concentration in the lake (mg/L),

$Flux_{ion}$ is the total/partial flux of each ion to the lake (mtons/year), and

Q_{out} is the annual outflow of water through the outlet (760 x 10^6 m^3/year).

Table 5. Fluxes of chloride and sodium in the Seneca Lake watershed.

	Chloride	Sulfate	Sodium	Potassium	Calcium	Magnesium
Measured Mean Lake Concentration (mg/L)	128.0	34.4	76.9	3.7	39.3	11.1
Measured Mean Stream Concentration (mg/L)	54.4	31.9	30.7	3.9	64.4	18.9
Total Influx - Sum Individual Stream Inputs (metric tons/yr)	33,765	21,776	20,333	3,038	45,048	12,723
assumes Q = 863 million m3/yr						
Total Efflux Out (metric tons/yr)	97,306	26,164	58,453	2,791	29,887	8,439
assumes Q = 760 million m3/yr Winf et al., 1995						
Annual Unaccounted Influx/Efflux (metric tons/yr)	(63,541)	(4,387)	(38,120)	247	15,161	4,284
Mean Annual Combined Mine Waste (metric tons/yr)	9,204		5,968			
Unaccounted Flux after including fluvial and mine inputs	(54,337)		(32,152)			
Estimated Lake Concentrations (mg/L)						
a- Stream Input Alone	44.4	28.7	26.8	4.0	59.3	16.7
b- With 3,500 kg/day Cl Mine Waste*	46.1		27.8			
c- With 26,000 kg/day Cl Mine Waste*	56.9		34.9			

*Sodium calculation assumes molar 1:1 ratio with Cl

Mean Annual Combined Mine Wastes (metric tons/yr)
Cargill Waste Stream Avg Cl: 7,550 kg/day, Oct 97 - May 14
US Salt Waste Stream Avg Cl: 18,450 kg/day, Oct 99 - May 14 Pipes 1&2
Combined Cl: 26,000 kg/day

Theoretical lake concentrations were first calculated assuming the only ion source was from the fluvial fluxes. This was done to compare the theoretical concentrations to the actual lake concentrations, and determine which ion requires an additional source to the lake, which ion required a sink from the lake and which ion is in equilibrium with the lake. These steady-state, equilibrium calculations assumed a discharge of water into (863 x 10^6 m^3/yr) and out of (760 x 10^6 m^3/yr) the lake used by Wing et al. (1995) and again by Halfman et al. (2006). Please note: The recent discharge data out the outlet measured by the USGS Gauge 04232739 at Seneca Falls are smaller than the outflow used previously and used in this report. The mean annual discharge measured at Seneca Falls from 2006 to 2013 was 592 x 10^6 m^3/year, with a range from 407 x 10^6 to 973 x 10^6 m^3/yr. Continuous stream discharge data were also not available for any subwatershed, except for the Keuka Outlet, a stream influenced by precipitation/runoff and the outlet gates for Keuka Lake. Finally the lake's bathymetry, thus lake volume, is poorly constrained because the available bathymetric data are old. Despite these issues, I doubt if the theoretical concentration results will significantly change from those presented here because the theoretical concentrations are based on the ratio between inflow and outflow, and this ratio will probably not significantly change.

The present day fluvial fluxes support a steady-state, theoretical, chloride concentration of 44 mg/L and sodium concentration of 27 mg/L. These concentrations are similar to the measured concentration of chloride and sodium in the other Finger Lakes. It suggests that the fluvial inputs measured in this watershed are sufficient to explain the concentration of these two ions in the other Finger Lakes. The small differences between the other lakes could result from different road densities and road salt inputs, or a slightly different evaporation to inflow ratio. A weak correlation is found between the road density and mean chloride concentration in the Finger Lakes after excluding Keuka Lake ($r^2 = 0.4$). The Finger Lake residence times and watershed to lake surface area ratios vary between lakes as well but only water residence times weakly correlates to chloride concentrations ($r^2 = 0.3$); watershed to lake surfaces areas do not correlate ($r^2 = 0.0$).

The flux of chloride and sodium to the lake is also influenced by mine wastes. The mean annual discharge of chloride and sodium from the two salt mines near Watkins Glen are available on the EPA ICS web site (Cargill Salt Inc., NPES NY0002241 and US Salt LLC – Watkins Glen Refinery, NPES NY0002330). The web sites tabulate monthly maximum and/or average concentration, flow and/or loading data starting in the late 1990s. The sodium flux from the mines were calculated from the chloride numbers assuming a 1:1 molar ratio with chloride (Table 5).

The mine fluxes were added to the fluvial fluxes for chloride and sodium to determine the contribution to another theoretical lake concentration. Please note: these calculations overestimated the chloride and sodium contribution from the salt mines because some of the mine waste water started as lake water thus the mine waste effluent included existing ions that were already in the lake and new ions from the mine operations. If the lake chloride is excluded from these calculations, then the mine loads should be reduced to 80% of the reported values, and the theoretical concentrations due to the combined fluvial and mine waste inputs should be reduced to 95% of the reported values. The difference in the percentage from 80 to 95% reflects the addition of a constant fluvial flux to a reduced mine waste flux. Unfortunately, the majority of the EPA ICS data lacked concentration and flow data. Therefore, this reduction was not included in this report.

The theoretical chloride concentration for Seneca Lake increased from 44 to 57 mg/L and sodium increased from 27 to 35 mg/L after adding the mean annual EPA ICS reported flux of chloride and sodium from the two salt mines. Even these concentrations are significantly below the current concentrations measured in Seneca Lake (128 and 77 mg/L, respectively). Clearly, the lake must have a significant extra source of chloride and sodium, presumably from a groundwater source, as reported by Wing et al. (1995) and later substantiated by Halfman et al. (2006). Alternatively, some other process could be at work in Seneca Lake.

The theoretical calculations also highlight the following: (1) the lake gains an extra 54,000 metric tons of chloride, 32,000 metric tons of sodium and 4,400 metric tons of sulfate each year from another, non-fluvial, source (or sources) to attain their measured concentrations in the lake; (2) carbonate precipitation removes 22,000 metric tons of calcium and 6,100 metric tons of magnesium each year from the water column to attain the measured concentrations in the lake; and (3) the lake is at equilibrium with the measured fluvial inputs of potassium. This grouping is identical to the earlier publications. However the additional data typically increased the concentrations and the fluvial and mine waste fluxes reported earlier (Halfman et al., 2006).

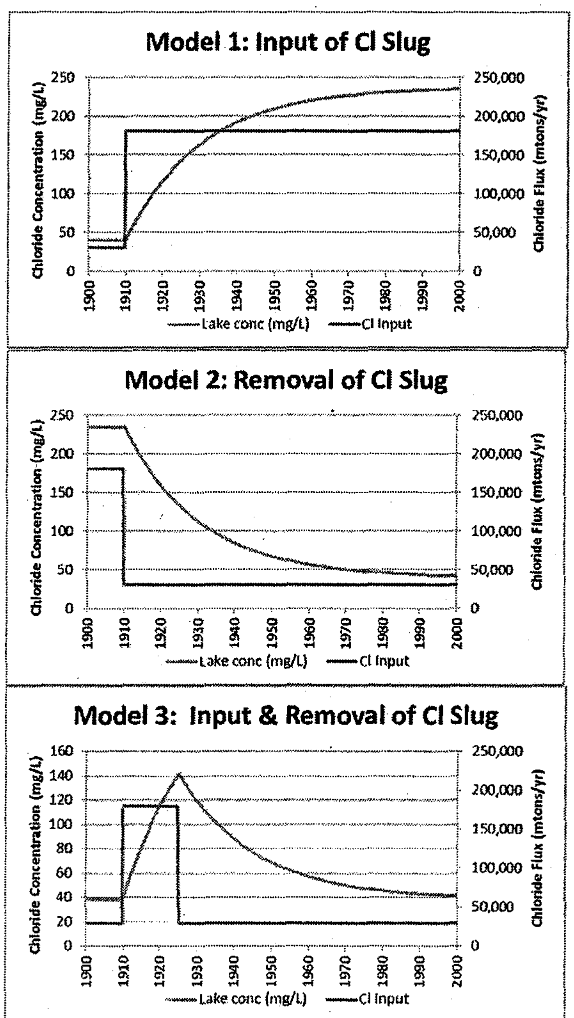


Fig. 8. Modeling Seneca Lake chloride concentrations with three different inputs of chloride.

These theoretical calculations are only valid in steady-state systems, i.e., the ions in the lake must be at equilibrium. This means that the ion inputs and output must be equal and the lake concentrations cannot vary. Three models will help explain this concept (Fig. 8). These models used the assumed hydrology for Seneca Lake to investigate the addition or removal of chloride in a stepwise manner.

Model 1: If the annual flux of chloride to the lake increased in 1910 by five times the original input of ~30,000 mtons/yr to a total influx of 180,000 mtons/yr, then the chloride concentration in the lake would exponentially increase from a concentration of 40 mg/L to a steady-state, equilibrium concentration of 240 mg/L. The right-hand, nearly horizontal portion of the lake concentration curve reveals its approaching to a steady-state concentration. More importantly, the concentration increase is not instantaneous. It takes over 100 years (or greater than five times the water residence time) to exponentially achieve the equilibrium concentration in this lake.

Model 2: If the annual flux of chloride decreased from ~180,000 mtons/yr in 1910 by 150,000 mtons/yr to the 30,000 mtons/yr "original input" of chloride used in the first example, then the chloride concentration in the lake would exponentially decrease from 240 to a steady-state concentration of 40 mg/L, and more importantly, the freshening would take time, over 100 years in this lake.

Model 3: If the original chloride influx of 30,000 mtons/yr was instantaneously increased in 1910 by five times the original input, but this extra annual input only persisted for 10 years and not for the remaining run as the earlier two models, then chloride concentrations would increase exponentially from 40 mg/L to a peak of 140 mg/L in 1925, and then return to the original concentration of 40 mg/L about 100 years later. Notice, the lake never reaches equilibrium concentrations with the extra input of chloride because the total flux of chloride was reduced before it could reach equilibrium. The model eventually attained equilibrium concentrations near the end of the model run.

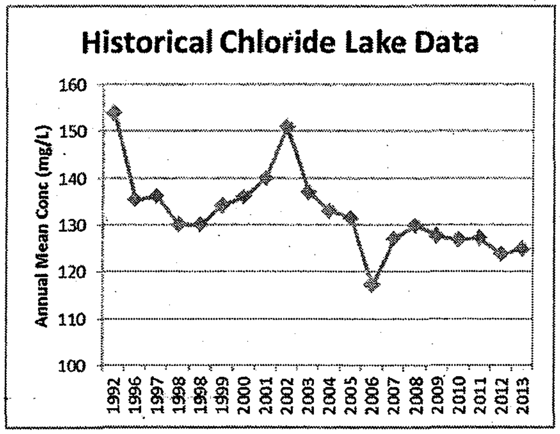
These three models suggest that the present day chloride concentration in Seneca Lake could be explained by a one-time addition of a large slug of chloride many years ago, an amount larger than the current fluvial, mine waste and other inputs to the lake. The current lake's concentration could then be influenced by the equilibrium-striving decrease in lake concentrations from the addition of this slug as well as the fluvial and mine waste inputs. The critical factors are the relative quantities of a slug and fluxes to and from the lake as well as the lake's residence time and initial concentration. Thus, it is critical to know the history of chloride in the basin. Was chloride in Seneca Lake at steady-state, i.e., in equilibrium over time? The answer is yes, if the lake had constant chloride concentrations over time. The answer is no, if the concentrations changed over time.

Decade-Scale Chloride Concentration Trends:

Chloride concentrations do change in Seneca Lake on decade- and century-scale time scales. On the decade-scale, annual mean chloride concentrations decreased from 1992 to today (Fig. 9). Annual averages were used to remove any seasonal trends. It was not a uniform decrease over time. Annual mean chloride concentrations remained between 130 and 140 mg/L from 1992 to 2001, rose to 150 mg/L in 2002 and decreased since to 125 mg/L in 2013 with a noticeable dip to 117 mg/L in 2006. The annual mean epilimnetic CTD specific conductance data also consistently decreased from 698 μS/cm in 2005 to 672 μS/cm in 2014, earlier data are not available. The potential drivers for this decade-scale decrease in salinity are numerous and include increased rainfall, decreased road salt application and associated fluvial fluxes, increased removal of chloride by the outlet, decreased loading by the salt mines, decreased salt production by the salt mines, and/or some other unknown factor.

Annual precipitation measured by the Cornell's New York State Agricultural Experiment Station in Geneva, NY, revealed variable annual and seasonal precipitation accumulations since 1901 (Fig. 10). The annual precipitation pattern does not correlate with the chloride data ($r^2 < 0.01$). No correlation is detected when using annual precipitation data from the Penn Yan Airport either ($r^2 = 0.02$). However, perhaps these two weather stations are not representative of precipitation totals over the entire lake, as annual rainfall at these two sites does not co-vary as well. Thus, more work is necessary to quantify rainfall patterns and totals over the Finger Lakes region.

Exhibit B



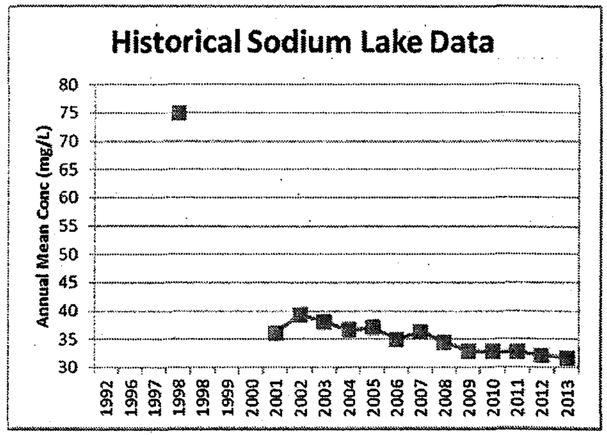


Fig. 9. Annual mean chloride and sodium concentrations in Seneca Lake since 1990.

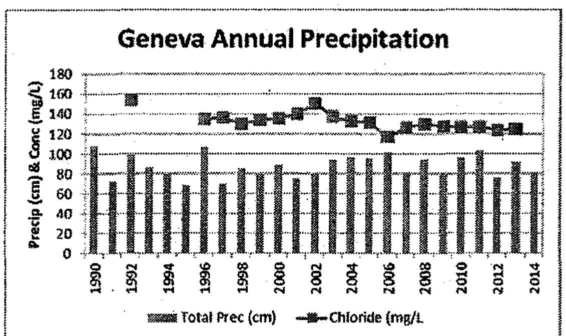


Fig. 10. Annual mean precipitation totals from Agricultural Experiment Station in Geneva, NY.

Unpublished historical chloride concentrations for Fall Creek, which flows into Cayuga Lake, and Keuka Outlet, which flows into Seneca Lake, increased from < 10 mg/L before 1960, to 10 & 20 mg/L in the 1980s and to 20 & 30 mg/L after the 1990s (Jolly, 2012). A parallel increase in chloride concentration over the past 15 years was also detected in other streams in the Seneca watershed and other Finger Lakes (see subsequent discussion, Fig. 14). These trends are consistent with the known, two-step, increase in road de-icing salt tonnages supplied to municipalities throughout the northeast and a parallel increase in stream chloride concentrations throughout the northeast during the 1960s and 1990s (e.g., Goodwin et al., 2003, Robinson et al., 2003). It indicates that fluvial sources of chloride increased over time to Seneca Lake, presumably by the increased use of road salts. This hypothesized increase in fluvial fluxes however, are counter to the decade-scale decrease in chloride concentrations in Seneca Lake.

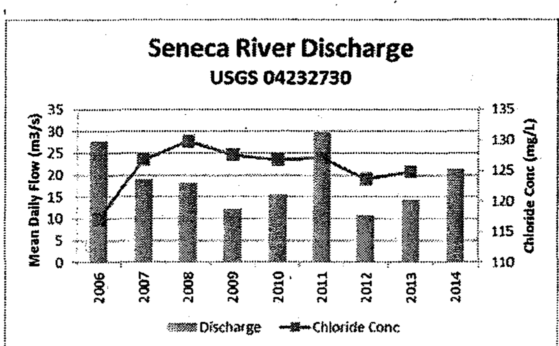


Fig. 11. Annual mean daily outflow discharge from Seneca Lake.

The outlet removes, on average, 592 x 10^6 m^3/year of lake water. Thus, 75,800 metric tons of chloride and 45,500 metric tons of sodium are removed, on average, by the outlet each year (Fig. 11). The range in the chloride flux from the lake was 40,000 to 120,000 metric tons/yr for chloride and 25,000 to 71,000 metric tons/yr for sodium using the measured annual variability in the outflow and the annual mean chloride and sodium concentrations in the lake. The annual chloride fluxes out of the lake do correlate to the chloride concentrations in the lake, as expected, as the calculated fluxes equal the concentration times the discharge ($r^2 = 0.9$). The annual discharges themselves however, do not correlate to the mean annual lake chloride concentrations

Exhibit B

($r^2 = 0.1$). Thus, the outlet removes the chloride available in the lake but does not appear to control the chloride concentration.

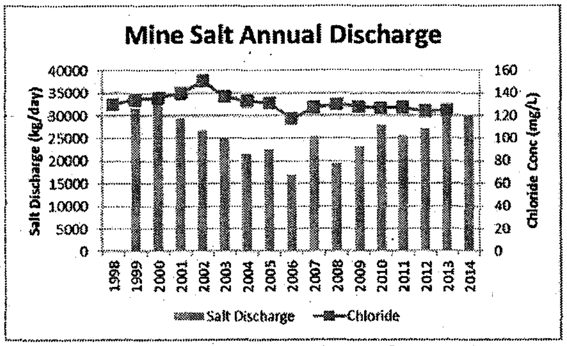


Fig. 12. Annual mean salt-mine discharge of waste chloride and sodium to the lake from the two salt mines near Watkins Glen.

The combined chloride loading from the two salt mines near Watkins Glen decreased from 1999 through 2006 from approximately 34,000 kg/day to 17,000 kg/day, and then returned to 1999 loads (30,000 kg/day) by 2014 (Fig. 12, EPA ICS web site). This pattern however does not directly co-vary with the chloride data ($r^2 < 0.1$) but reveals a weak correlation when the salt loads are compared to the following year's chloride data ($r^2 = 0.3$). The lag is expected because the modeled change in the lake's concentration happens after a change in the inputs or outputs, but the delay should be a few more years in this lake.

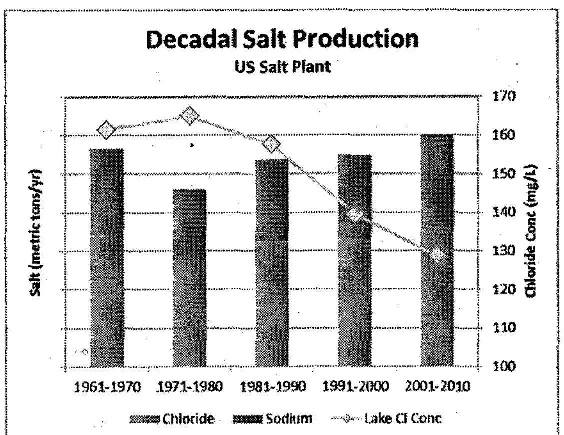


Fig. 13. Decadal mean mine production data from US Salt, Watkins Glen. The units for salt production are omitted due to their proprietary nature.

Finally, salt production may influence the input of salt to the lake (Fig. 13). A presumed increased in fluid pressures applied to the salt caverns for additional salt production may induce more salt seepage into the lake from the bedrock. However, decadal salt production data from US Salt at Watkins Glen starting in the 1960s negatively correlates to the decadal average salt concentration in the lake ($r^2 = 0.5$). Unfortunately, Cargill was unwilling to provide salt production data.

Thus, the observed 20-year decline in chloride concentrations does not correlate to the available annual rainfall totals, fluvial records of road salt loads, Seneca River outflow, salt mine waste discharge rates, and the available salt mine production data. Perhaps a number of these processes combined to generate the observed decrease in chloride concentrations in the lake. Unfortunately, these signals are too short to isolate the specific contributions of each. The decrease in chloride concentrations over the past few decades however, indicates a more important conclusion. The chloride concentrations in the lake and chloride inputs and outputs are not at equilibrium, i.e., not at steady-state in this watershed as previously assumed.

This suggests two non-steady state possibilities to explain the long-term changes in chloride concentrations in the lake. The lake may be becoming fresher with time after a large amount of salt was added a few decades earlier despite the increase in fluvial sources, and/or the seepage of salt from the ground may have decreased over time. If either are true, then the decade-scale correlations are probably not critical because the record would be dictated by

Exhibit B

another, more influential control. Long-term, century-scale records are required to investigate these possible mechanisms.

Century-Scale Chloride Concentration Trends:

Two groups of chloride trends are evident in the available long-term data. Data from Hemlock, Canadice, Canandaigua, Keuka, Owasco, Skaneateles and Otisco Lakes revealed increasing chloride concentrations over time (Fig. 14). The three longest data sets in this group revealed a small (a few mg/L) increase in the 1960s. All of the data sets note a second, more pronounced, increase by 10 to 20 mg/L in the mid to late 1990s. The concentrations have not significantly changed since 2005. These increases are interpreted to mimic the increased use of road de-icing salts in the Finger Lakes region in the 1960s and another larger increase in the 1990s, as discussed above. The increased fluvial fluxes therefore increase chloride concentrations in all the Finger Lakes, except Cayuga and Seneca Lakes.

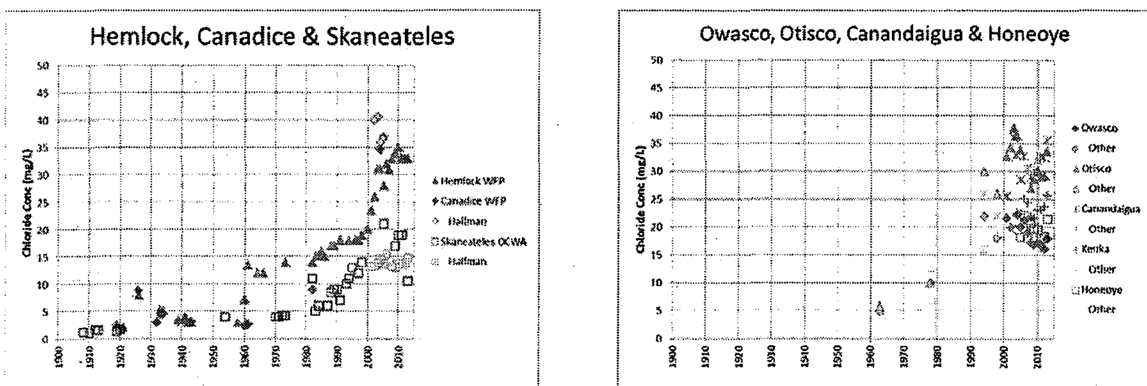


Fig. 14. Available annually-averaged century-scale chloride data from Hemlock, Canadice, Canandaigua, Keuka, Owasco, Skaneateles and Otisco Lakes (refs in text).

Curiously, Hemlock, Candice, Canandaigua and Otisco Lakes had larger concentrations than Skaneateles and Owasco Lakes since the 1990s, a circumstance that might be related to road density and bedrock composition. Road density weakly correlates ($r^2 = 0.4$) to recent chloride concentrations, if Keuka Lake is excluded from the analysis. Weathering of some rock types would liberate more chloride and sodium than others. Carbonates (and interbedded sulfates and halides) comprise up to 5% percent the bedrock underlying Skaneateles, Canandaigua, Owasco and Otisco watersheds, and none underlies Hemlock and Candice watersheds The bedrock variability does not parallel the chloride trends. The small concentrations in Skaneateles Lake may reflect a strong history of water quality protection in this watershed, as the lake is one of a handful of water bodies across the US with a filtration exception for public drinking water use. However, Owasco Lake has a similar low chloride concentration but is less regulated in its watershed protection. A tally of the actual salt tonnage applied in the individual watersheds over time would help answer this curiosity but it is beyond the scope of this report. Please note: Luckily, the Finger Lakes have not attained chloride concentrations as large as those observed in some of the urban waterways of the northeast, that has prompted the creation "salt-free" or "salt-reduction" roadway zones that fall within the watersheds of critical water supplies for major metropolitan areas.

Exhibit B

Chloride concentrations in Seneca and Cayuga Lakes were consistently larger than the other Finger Lakes throughout the past century, and the rise in chloride concentrations started significantly earlier than what was observed in the other Finger Lakes, as well (Fig. 15). In Seneca, and to a lesser extent in Cayuga lake, chloride concentrations steadily increased from 40 mg/L in the early 1900s to a pronounced peak starting at 1965 that lasted for 5 to 10 years. Chloride concentrations declined afterwards as noted in the decade-scale data. Some scatter is observed in the raw data, especially during the 1965 to 1975 concentration peak, but the century-scale trend is unique. The decline since 1975 is notable because the concentration declined in both lakes despite likely increased fluvial inputs of chloride over time.

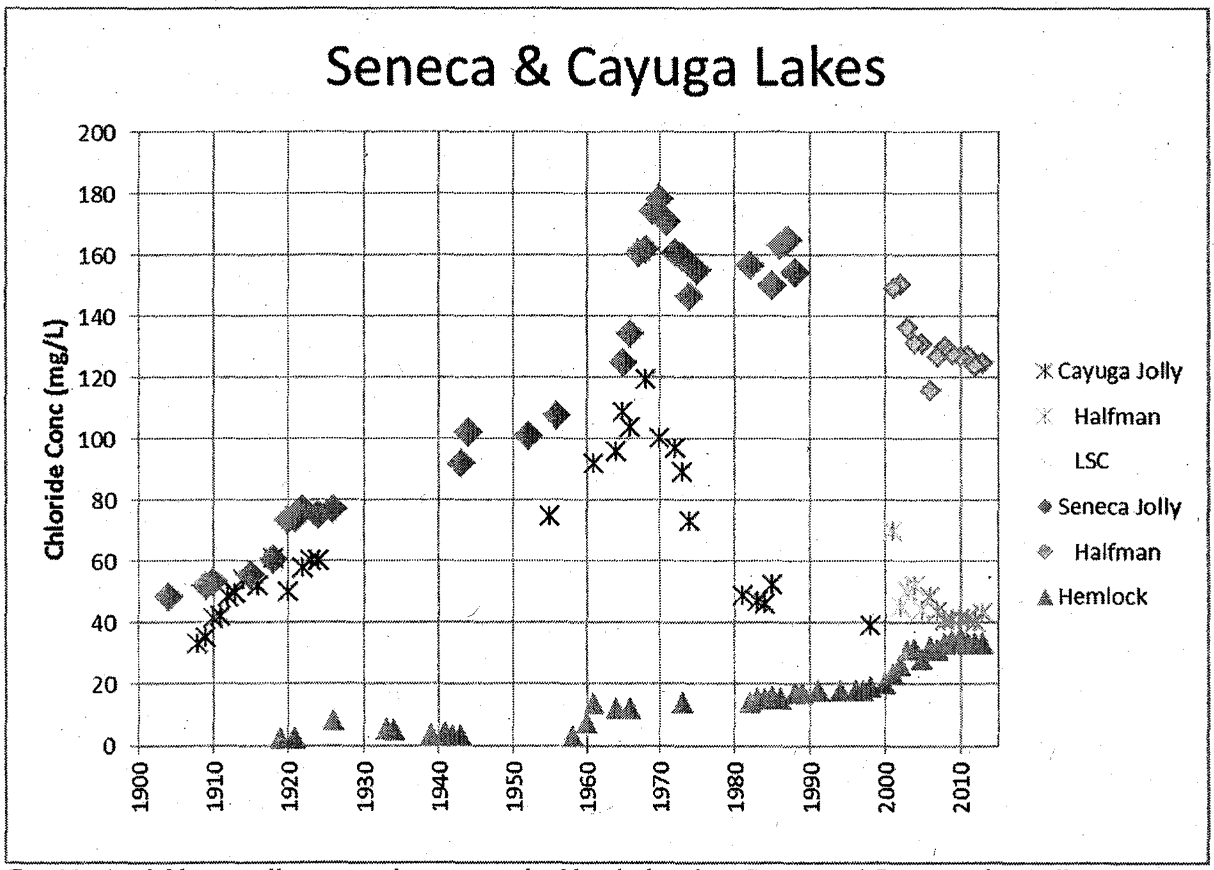


Fig. 15. Available annually-averaged century-scale chloride data from Seneca and Cayuga Lakes (Jolly, 2005, 2006, Hemlock Water Filtration Plant, Cornell's Lake Source Cooling (LSC) Data, Halfman et al., 2006).

Effler et al. (1989) wrote that their complete-mixed model of the decrease in Cayuga chloride concentrations since the 1965 to 1975 peak is consistent with an abrupt decrease in salt mine wastes input into the lake at that time, and subsequent freshening of the lake since as the lake regained equilibrium to the entering fluvial and mine waste fluxes. The 1970s timing corresponds with a major change in the disposal methods for salt tailings from the Cargill Rock-Salt Plant in the Cayuga watershed. This change significantly decreased chloride disposal into the lake. Now, chloride concentrations in Cayuga Lake are similar to the saltier members of other Finger Lakes, and suggest that the chloride in Cayuga Lake reached equilibrium from its 1960s slug and has now returned to steady-state conditions as predicted by Effler. Presumably chloride in Cayuga Lake is currently supported by fluvial and mine waste inputs. It also implies that mining practices probably controlled the pre-1960 elevated chloride concentrations. Thus, Cayuga Lake may never have received any groundwater inputs over the past century. Maybe Cayuga Lake is not deep enough to intersect the Silurian rock salts underneath the basin as previously postulated which eliminates an avenue for groundwater inputs.

Seneca Lake chloride concentrations were consistently larger than any other Finger Lake during the past century (Fig. 5). The earliest chloride concentrations measured in Seneca Lake were 48 and 49 mg/L in 1904, a concentration near but slightly larger than those of the other modern day Finger Lakes. These early 1900s Seneca Lake concentrations were significantly larger than the early 1900s data reported for Skaneateles and Hemlock Lakes. Chloride concentrations clearly varied over time in Seneca Lake as well, increasing from the early 1900s to a concentration peak from 1965 to 1975, and declining since.

The changes were modeled for the Seneca Lake Watershed Management Plan: Characterization and Evaluation report using a non-steady state, mass balance approach (Fig. 16, Halfman et al., 2012). The model assumed a constant inflow of water (863 x 10^6 m^3/yr), a constant evaporation rate (103 x 10^6 m^3/yr) and a constant surface water outflow (760 x 10^6 m^3/yr) as before. It also assumed an initial input of chloride (30,000 mtons/yr) to attain an assumed pre-1900 chloride concentration of 40 mg/L in the lake. The model did not attempt to differentiate one chloride source from another. Rather it lumped all sources together into one to determine the total quantity of chloride, in units of the initial input (30,000 mton/yr), that must be added to, or removed from, the lake to mimic the concentration distribution over time.

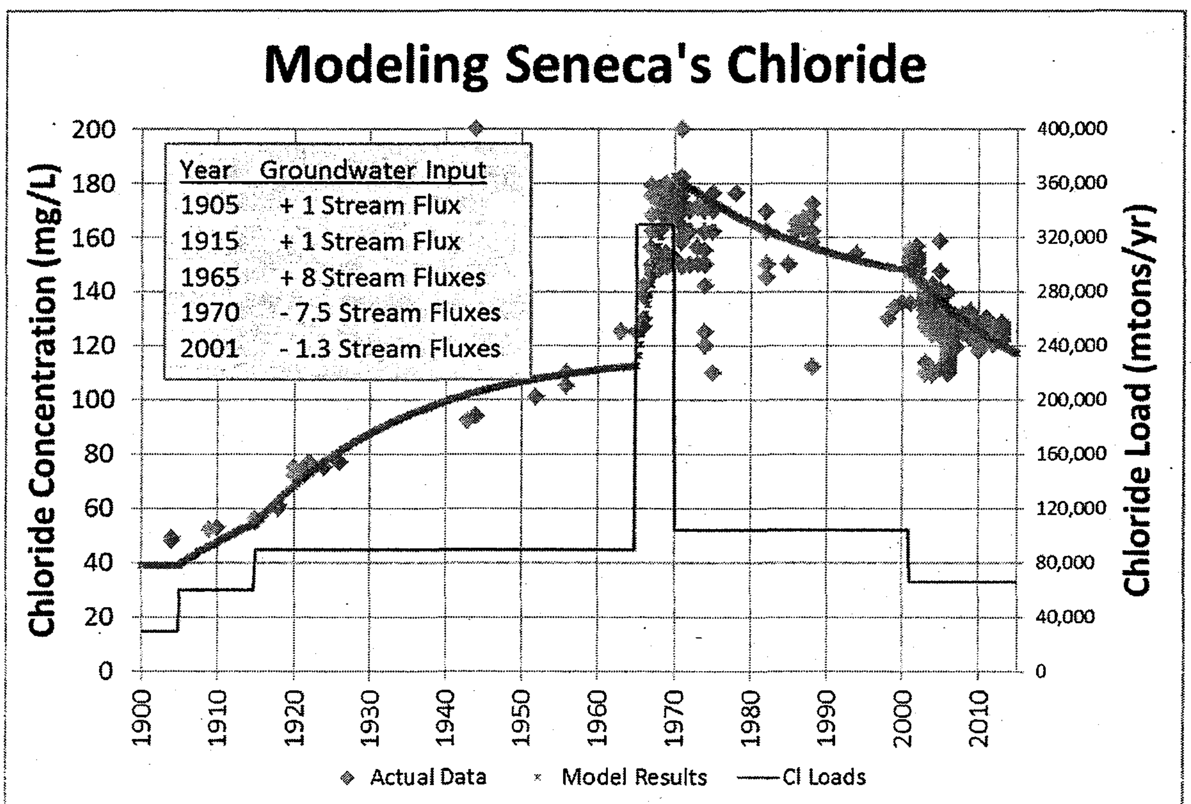


Fig. 16. Modelling changes in the total chloride flux to attain the historical record of chloride concentrations in Seneca Lake (updated from Halfman et al., 2012).

Exhibit B

The model indicates that increasing the influx of chloride by 1 initial unit (increase by 30,000 mtons/yr) in 1905, by another 1 initial unit in 1915, then once again by 8 additional units in 1965, provides enough chloride to attain the peak concentrations in the 1970s. At this time, some ~ 350,000 mtons of chloride were added to the lake each year. Then, the model decreased the input of chloride by 7.5 units in 1970, and another 1.3 units in 2001, to achieve the observed decrease in chloride concentrations since the 1965 to 1975 peak to today. Over the entire century, the net increase in the total chloride fluxes from 1900 loads was 36,000 mtons/yr. Most of the changes in chloride fluxes never attained equilibrium concentrations, especially since 1965. Regardless, this model has shown that the input of chloride to the lake increased above the initial input of 30,000 mtons/yr until the mid-century peak in chloride concentrations, and this excess was subsequently and almost completely turned off by 2001. It also revealed that chloride in Seneca Lake should eventually return to equilibrium concentration of 85 mg/L by 2085 assuming nothing modulates chloride inputs and/or outputs in the future from the current fluvial and mine waste inputs, and outlet outputs. The decline since 1970 can explain the recent decade-scale decrease in chloride concentrations.

Chloride Sources:

The model unfortunately could not differentiate the sources for the chloride or the relative proportion of one source to another because critical numbers are lacking. The existing data only indicate that fluvial, mine wastes, mine accidents, and perhaps groundwater sources have all played an important role in the history of chloride in Seneca Lake. A few points in time are worth mentioning though.

Today's concentration in the lake reflects its attempt to reach equilibrium concentrations from the large slug of chloride that entered the lake back in the 1960s, along with the current inputs from the streams and mines. The overprint of the mid-century chloride slug on subsequent chloride concentrations in the lake, and the decreasing salinities since the 1970s also precludes any attempts to look for any correlations between potential forcing functions and the past 50 years of chloride concentrations in the lake as attempted earlier in this report.

The next period of time worth noting is the early 1900s. The historical records from Fall Creek, Keuka Outlet, and other Finger Lakes outlined above indicate that fluvial sources to Seneca Lake, were smaller in the early 1900s than today. The 1900 fluvial flux to Seneca Lake is estimated at 15,000 mtons/yr, assuming the present-day hydrologic budget in Seneca Lake and a fluvial supported equilibrium concentration of 20 mg/L, which was the earliest concentration detected in Hemlock Lake and the largest in the available historical lake data. Combining the estimated 1900 fluvial fluxes with a mine waste identical to today's discharge (~9,000 mtons/yr), results in an input of chloride that is still insufficient to attain a combined input of 35,000 mtons/yr during the early 1900s. Perhaps mine wastes were larger back then. Reliable data are not publically available to investigate this possibility. Perhaps groundwater inputs were active back then. As earlier authors stated, Seneca Lake's depth, deeper than any of the other Finger Lakes, provides an avenue for saline groundwater to enter the lake from the rock salt formations.

Exhibit B

Another significant point in time is the 1965 to 1975 peak in chloride concentrations. Brine pool leaks, injection of saline wastes into leaky fractured bedrock (carbonates, sandstones and shales), dust from piles of rock salt and other issues at the abandoned hard-rock Morton-Himrod mine located in the Plum Point subwatershed influenced the 1965 to 1975 chloride peak detected in the lake. According to newspaper articles, the opening of the Himrod mine in the late 1960s came with a number of mine waste "issues" that resulted in the leakage of an estimated 1.1 million tons of salt into the lake. The concentration spike is consistent with the chloride record if it leaked over a span of a few years. Specific details follow: The mine started construction in 1969. By 1973 a news report stated neighbors complained of salt disposal down Plum Point Creek beginning in the fall of 1972, most likely due to brine pool breaches. The mine shut down in 1979 after extracting 4,000 tons of salt a day from the ground. Saline water still flows down Plum Point Creek, as mentioned above, probably a legacy issue from the abandoned mine but also from a high density of roads and de-icing salts. The 1.1 million ton leakage of salt is similar to the modeled input to generate the 1965 to 1975 peak, if discharged into the lake over a period of a few years. Unfortunately, the timing of the mine "issues" post-date the rise in chloride concentrations in the lake by a few years so the event does not explain the entire peak but rather sustained the peak for a few years. Thus, some other unknown source must have combined with the Himrod mine accidents to create the chloride peak. Was it a modulation of mine wastes and/or groundwater inputs and/or something else? Data are lacking to answer this important question.

Groundwater inputs may still be a significant source of chloride to Seneca Lake. Earthquakes could have opened and closed the abundant fractures in the local bedrock and provide avenues for groundwater flow during discrete intervals of time in the lake's geologic history. The shale-rich bedrock in the region is full of fractures (Jacobi, 2002). This is especially true at depths shallower than 1,000 meters. Natural gas companies will not "frack" the Marcellus Shale shallower than 1,000 meters because the unit was already naturally fractured and released its gas. These fractures could have opened and closed as the region experienced the occasional earthquake and associated ground movements. Earthquakes have occurred in the region, as strong as 5.8 on the Richter Scale, especially along the St Lawrence Seaway but also within the central and western portion of New York. The solution cavities used by the mining companies typically eroded into the non-salt bedrock above and below and interbedded within the salt layers. These cavity wall breaches into interbedded and neighboring bedrock could have provided an avenue for groundwater flow.

Alternatively, pressures from the solution mining processes at the Cargill and US Salt mines near Watkins Glen may have also induced saline groundwater flow into the lake. The onset of mining practices in the late 1800s may have increased the formation pressures to stimulate groundwater flow into the lake, i.e., sufficiently pressurize the unit so groundwater could flow uphill and overcome gravity. Thus, the rise and fall of mining pressures may have modulated the chloride concentration in the lake. However, a gentle 1^{0} southerly dip of the bedrock, the density of the brine, and a southward location of the mines from where the bedrock intersects the lake, creates a difficult hurdle for this groundwater flow. As a general rule, groundwater always flows downhill under the force of gravity unless additional pressures push the water to overcome gravity. The available 50-year production data form US Salt also negatively correlates to the chloride concentrations. Yet, artesian systems and saline springs are found in the region, e.g., Tully Valley, Clifton Springs, Geneva, and other locations in New York

State. The possibility that mining pressure has induced the flow of chloride into the lake has implications for the current proposal to store liquid propane and natural gas in the abandoned salt cavities. I would highly recommend a pressure test of the abandoned salt cavities and check for any rise in the chloride and/or sodium concentrations throughout the lake before they are used to store liquid propane and natural gas. Alternatively, any leakage from the current storage of natural gas in abandoned salt cavities on the US Salt property should be made public to ferret out or put to rest these concerns.

Conclusions:

Decade and century-scale records of salt content in the majority of the Finger Lakes dictate a two-part, step-wise increase in the fluvial inputs of chloride to the lakes, during the 1960s and 1990s. The increase in chloride concentrations parallels the documented increase in fluvial chloride concentrations across the northeast and in two local streams from the increased use of road de-icing salts to keep roadways ice-free. The historical chloride concentration pattern for and source of chloride ions to Seneca and Cayuga Lakes were different. Cayuga Lake was influenced by extra mine wastes discharged into the lake up to and during the 1970s. Its chloride concentrations have decreased since, to the early 2000s as the lake moved towards equilibrium concentrations after the 1970s pulse. The present day chloride content in Cayuga Lake is presumably supported by the present-day fluvial and mine waste inputs.

The century-scale history of chloride in Seneca Lake revealed chloride concentrations of ~40 mg/L at the turn of the 20th century, smaller than any other time in the lake's history, but larger than nearly all of the other Finger Lakes. The history also revealed much larger concentrations during a mid-century peak of 180 mg/L only to subsequently decline to the present day concentrations of 125 mg/L. The earliest recorded concentrations are much larger than those found in other lakes, and indicate that fluvial sources alone were insufficient to support Seneca's chloride concentrations at the turn of the 20th century. Either significantly larger mine wastes than today's inputs and/or a significant groundwater flux is/are required to reach these earliest concentrations.

Models indicate that significant increase in the annual chloride loads were required during 1905 and again in 1915 to attain the slow historical rise in concentrations from 1900 to 1965. The fluvial sources were insufficient at that time and must have been augmented by mine wastes larger than present day inputs and/or groundwater inputs. A slug of chloride leaked into Seneca Lake from the now abandoned Morton-Himrod mine probably sustained the mid-century chloride peak but its release was a few years after the chloride rise and thus cannot be the sole cause of the peak. Since the late 1800s, solution mining operations at the southern end of the lake have discharge chloride-rich brines into Seneca Lake. The loads from reliable sources are unknown until the late 1990s, but the reported loads and the recent fluvial fluxes are still insufficient to attain or even modulate the record of concentrations in the lake. However, the recent concentrations do not require groundwater inputs to attain the present day concentration in the lake, as hypothesized by previous authors. The elevated concentration observed today can be attributed to the time lag to reach equilibrium from the input of the 1970s slug of chloride.

Exhibit B

It follows that Seneca Lake has had a multifaceted chloride history. Sources include the streams, mine wastes, former mine issues, and groundwater. Stream inputs have limited data throughout the century and still need to be estimated from century-scale records from neighboring lakes to fill in the gaps. Reliable mine waste reports were only available since the late 1990s. Earlier reliable records would help answer questions in the total chloride input to the lake over the past century. The former Himrod mine "issues" are unfortunate, but provide a glimpse into what might happen if another slug of chloride enters the lake. Finally, groundwater inputs are the biggest unknown. They were postulated to make up the present day gap in chloride inputs, but recent evidence presented here suggests groundwater inputs are probably not required today. This does not preclude significant groundwater inputs during the past. Once these source questions are sorted out, the next generation of models will probably glean additional insights into the chloride history of Seneca Lake.

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Exhibit B

Appendix:

Table 3. Results from the 10/25/2014 full-lake cruise.

Sites	Chloride (Cl mg/L)		Sulfate (SO4 mg/L)		Sodium (Na mg/L)		Potassium (K mg/L)		Magnesium (Mg mg/L)		Calcium (Ca mg/L)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
1	122.3	121.2	31.6	31.5	75.7	75.2	5.4	5.3	10.5	10.5	36.2	36.5
3	121.6	126.9	31.5	32.4	75.0	77.7	5.4	5.5	10.5	10.6	36.5	38.0
5	122.9	129.2	31.5	32.6	75.0	78.9	5.4	5.5	10.5	10.7	36.6	38.4
6	122.2	128.1	31.5	32.5	74.9	78.3	5.3	5.5	10.6	10.6	36.7	38.3
7	121.6	137.6	31.3	33.2	74.9	84.5	5.4	5.7	10.6	10.8	37.1	39.6
8	121.4	135.8	31.2	33.0	75.1	83.8	5.4	5.7	10.6	10.8	37.2	39.4
9	121.1	127.4	31.1	32.0	75.0	78.9	5.4	5.5	10.6	10.7	37.0	38.8
10	120.8	124.1	31.1	31.7	74.7	76.6	5.6	5.6	10.6	10.7	37.1	38.5
11	121.4	125.7	31.1	32.3	75.1	76.8	5.5	5.6	10.7	10.6	37.4	38.5
Average	121.7	128.4	31.3	32.4	75.0	79.0	5.4	5.5	10.6	10.7	36.9	38.4

Data Comparison between Labs

Sites	Chloride (Cl mg/L)		Chloride CSI	
	Surface	Bottom	Surface	Bottom
1	122.3	121.2	128	131
3	121.6	126.9	130	133
5	122.9	129.2	130	131
6	122.2	128.1	129	132
7	121.6	137.6	132	146
8	121.4	135.8	127	139
9	121.1	127.4	129	136
10	120.8	124.1	130	131
11	121.4	125.7	129	132
Average	121.7	128.4	129	135

Sites	Sodium (Na mg/L)		Sodium CSI	
	Surface	Bottom	Surface	Bottom
1	75.7	75.2	80	79
3	75.0	77.7	78	81
5	75.0	78.9	76	83
6	74.9	78.3	83	79
7	74.9	84.5	81	90
8	75.1	83.8	78	91
9	75.0	78.9	80	86
10	74.7	76.6	83	83
11	75.1	76.8	80	81
Average	75.0	79.0	80	84

Sites	Sp Cond (uS/cm)		Sp Cond CSI	
	Surface	Bottom	Surface	Bottom
1	675.0	684.0	654	669
3	666.0	719.0	662	680
5	669.0	730.0	660	692
6	671.0	728.0	662	690
7	668.0	760.0	665	728
8	677.0	763.0	667	720
9	670.0	730.0	668	667
10	671.0	704.0	655	680
11	668.0	716.0	666	683
Average	670.6	726.0	662	690

Sites	Sp Cond (uS/cm)		Sp Cond CTD	
	Surface	Bottom	Surface	Bottom
1	675.0	684.0	666	673
3	666.0	719.0	662	705
5	669.0	730.0	663	712
6	671.0	728.0	662	710
7	668.0	760.0	663	747
8	677.0	763.0	664	741
9	670.0	730.0	664	714
10	671.0	704.0	663	698
11	668.0	716.0	665	701
Average	670.6	726.0	663.5	711.1

Community Science Institute, Inc. (CSI) data by permission of John Dennis

New York State Department of Environmental Conservation

In the Matter of the Applications of FINGER LAKES LPG STORAGE, LLC For the Liquefied Petroleum Gas Storage Facility at Seneca Lake for permits to construct and operate pursuant to the Environmental Conservation Law	Application Number 8-4432-00085 **AFFIRMATION OF SERVICE**

I, Daniel Raichel, an attorney duly admitted to practice law before the Courts of the State of New York, affirm under penalty of perjury:

That I am over 18 years of age, and am employed by the Natural Resources Defense Council, 40 W. 20th St., 11th Fl., New York, NY 10011.

That on January 16, 2015, the foregoing Petition for Full Party Status of the proposed parties Seneca Lake Communities—Seneca County, Yates County, the City of Geneva, the Town of Fayette, the Town of Geneva, the Town of Ithaca, the Town of Romulus, the Town of Starkey, the Town of Ulysses, the Town of Waterloo, the Village of Waterloo, and the Village of Watkins Glen—was served on the following by email, with a hardcopy of the foregoing petition being mailed to the same (except where email-only service has been requested and agreed to, as indicated below):

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AFFIRMED: January 16, 2015
New York, NY

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