NYSDEC OHMS Document No. 201166576-00026

PUBLIC VERSION

New York State Department of Environmental Conservation

In the Matter of the Application of

FINGER LAKES LPG STORAGE, LLC

Application Number 8-4432-00085

for a permit pursuant to the Environmental Conservation Law to construct and operate a new underground liquid petroleum gas storage facility in the Town of Reading, Schuyler County

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PETITION FOR FULL PARTY STATUS

by

Gas Free Seneca

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INTRODUCTION

Pursuant to title 6, section 624.5(b), of the New York Codes, Rules and Regulations ("NYCRR"), Gas Free Seneca ("GFS"), by its counsel, Earthjustice, hereby petitions for full party status in the above-captioned proceeding. *See* 6 NYCRR § 624.5(b)(1)(i), (iv). GFS is an organization of concerned citizens, local business owners, and regional environmental groups seeking to protect Seneca Lake, its iconic landscape, and home-grown businesses from the threat of invasive industrialization. GFS's members live, raise their families, and own property in the area surrounding Seneca Lake and the wider Fingers Lakes region. They have worked for years—and in some cases generations—to build a thriving, mutually supportive, and sustainable community centered on the region's rich agricultural land, scenic beauty, and outdoor recreational opportunities.

GFS seeks full party status to resist threats to the character of its community and the integrity of its natural environment that are presented by the proposal of Finger Lakes LPG Storage, LLC ("FLLPG" or the "Applicant") to develop liquid petroleum gas ("LPG") storage facilities on the western shore of Seneca Lake in the Town of Reading, Schuyler County, New York (the "Project"). The Project would involve injection of 2.1 million barrels (88.2 million

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gallons) of propane and butane into solution-mined salt caverns and the establishment of ancillary industrial facilities at the surface, including a rail yard, two brine ponds, and numerous large storage tanks. FLLPG has submitted an application (the "Application") for an underground storage permit pursuant to article 23, title 13 ("Title 13"), of the Environmental Conservation Law ("ECL"), and the New York State Department of Environmental Conservation ("DEC" or the "Department") has published a set of conditions proposed for the permit, if a determination is made to grant the Application.

Before DEC determines whether to grant the Application, the disputed substantive and significant issues identified below must be resolved through adjudication, and several legal issues not dependent upon facts must be resolved on the merits. If granted party status at a hearing on the adjudicable factual issues, GFS will present evidence, including expert testimony, that the Project will result in significant and unmitigated adverse cavern integrity, public safety, water quality, noise, and community character impacts on the natural and human environment of Seneca Lake, specifically, and the Finger Lakes, generally. In this Petition, GFS demonstrates that the Draft Supplemental Environmental Impact Statement ("DSEIS") for the Project fails to meet the requirements of the State Environmental Quality Review Act ("SEQRA"), and a revised DSEIS should be released for public comment before DEC decides whether to grant the Application, because: the DSEIS fails to include any analysis of community character; the DSEIS fails to include any cumulative impact analysis; and the DSEIS fails to analyze the no-action alternative or most reasonable alternatives to the Project. The factual evidence and legal arguments proffered by GFS warrant denial of the underground storage permit for LPG because: (i) the DSEIS and other documentation submitted in support of the Application provide a factually and legally inadequate foundation for the findings required under SEQRA and its

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implementing regulations, ECL art. 8; 6 NYCRR Part 617; and (ii) FLLPG has not proven the Application's compliance with the regulatory standards established in section 23-1301(1) of the ECL.

IDENTITY AND ENVIRONMENTAL AND STATUTORY INTERESTS OF GFS (6 NYCRR § 624.5(b)(1)(i)–(iii))

GFS is a group of concerned citizens and 266 local business owners from the Seneca Lake area who are committed to protecting their communities from the Project and related natural gas storage infrastructure. GFS was formed in 2011 in response to the Applicant's plan to use underground salt caverns on the shore of Seneca Lake to store millions of barrels of LPG. GFS's mission is to protect Seneca Lake and its environment and communities from the threat of significant industrialization.

GFS and its members have participated actively in DEC's review of the Project. The group and its members submitted comments on the DSEIS, including letters relating to cavern integrity and regional geology, community safety, and the impact of the Project on the local sustainable economy. GFS also met with key decisionmakers to highlight deficiencies in the DSEIS and to emphasize the conflict between the Project and the local economy and community character. Joseph Campbell, Yvonne Taylor, and Jeffrey Dembowski, the three co-founders of GFS, will act as GFS's organizational representatives during the issues conference and at the adjudicatory hearing, if GFS is granted full party status. GFS is represented by Earthjustice, with Deborah Goldberg and Moneen Nasmith acting as counsel.

The members of GFS possess a common and profound interest in the health of the environment and communities of the Seneca Lake area. The construction and operation of the Project will result in significant adverse environmental impacts, including potential contamination of Seneca Lake, degradation of the viewshed, significant noise pollution, and

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increased risks to public safety. The members of GFS live, work, and recreate in the Seneca Lake area. Some members' families have owned land and operated businesses in the Seneca Lake area for generations. All GFS members have a substantial interest in protecting the quality of their local environment from the Project and similar industrial development.

The Project will transform a rural, tranquil, and scenic area into a region degraded by re-industrialization. The Project will forever mar the scenic beauty of the Seneca Lake landscape, injuring the interests of GFS members who live on the opposite shore of the lake or who recreate on the lake itself. Construction and operation of the Project will involve the use of heavy machinery and equipment and result in significant noise, which will negatively affect not only members who live or recreate near the facility, but also those individuals who live across the lake, where the noise can be transmitted over the water. Injection of LPG into the underground caverns threatens to increase the salinity of Seneca Lake, a source of drinking for many GFS members. Moreover, members of GFS live in the communities around the Project and face increased threats to public safety due to unaddressed questions about cavern integrity and the potential for LPG to leak out of the caverns and migrate, as well as the increased presence of LPG-laden trains traveling through the area. The members of GFS therefore have a significant environmental interest in this proceeding which will address whether and under what conditions the Project should proceed.

GFS' interests also relate to the administration and implementation of SEQRA and Title 13 of the ECL. As discussed in greater detail below, questions relating to cavern integrity and the impact of injecting LPG into the underground caverns on the salinity of Seneca Lake raise significant concerns regarding the adequacy of the Application and the draft underground storage permit under Title 13. The adverse noise, community character, public safety, and cumulative

impacts from the Project also raise questions about the sufficiency of the DSEIS and present significant issues under SEQRA.

PRECISE GROUNDS FOR OPPOSITION
(6 NYCRR § 624.5(b)(1)(v))

The five factual grounds for GFS's opposition to the Project are explained in the six expert reports attached to this Petition. In addition, the grounds for opposition are elaborated in the discussion below, identifying the substantive and significant issues that qualify for adjudication.

ISSUES FOR ADJUDICATION AND OFFERS OF PROOF
(6 NYCRR §§ 624.4(c), 624.5(b)(2))

GFS proposes for adjudication five factual questions regarding the significant and unmitigated adverse impacts related to (1) cavern integrity, (2) public safety, (3) water quality, (4) noise, and (5) community character of the Project. All five issues presented by GFS are both substantive and significant and therefore satisfy the regulatory standard for adjudication.

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." 6 NYCRR § 624.4(c)(2). An issue 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.* § 624.4(c)(3). Because DEC is the lead agency and prepared the DSEIS, the determination whether to adjudicate issues relating to the sufficiency of the DSEIS or the ability of DEC to make necessary findings pursuant to SEQRA also is made according to the "substantive and significant" standard. *See id.* § 624.4(c)(6)(i)(b).

Under Title 13, the Applicant is required to show that the caverns are adaptable for storage purposes before DEC may grant the underground storage permit. ECL § 23-1301(1).

The attached expert reports on cavern integrity, the potential salinization of Seneca Lake, and public safety demonstrate that the Applicant has failed to provide sufficient data to demonstrate that the caverns are safe for LPG storage. At a minimum, further inquiry into the propriety of storing LPG in these caverns therefore is required before Title 13 can be satisfied, demonstrating the existence of substantive issues. The questions raised below regarding the long-term integrity of the caverns, the impacts to public safety, and the potential for salt flow into Seneca Lake also are significant. If left unresolved, these issues require the denial of the permit Applicant's permit application. Even with additional information from the Applicant, GFS's testifying experts conclude that the permit cannot be granted without substantial additional conditions.

The expert testimony proffered with this Petition also demonstrates the existence of substantive and significant issues under SEQRA. As the expert reports appended to the Petition show, the DSEIS does not present an adequate analysis of potentially significant adverse environmental impacts in the areas of cavern integrity, public safety, the water quality of Seneca Lake, noise, and community character, as required under SEQRA, 6 NYCRR § 617.9(b)(1). Further evaluation of the Project's significant adverse impacts and potential mitigation or avoidance therefore is required. GFS's experts also will show that, even with that additional analysis, the permit should be denied because DEC will not be able to make the findings required under SEQRA that:

> consistent with social, economic and other essential considerations from among the reasonable alternatives available, the action is one that avoids or minimizes adverse environmental impacts to the maximum extent practicable, and that adverse environmental impacts will be avoided or minimized to the maximum extent practicable by incorporating as conditions to the decision those mitigative measures that were identified as practicable.

Id. § 617.11(d)(5). The questions raised by the experts therefore qualify as substantive and significant issues.

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I. Salt Cavern Integrity

The Project raises substantive and significant issues for adjudication because numerous outstanding questions remain regarding the current and future integrity of the solution-mined caverns, and the Application contains data gaps that are serious enough to warrant denial of the underground storage permit. The attached report authored by Dr. H.C. Clark (attached hereto as Ex. 1), a geologist with expertise in salt cavern integrity proffered here as an expert witness, demonstrates that the permit should be issued *only if* new studies are performed to supply crucial missing information, and the Application materials are revised to demonstrate a high probability of long-term cavern integrity. Significant additional conditions also must be included in the underground storage permit, if it is issued, to ensure that a timely and effective response can be made to any problems that may develop during the operation of the Project.

Dr. Clark will testify to the findings in his report, including that the evidence presented by FLLPG's Application materials fails to demonstrate long-term cavern integrity. Ex. 1 at 2. His report concludes that "much of the information that a geologist would ordinarily expect to find about the surrounding geology and features of the caverns is missing, incomplete, or incorrect." *Id.* He concludes that "the FLLPG application and draft permit conditions defeated all of my expectations and failed to conform to standard industry practices I have observed over decades as a professional geologist," *id.* at 4, and recommends that the issues conference be postponed until substantial additional information is provided to DEC. *Id.* at 31–33.

The data gaps and errors Dr. Clark identifies in FLLPG's Application include:

- [redacted] showing all faults, fracture systems, lineations, historical cavern outlines, fracture pathways, and fracture histories, *id.* at 12; [redacted]

- [redacted] that do not include thrust faults and tear faults and incorrectly display cavern floors as being solid rather than mounds of broken rock, *id.* at 12–13; Ex. B; and
- Measurements for Caverns 27, 28, 30, and 31 that do not fully characterize the size and shape of the rubble pile at the bottom of the gallery, *id.* at 14–16.

"When the [Applicant's] omissions are cured, and the mistakes corrected, the need for further study is immediately apparent." *Id.* at 3. [redacted] without more study, "the data …is insufficient to demonstrate that the reservoir is suitable for LPG storage." *Id.* at 27. Review of other scientific sources also provides information [redacted] that indicates that the Project's caverns "show effects of age and anomalies suggesting that long-term integrity may not be possible." *Id.* at 2.

Even if the information gaps are filled and errors are corrected to demonstrate a substantially higher likelihood of long-term cavern integrity, Dr. Clark recommends that extensive additional permit conditions be imposed. *Id.* at 33–34. The additional monitoring measures Dr. Clark has deemed necessary are listed at the end of his report. *Id.* at 33. "Without the addition of these monitoring requirements as permit conditions, DEC cannot ensure that emerging cavern integrity problems will be timely identified." *Id.* at 34.

The issues discussed by Dr. Clark plainly are substantive and significant. Neither the DSEIS nor the Application materials provide sufficient information to assess whether the caverns are suitable for storage of LPG or to take a hard look at whether the caverns could leak and cause

significant environmental impacts. The record provided by the Applicant to date requires the denial of the underground storage permit and fails to provide DEC with an adequate record to make the findings required by SEQRA. Indeed, even with further inquiry, there is serious doubt that the Applicant can establish the long-term integrity of the caverns with enough certainty to satisfy regulatory requirements, at least not without additional permit conditions. Questions about cavern integrity therefore qualify as adjudicable issues.

II. Overall Project Safety

A substantive and significant issue exists regarding the overall safety of the Project. Dr. Rob Mackenzie, who is proffered here as an expert witness, conducted a high-level quantitative risk assessment ("QRA") to evaluate the major risks associated with the Project (attached hereto as Ex. 2). Although the Applicant employed an outside contractor to conduct a QRA in 2012, the previous QRA's analysis was limited to the risks associated with on-site releases from equipment.[1] The DSEIS also does not analyze the safety impacts of the Project beyond the property line or evaluate the risks of events associated with rail transport, pipeline transmission, and salt cavern storage of LPG. Dr. Mackenzie's QRA evaluates these risks and finds that the Project poses an unacceptable risk to the community that cannot be sufficiently mitigated. Ex. 2 at 1.

QRAs are designed to categorize risks according to an event's probability of occurrence and likely consequences into three categories: (1) "unacceptable" requiring that measures be taken to reduce the risk, (2) within an "assessment range" where mitigation measures must be considered, or (3) "acceptable" and mitigation measures can be considered based on other

[1] *See* 2012-02-16, Quantitative Risk Assessment, Quest Consultants.

considerations.[2] *Id.* at 3. Dr. Mackenzie analyzes two sets of risks that are ignored by the DSEIS: the risk of transporting LPG by rail to the Project and the risk of transmitting LPG by pipeline to and from the Project. Dr. Mackenzie concludes that the risk of transporting LPG by rail is within the "assessment range" and requires consideration of further mitigation. *Id.* at 6–7. Although unlikely, it is possible for a catastrophic event to occur if a train carrying LPG to the facility derailed on the trestle located near the Project, which is located over a gorge uphill from the Village of Watkins Glen. If the rail cars were punctured and leaked their contents, it is possible that LPG could flow into the town and ignite. *Id.* at 5–6. Because such an event would result in extremely serious consequences, Dr. Mackenzie concludes that the risk of transporting LPG by rail requires consideration of further mitigation measures. *Id.* at 6–7. Similarly, pipeline accidents occur with medium frequency and with moderate consequences and therefore Dr. Mackenzie concludes that the risk posed by transporting LPG via pipeline is within the "assessment range" and requires consideration of additional mitigation measures. *Id.* at 7–8.

Dr. Mackenzie also reviews the risk of using salt caverns to store LPG, which the DSEIS fails to evaluate adequately. The storage of LPG in the Project's salt caverns poses an unacceptable risk that must mitigated. *Id.* at 8–13. Numerous accidents have occurred in the U.S. involving salt cavern facilities; as discussed above in Section I, there is significant concern regarding the long-term integrity of the caverns; and as discussed in Section III below, the storage of LPG in the caverns poses a risk to Seneca Lake. Based on this and other information, Dr. Mackenzie concludes that storing LPG in these salt caverns poses a medium likelihood of an

[2] For example, an event with a low probability of occurrence BUT extremely serious consequences poses an unacceptable risk, whereas an event with a low probability occurrence with serious or moderate consequences is within the "assessment range."

extremely serious event and therefore represents an unacceptable risk to public safety. *Id.* at 9, 12, 14.

Dr. Mackenzie's report demonstrates that there is a substantive and significant issue with respect to the Project's compliance with Title 13 and SEQRA. According to Dr. Mackenzie, the safety risks associated with the storage of LPG in salt caverns raise real doubts about the Applicant's ability to demonstrate that the caverns are "adaptable for storage purposes." *See* ECL § 23-1301(1). Dr. Mackenzie's report also raises substantive issues under SEQRA, as the significant adverse impacts he describes relating to rail and pipeline transportation were not analyzed or proposed for mitigation in the DSEIS, and the DSEIS's discussion of safety risks relating to storage of LPG in salt caverns is inadequate. The DSEIS therefore does not provide DEC with a sufficient record on which to base DEC's findings under SEQRA. *See* 6 NYCRR § 617.11(d)(5). As Dr. Mackenzie is prepared to testify, because the Project as proposed will result in significant public safety impacts which cannot be mitigated, the Project should undergo major modification, or the permit should be denied. The public safety concern raised by Dr. Mackenzie therefore qualifies as a substantive and significant issue.

III. Potential Salinization of Seneca Lake

Even if the Applicant is able to demonstrate that no substantive and significant issues exist with respect to cavern integrity, the storage of LPG in these formations still presents a substantive and significant issue for adjudication because the Application and DSEIS fail to adequately address the Project's potentially significant adverse impacts to the water quality of Seneca Lake. As expert hydrologist, Dr. Tom Myers, explains in his report (attached hereto as Ex. 3), there is a high risk that changes in pressure in the caverns caused by the storage of LPG therein may result in significant salt discharges into Seneca Lake from deep groundwater sources.

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As is discussed above in Section I, the geology underlying the shores of Seneca Lake consists of bedded salt formations. The proposed storage caverns do not intersect with the lake bottom, which is made of sediment, but the bedded salt formation that houses the caverns slopes upwards from south to north and ultimately intersects the porous sediments of the lake bottom. Ex. 3 at 7–8. Groundwater is driven from higher to lower pressure areas and thereby moves through the layers of sediment below the lake and into the lake itself. *Id.*, Appx. D. When groundwater moves through salt layers and into the lake, it contributes to the lake's salinity.

Pumping LPG in or out of the caverns creates significant pressure changes that spread through the salt beds surrounding the caverns. *Id.* at 11–12. Increasing the pressure within the caverns, especially if they are tight, squeezes the surrounding formations and causes a compression or strain to spread across the viscoelastic salt layers. *Id.* at 12; Appx. E at 4. Although the stress changes will decline with distance, the stress change caused by the cavern could still affect salt layers that intersect the lake sediments and cause brine to be squeezed from these layers. *Id.* In addition, even a small increase in pressure to the salt layers under the lake will raise the pressure gradient between the lake and underlying formations, causing an increased flow of now-salt-laden groundwater into the lake. *Id.*

Although this phenomena is difficult to detect or monitor given the involvement of subsurface formations, Dr. Myers' conclusion that changes in pressure in the LPG caverns pose a real risk of increasing the salinity of Seneca Lake is supported by an examination of a previous spike in the lake's chloride levels in the mid-1960s. This significant increase coincided with the beginning of LPG storage in salt caverns close to those that FLLPG proposes to use. *Id.* at 5. Dr. Myers evaluated and rejected other potential explanations for this increase in salinity in

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Seneca Lake, concluding that "the most likely source is advection through the sediments beneath the lake." *Id.* at 11.

The risk that cycling LPG into the caverns will cause increased salinity in Seneca Lake is both a substantive and significant issue. Seneca Lake is the source of drinking water for more than 100,000 people, the salt levels in Seneca Lake already are much higher than other Finger Lakes, and an increased amount of chloride in the lake would take a very long time to dissipate given the lake's limited outflow. *See id.* at 6, Appx. A at 1, 6. The Application and the DSEIS do not assess whether the reintroduction of underground LPG storage will degrade Seneca Lake's water quality and do not form a sufficient basis for DEC to make the required findings under SEQRA. Dr. Myers' report also demonstrates that, absent proof that pressure changes from storing LPG will not drive salt into Seneca Lake, the underground storage permit should not be granted. *Id.* at 14–15. The Project's potential to cause salt migration into Seneca Lake therefore qualifies as a substantive and significant issue. *See* 6 NYCRR § 624.4.

IV. Noise Impacts

The Project raises substantive and significant issues for adjudication because the DSEIS fails to take a hard look at the Project's adverse noise impacts. The attached expert report by Dr. A. Brook Crossan of Sandstone Environmental Associates, Inc. ("SEA") (attached hereto as Ex. 4) concludes that "residents of the Seneca Lake community and tourists visiting the area are likely to suffer significant and unmitigated noise impacts from the Project, notwithstanding the mitigation measures proposed by the Applicant and conditions that [DEC] proposes to attach to the Applicant's permit." Ex. 4 at 1–2.

SEA identifies multiple deficiencies in the Applicant's evaluation of the Project's noise impacts. *Id.* at 9–15. These include:

- Delineating the "region of influence" or the area of interest for purpose of analysis to include only the on-site and receptors in the immediate vicinity of the Project, when the Project will increase off-site transportation noise, *id.* at 9–10;
- Failing to evaluate sufficiently the noise impacts of the Project on residential and recreational receptors on the eastern shore of Seneca Lake, *id.* at 2, 10–11;
- Failing to properly monitor and report baseline noise levels, *id.* at 11–12; and
- Omitting an analysis of effective mitigation measures, *id.* at 15.

SEA makes numerous recommendations for improvement of the noise analysis, including definition of a region of influence that includes the western portion of Seneca Lake from Watkins Glen to Geneva and the entire eastern shore, a special study of noise transmission over Seneca Lake during different meteorological conditions, and the complete characterization of Project construction and operation, including the hours during which those activities will take place. *Id.* at 16–19. SEA also concludes that the Applicant must model construction and operation noise at all receptors and develop a revised Sound Study that addresses all of the deficiencies noted in SEA's report. *Id.* 16–19.

Until the measures recommended in the SEA report are completed and the numerous deficiencies in the Applicant's analysis of noise impacts corrected, SEA's expert opinion is that "it will be impossible for [DEC] to make the findings required under SEQRA, and the permit therefore should not be issued." *Id.* at 19. The DSEIS therefore did not take the requisite hard look at the potential adverse significant noise impacts and does not provide DEC with an adequate legal or technical record on which to base findings under 6 NYCRR § 617.11(d)(5). Noise that will be created by the Project therefore is a substantive and significant issue.

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V. Community Character Impacts

As discussed in greater detail in the expert reports by Dr. Harvey Flad (attached hereto as Ex. 5) and Dr. Susan Christopherson (attached hereto as Ex. 6), the Project likely will result in significant adverse impacts to community character. The DSEIS however contains absolutely no discussion of community character impacts. SEQRA regulations on determining the significance of a proposed project's impacts require consideration of "the creation of a material conflict with a community's current plans or goals as officially approved or adopted," and "the impairment of the character or quality of … existing community or neighborhood character." 6 NYCRR § 617.7(c)(1)(iv)–(v). "[T]he impact that a project may have on … existing community character … is a relevant concern in an environmental analysis." *Chinese Staff & Workers Assn. v City of New York*, 68 NY2d 359, 366 (1986).

Dr. Flad's attached expert report details how the Seneca Lake area combines scenic views, historic sites and districts, scenic roads, open spaces, federally designated viticulture economic zones, and multiple recreation and tourism opportunities to form a distinct cultural landscape that "reflects the integrated social and aesthetic values of residents and vacationers." Ex. 5 at 28. The emergent community character of the area thus is premised on local inhabitants' relationship to the quality of their environment. Ex. 6 at 1. Moreover: "The community is consciously pursuing economic development strategies—especially recreation and agri-tourism—that will enable it to preserve these aesthetic and environmental values and to continue enjoying the high quality of life central to its self-image." Ex. 5 at 4. The Finger Lakes wine and grape industry, in particular, has embraced the clean, serene, and bucolic community character as its brand, attracting thousands of visitors and allowing vineyards, wineries, and hundreds of small business that serve tourists to expand. This is reflected in the region's branding and in turn supports the development of other industries with skilled workers who

demand a high quality of life. *See* Ex. 6 at 1–2, 4–5. The economic impact of this growth also has been substantial, with tourism in the Finger Lakes supporting 58,000 jobs and contributing $2.8 billion to the local economy. *Id.* at 8.

Dr. Flad's assessment identifies "seriously detrimental effects of the Project" on scenic vistas, lake-based recreation, and the regional economy and concludes that it "will overlay an indelible industrial image on the cultural landscape of Seneca Lake, and the Finger Lakes more broadly, which will significantly and adversely affect the inhabitants' hard-won and prized community character." Ex. 5 at 39–40. According to Dr. Flad, the Project will cause disruption of scenic vistas, traffic and noise impacts, and "socio-economic impacts on the region's wineries and tourist-related business, which depend on stable community character as the foundation of their brand." *Id.* at 40. The Project will cause significant adverse economic effects by industrializing the Seneca Lake shoreline and thereby undermining the perception that the regional environment is centered on "aesthetic values, such as scenic views; prospering wineries and vineyards; culinary arts; heritage sites; and recreational activities such as fishing and boating." *Id.* at 37; *see* Ex. 6 at 1, 2 (noting that "damage to the regional brand from the risks posed by the Project is likely to have a significant adverse effect on the growth trajectory in the region").

The DSEIS does not provide any analysis whatsoever of community character and therefore fails to meet the requirements of SEQRA. The failure to address any of the Project's significant negative impacts on community character renders the DSEIS insufficient and precludes DEC from issuing the required finding under SEQRA section 617.11(d)(5) that, "consistent with social, economic and other essential considerations," the Project "avoids or minimizes adverse environmental impacts to the maximum extent practicable." The Project

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impacts on community character also cannot be mitigated by FLLPG and should form the basis for denial under SEQRA of the Project's underground storage permit. The Project's potentially significant adverse impact on community character therefore is a substantive, significant, and adjudicable issue.

LEGAL ISSUES FOR RESOLUTION (6 NYCRR § 624.4(b)(2)(iv))

Deficiencies in the DSEIS raise legal issues the resolution of which is not dependent on disputed facts and that can be resolved on their merits following argument at the issues conference. *See* 6 NYCRR § 624.4(b)(2)(iv). As is discussed above, the DSEIS violates SEQRA because it did not include any analysis of community character and therefore failed to provide both the requisite "description of the environmental setting . . . sufficient to understand the impacts of the proposed action and alternatives" and the required "statement and evaluation of the potential significant adverse environmental impacts." *Id.* § 617.9(b)(5)(ii)-(iii). The DSEIS also failed to include any analysis of potentially significant cumulative impacts. Further, the DSEIS did not analyze the no-action alternative or any other reasonable alternatives to the Project (except for a few different brine pond configurations), as is required under SEQRA. *See id.* § 617.9(b)(5)(v). DEC's compliance with those procedural requirements is subject to a "strict compliance" standard of review. *See Matter of King v Saratoga County Bd. of Supervisors*, 89 NY2d 341, 347–48 (1996).

Such major omissions cannot be cured merely by including the missing analysis in the Final SEIS. *See Webster Assoc. v Town of Webster*, 59 NY2d 220, 228 (1983) ("[T]he omission of a required item from a draft EIS cannot be cured simply by including the item in the final EIS."). Rather, DEC must issue a revised version of the DSEIS for public comment. A revised DSEIS should be submitted for public comment also because the Applicant has substantially

changed the Project since the DSEIS was published in August 2011, including as recently as last December 2014. *See* 2014-12-02, Product Transportation Allocation – Revised December 2014, letter and attachment. Although GFS repeatedly has requested—on these and other grounds—that DEC publish a revised DSEIS, the Department so far has refused to do so.[3] GFS therefore requests that argument be heard on this legal issue at the issues conference.

I. The DSEIS Does Not Comply with SEQRA Because It Ignores Potential Cumulative Impacts.

The DSEIS fails to include an analysis of the cumulative impacts of the Project, in violation of SEQRA. An EIS must discuss the "reasonably related short-term and long-term impacts, *cumulative impacts* and other associated environmental impacts." 6 NYCRR § 617.9(b)(5)(iii)(a) (emphasis added). DEC acknowledges that cumulative impacts "can occur when the incremental or increased impacts of an action, or actions, are added to other past, present and reasonably foreseeable future actions."[4] DEC also requires that cumulative impacts be assessed "when actions are proposed, or can be foreseen as likely, to take place simultaneously or sequentially in a way that the combined impacts may be significant."[5]

As DEC is well aware, Arlington Storage Company, LLC ("Arlington"), an affiliate of FLLPG, has received permission from the Federal Energy Regulatory Commission ("FERC") to expand its natural gas storage facility on property adjacent to the Project. Arlington received FERC permission to acquire the property from NYSEG in August 2010, and DEC knew of "future NYSEG/Arlington natural gas storage" in the wells providing the expanded capacity by

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[3] Counsel for GFS sent Ms. Schwartz written requests for a revised DSEIS in an e-mail message on March 4, 2013 and in letters dated May 5, 2013, September 4, 2013, and August 8, 2013.
[4] DEC, 83 (3d ed. 2010) *available at* http://www.dec.ny.gov/docs/permits_ej_operations_pdf/seqrhandbook.pdf [hereinafter "SEQR Handbook"].
[5] *Id.*

April 2011.[6] The expansion thus was reasonably foreseeable when DEC prepared the DSEIS, and the expanded operation predictably would affect the same environmental resources and communities as the Project. DEC therefore was obligated to evaluate, but failed to evaluate, whether these two adjacent projects, as well as any other nearby projects, cumulatively would have significant adverse environmental impacts. Having failed to conduct that assessment, DEC also could not evaluate whether any of the significant impacts could be mitigated, and if so, to what extent and using what measures. Absent a meaningful analysis of cumulative impacts, DEC cannot make a reasoned finding under SEQRA that the Project's significant adverse environmental impacts have been minimized or mitigated to the maximum extent practicable. *See* 6 NYCRR § 617.11(d)(5). The DSEIS therefore is deficient under SEQRA and must be revised to include a cumulative impacts analysis that is made available for public comment.

II. The DSEIS Is Fatally Flawed Because it Does Not Analyze the No Action Alternative or Reasonable Alternatives to the Project.

The DSEIS does not include a discussion of the no action alternative or any reasonable alternative to the Project, except for alternative designs for the brine ponds. SEQRA regulations provide, however, that all EISs *must* include "a description and evaluation of the range of reasonable alternatives to the action that are feasible," including the no action alternative. 6 NYCRR § 617.9(b)(5)(v). DEC's SEQR Handbook states that "[t]he 'no action' alternative must always be discussed to provide a baseline for evaluation of impacts and comparisons of other impacts."[7] The failure to include a discussion of the no action alternative in the DSEIS therefore is a fatal error under SEQRA. *See, e.g.*, *MYC NY Mar., L.L.C. v Town Bd. of Town of E. Hampton*, 842 NYS2d 899, 906 (Sup Ct, Suffolk County 2007); *Matter of Long Is. Pine Barrens*

[6] 2011-04-19, BSK to DEC – NOIA Response (redacted) at 3–4.
[7] SEQR Handbook, *supra* note 4 at 126.

Socy., Inc. v Town Bd. of Town of Riverhead, 736 NYS2d 87, 88 (2d Dept 2002). This defect can be cured only by issuing a new draft SEIS for the Project. *See Webster* 59 NY2d at 228.

The DSEIS also contains almost no discussion of reasonable alternatives to the Project. The "Alternatives to the Proposed Action" section of the DSEIS is limited to an analysis of alternative designs to the proposed brine pond. Final DSEIS Text at 170–73. That discussion falls far short of the required consideration of all feasible and reasonable alternatives. *See, e.g.*, *Matter of City of Ithaca v Tompkins County Bd. of Representatives*, 565 NYS2d 309, 311 (3d Dept 1991) (upholding an environmental review that initially considered 11 alternative sites "with attention devoted to such matters as wetlands, aquifers, wildlife, traffic, zoning and the like" and conducted further evaluation of six plans on five sites, including a review of issues relating to "water, soils, wetlands, land use, visual and noise impacts and traffic."); *Aldrich v Pattison*, 486 NYS2d 23, 30 (2d Dept 1985) (upholding a environmental review under SEQRA that considered "a continuum of options" with respect to multiple aspects of the proposed project).

One obvious alternative that should have been analyzed is suggested by FLLPG's recent submission of a revised Product Transportation Allocation. With this submission, the Applicant ostensibly has adopted an alternative to the originally proposed Project—one that no longer uses trucks for delivery of LPG to markets.[8] According to this recent submission, all of the LPG will be transported to and from the FLLPG facility via rail or pipeline. The alternative of eliminating the use of trucks at the Project clearly is reasonable but was not analyzed in the DSEIS, and there is no other analysis of the alternative's environmental impacts.

[8] 2014-12-02, BSK to DEC, Transportation Allocation.

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As the Court of Appeals recognized in *Webster*, "the purpose of requiring inclusion of reasonable alternatives to a proposed project is to aid the public and governmental bodies in assessing the relative costs and benefits of the proposal." *Webster*, 59 NY2d at 228. The failure of the DSEIS to discuss an alternative eliminating truck deliveries makes it impossible for the public to understand the adverse environmental impacts associated with this alternative, including the risk to public safety and natural resources posed by increasing the amount of LPG transported by rail and pipeline. Announcing this major change to the Project more than three years after the publication of the DSEIS also eliminates the public's ability to compare the impacts of this alternative with those of the Project, as discussed in the August 2011 DSEIS. Moreover, neither the public nor DEC can evaluate the impacts of other changes to the Project that might result from FLLPG's announced change in product transportation allocation. For example, the Applicant has not indicated whether eliminating trucks for LPG deliveries also will alter the design of the Project, for instance by removing the need to construct the previously-contemplated truck depot or by requiring alterations to the design of the rail terminal or pipeline system. Such a major change in the Project warrants the issuance of a new DSEIS.

The new DSEIS also should discuss another alternative to the Project suggested by the revised Product Transportation Allocation. If propane goes by pipeline straight to Selkirk, as counsel for the Applicant suggests it will, the LPG stored at FLLPG's facility almost certainly will not be delivered to local customers. Residents of the Finger Lakes region therefore no longer stand to benefit from the propane price reductions that supposedly would result from storing LPG closer to their homes and businesses, because the Project will not alleviate local price spikes. Locating an LPG storage facility closer to the likely consumers could better address the declared purpose and need for the Project, *see* Final DSEIS Text at 12–14, and

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therefore should be considered as an alternative to the Project. *See Webster*, 59 NY2d at 227–28. (holding that "both the draft and final EIS, must contain a description and evaluation of reasonable alternatives to the action which would achieve the same or similar objectives.") (internal quotations omitted). The failure to discuss this option in the DSEIS has deprived the public of the opportunity to evaluate a range of reasonable alternatives.

DEC therefore should be required to prepare a new DSEIS that analyzes the no action alternative, clearly reasonable alternatives of eliminating truck deliveries and relocating the Project, as well as other reasonable alternatives. The failure to include any discussion of any of those alternatives cannot be cured by including the missing discussion of alternatives in a final EIS. *See id.* at 228. Although the *Webster* Court declined to overturn the environmental review at issue in that case, it did so *only* because the omitted alternative had been "the subject of extensive publicity and of debate by public officials and the general public." *Id.* at 228–29. There has been no such publicity or debate with respect to the foregoing transportation and location alternatives to the Project, and the no action alternative must be included under all circumstances. Because the DSEIS therefore is fatally flawed, it requires revision and resubmission for public review and comment.

CONCLUSION

For the foregoing reasons, GFS requests that it be granted full party status in a hearing scheduled for adjudication of the substantive and significant issues identified above and that all legal issues not dependent on disputed facts be resolved on the merits in favor of GFS.

Dated: New York, NY
January 16, 2015

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Respectfully submitted,

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Exhibit 1

Cavern Integrity Report
H. C. Clark, Ph.D.

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Cavern Integrity Analysis

Finger Lakes LPG Storage, LLC

January 15, 2015

H.C. Clark, Ph.D.

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I. Introduction

Finger Lakes LPG Storage, LLC (FLLPG) has applied for a permit to store liquid petroleum gas (LPG) in two underground galleries—known as Gallery 1 and Gallery 2—in the Watkins Glen Brine Field along the west side of Seneca Lake.[1] I was asked to prepare this technical report analyzing whether there are any risks to the integrity of the caverns proposed for LPG storage that are not addressed by FLLPG's application materials or the draft permit conditions published by the New York State Department of Environmental Protection (DEC) in connection with this project. In my opinion, there are serious questions remaining about the solution-mined salt caverns in this area and their future integrity, and the data gaps are serious enough to warrant denial of the permit. Moreover, even if sufficient new studies are performed to supply the missing information, and the application materials are revised to provide a comprehensive and accurate picture of the caverns and their geological context, it will be impossible to respond in a timely and effective way to any problems that may develop, unless significant additional conditions are included in the permit.

My report examines the geology of the area and its solution-mined caverns, with special focus on Galleries 1 and 2, the caverns bordering Galleries 1 and 2 on the south and north, and the high-angle strike-slip (tear) fault along the eastern boundary of the project. A thorough understanding of the surrounding geology is critical because that geology will be the container for LPG, and the caverns were not simply hollowed from a homogeneous and isotropic mass (that is, a uniform material with the same properties in all directions). The geology where these caverns have been dissolved has been folded, thrust faulted, and cut by vertical faults, leaving a complex geology that has controlled the development of the Watkins Glen Brine Field. The development, shape, and behavior of the caverns are, in large part, a product of that geology, acting over the history of each cavern, and for most of them, it's a very long history.

Questions about how this geology is involved with the caverns of the Watkins Glen Brine Field are important because problems involving salt storage caverns, wells, and mines have been documented over many years.[2] Examples of such problems in both bedded salt formations and domal salt include:

- Mid-1990s collapse of the Retsof, NY, bedded salt room and pillar mine, where a 500-foot-by-500-foot block of ceiling fell, leading to the flooding and closure of the mine.
- Yaggy bedded salt storage cavern leak and 2001 fire at Hutchinson, KS.
- Salt mine collapse in 1974 forming the 300-foot-diameter Cargill Sink at the Hutchinson, KS, bedded salt mine.

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[1] "The Watkins Glen brine field, located in Schuyler County, is in the south central part of New York State, along the west shore of Lake Seneca . . . . It is approximately four miles north of the Village of Watkins Glen." (Jacoby, 1962: 506) As used in this report, the "Watkins Glen Brine Field" or "Watkins Glen" refers to that area, including the wells and galleries in the Town of Reading that FLLPG proposes to use for LPG storage.
[2] Reports of these and other problems follow the list of references at the end of this report.

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- Explosion at Mt. Belvieu, TX, when stored LPG leaked from salt dome through corroded well casing, then to town sewer system.

- Ongoing collapse of Oxy3 Cavern at Bayou Corne, Louisiana, where a solution mined cavern in the Napoleonville Salt Dome has breached the salt wall, and subsequent collapse has chimneyed to the surface, creating a sinkhole that continues to expand.

Although the caverns listed above do not represent precise analogues of the FLLPG Galleries, the history should remind us that accidents do happen, and when they do, they can be very serious. No two caverns are exactly alike, if only because the local geology is different, and each requires careful study, controlled solutioning, and meaningful and frequent monitoring—to avoid the problems of these examples.

The basic question presented by FLLPG's application is whether or not there is adequate evidence of long-term cavern integrity—so DEC and the public can have confidence that problems encountered elsewhere will not happen at Seneca Lake—and the answer is no. The evidence is inadequate because much of the information that a geologist would ordinarily expect to find about the surrounding geology and features of the caverns is missing, incomplete, or incorrect. Moreover, the information that *is* available indicates that Galleries 1 and 2 and surrounding caverns—some more than half a century old—show effects of age and anomalies suggesting that long-term integrity may not be possible.

Documents supporting FLLPG's application for the underground storage permit were heavily redacted before public release, so public information about the site area is available largely from published articles and an application released by the New York State Electric Gas Corporation (NYSEG) for compressed air energy storage (CAES) nearby. That information was enough to raise a number of preliminary questions about the project, but it was not enough to answer them. [redacted]

To summarize the critical issues I identify:

- A professional geologist assessing the integrity of solution-mined salt caverns proposed for hydrocarbon storage will begin with the applicant's maps and cross-sections, which are supposed to depict the geology of the area, including stratigraphy and faults, as well as the extent, contours, and developmental history of the caverns. Comprehensive and accurate maps and cross-sections serve three crucial functions: (1) they allow analysts to flag issues that may become serious problems; (2) they help to identify where additional study or monitoring is needed; and (3) they expedite response when something goes wrong, by enabling analysts to understand quickly what happened and what corrective action is needed. FLLPG's application lacks the comprehensive and detailed maps and cross-sections that provide the framework for an adequate assessment of cavern integrity.

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- Some readily available and relevant data (for example, from publications by Charles Jacoby, the geologist who developed these caverns) is missing [redacted] and some of the visually displayed information is incorrect. When the omissions are cured, and the mistakes are corrected, the need for further study is immediately apparent. The map and cross-sections should be supplemented with the results of additional studies I identify below as well as known sources of information, both published and from company files evidently available to FLLPG.[3] Cavern integrity analysts should not have to comb through thousands of pages of application materials—as I have had to do—to piece together a comprehensive picture of the geology and storage cavities. It is dangerous and irresponsible not to have the resource readily available, if a problem develops in the future.

- For example, there are zones or planes of weakness in the walls and roofs of these caverns—such as thrust faults, fractures, and high-angle strike-slip faults—that are not shown on the maps and cross-sections. Some of these faults served as pathways for communication between wells in the past or for accidental transmission of fluids to the surface, and some have been linked to roof collapse. FLLPG insinuates that the documented Jacoby-Dellwig Fault does not exist or is sealed. Full studies of faults and fractures should be required, all such zones of weakness should be evaluated as potential pathways for communication, and the complete results of that analysis should be described and portrayed graphically in revised application materials, including in a monitoring plan.

- The caverns of the Watkins Glen Brine Field have grown outward and upward, and this growth will continue. Outward cavern growth may lead to communication with nearby caverns or fault zones. [redacted] Upward growth may lead to partial roof failure or complete collapse—as is evident from the rubble piles in the caverns of the Watkins Glen Brine Field. Sonars from 2009 and 2011 show that the roof of FLLPG Gallery 2 (Cavern 58)—which previously was abandoned because of a prior collapse—has reached the Camillus shale, appears to be sinking at the center, and may be unstable. This uncontrolled growth is partially depicted in the limited sonar slices shown on the cross-sections and [redacted]

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[3] The 2010 Reservoir Suitability Report submitted by FLLPG refers to "US Salt company files" (2010-5-14, BSK to DEC – NOIA Response Reservoir Suitability Report (redacted) at 1). Companies routinely maintain records of project development and performance over the lifetime of a project and after it has ended, so FLLPG may have access to additional historical documentation from company files. Such detailed records are important in understanding what has happened if there is a failure of some sort—such as a cavern roof fall—and in deciding how to address the problem.

[4] [redacted]

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[redacted] but a full complement of sonar comparisons, typical of cavern evaluations in the cavern development industry, is needed.

- The project borders are suspect. On the southern border of the FLLPG galleries (the site of the Arlington Storage Company, LLC ("Arlington") gas storage expansion project), the roof of Cavern 30 failed, and [redacted] Bordering caverns should be thoroughly evaluated, [redacted] These caverns should be fully characterized, and their ongoing measurement should be included in the monitoring program. The Federal Energy Regulatory Commission ("FERC") has required more extensive monitoring of Cavern 30 than previously was required for gas storage at the Arlington facility, as a condition of the approval issued for expansion. Enhanced monitoring should be required for both of the FLLPG Galleries and all neighboring caverns and galleries.

- The monitoring program planned is minimal, and much of it—including the subsidence leveling program that seems to monitor the weather, rather than the intended cavern roof subsidence—is inadequate. If the informational gaps and errors are addressed in revised documentation, and FLLPG's application is granted, DEC should require enhanced monitoring, providing real-time, continuous measurements, as additional conditions of the permit.

As a professional geologist, critically reviewing the FLLPG project, I would expect to see, at the beginning of an analysis, geologic maps and cross-sections fully describing the brine cavern field; the geology involved; operations, such as hydraulic fracturing, that created the passages between the caverns; and faults, folds, and fractures that have been involved the cavern development process. Then, I would expect to examine detailed studies, measurements, and discussions of specific issues introduced by a review of the basic data. FLLPG has provided enough information to raise safety questions and to create conflicts with published articles about the caverns to be used in this project and anomalous features of the surrounding geology. Ordinarily, I would expect a storage permit applicant to provide responses to those questions and resolution of those conflicts. Only after all the questions about cavern integrity are answered, would I expect to see development of a monitoring plan, using currently available technology, to serve as an early warning of impending cavern failure. The FLLPG application and draft permit conditions defeated all of my expectations and failed to conform to standard industry practices I have observed over decades as a professional geologist.[5] In my opinion, FLLPG understates cavern integrity risks, and the incomplete and inaccurate information in its application leads me to conclude that the Galleries cannot be used safely to store LPG, even with the monitoring required in the current draft permit conditions.

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[5] I have been an academic and consulting geologist and geophysicist for nearly 50 years. My curriculum vitae is attached to this report as Exhibit F.

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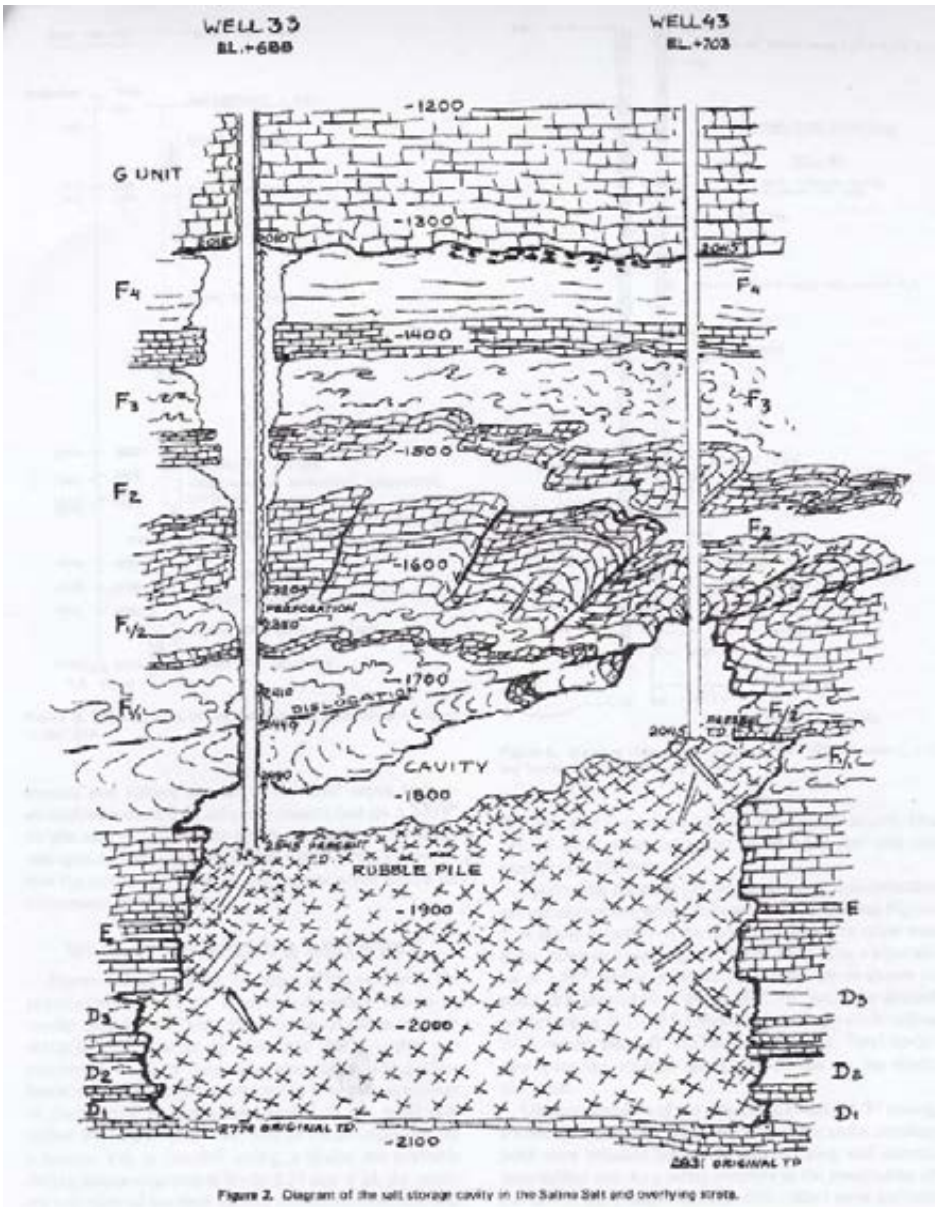
II. Overview of Relevant Geology

To place my analysis in context, it is important to understand the salt cavern solutioning process in its geological context. Making caverns like those in the Watkins Glen Brine Field is a matter injecting fresh water into a well, dissolving the bedded salt, and withdrawing the resulting brine. The geologic cross-section in Figure 1 below shows an injection well and a withdrawal well typical of the multi-well caverns at the Watkins Glen Brine Field. (Jacoby, 1973). In fact, this is a cross-section of two of the wells involved in Gallery 1 of the FLLPG project—Wells 33 and 43—now part of a mega-cavern joining Wells 33, 43, 34, and 44.

Figure 1: Wells 33 and 43
Source: Jacoby, 1973



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Both wells were first drilled, then fresh water was pumped into one under pressure—creating a hydraulically fractured connection along a fault plane connecting the two wells, and solution of the cavity followed. The wells still exist and can be opened for logging and to lower sonar devices or other equipment used to monitor cavern pressure, salinity, and seismic events with periodic or continuous measurements.

The stratigraphy (rock layers) shown in Figure 1, like that of the Watkins Glen Brine Field generally, involves salt beds (shown with the letters and subscripts) and interbedded layers of shale, limestone and dolomite (shown by the patterns). The cross-section illustrates the folded rocks and salt layers, along with thrust faults—one is just below elevation -1700 with the notation "dislocation." The original hydraulic fracture in this example was near the bottom of the cavern, and as solutioning of the cavity progressed, rock layers—which did not dissolve—were undermined and fell into the cavern, creating the "rubble pile." The tubing through which the fresh water was injected and the brine was removed was cut off as the process moved upward (and cut off pipe pieces are depicted in the rubble pile).

The caverns of the brine field are solutioned in bedded salt of the Silurian Syracuse Formation, sandwiched between Vernon shales below and Camillus shale (shale, dolomite and gypsum) above. The stratigraphic column in Figure 2, below, from the proposed NYSEG CAES plan, describes the nearby rock section (PB Energy Storage Services, 2011:5). Here, the interbedded salt and rock layers are designated by letters, then numbers and numbers within (like F1/1 and F1/2). The nomenclature has changed through the years and the lettering in Figures 1 and 2 may not match exactly.

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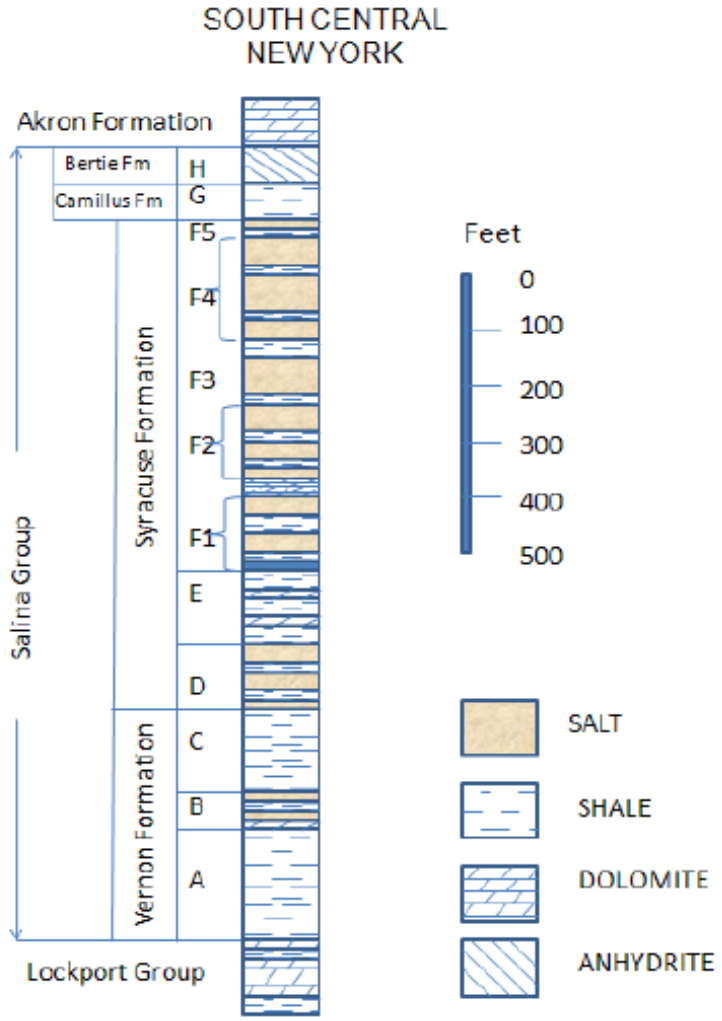
Figure 2: Column of Rock Layers
Source: PB Energy Storage Services, 2011



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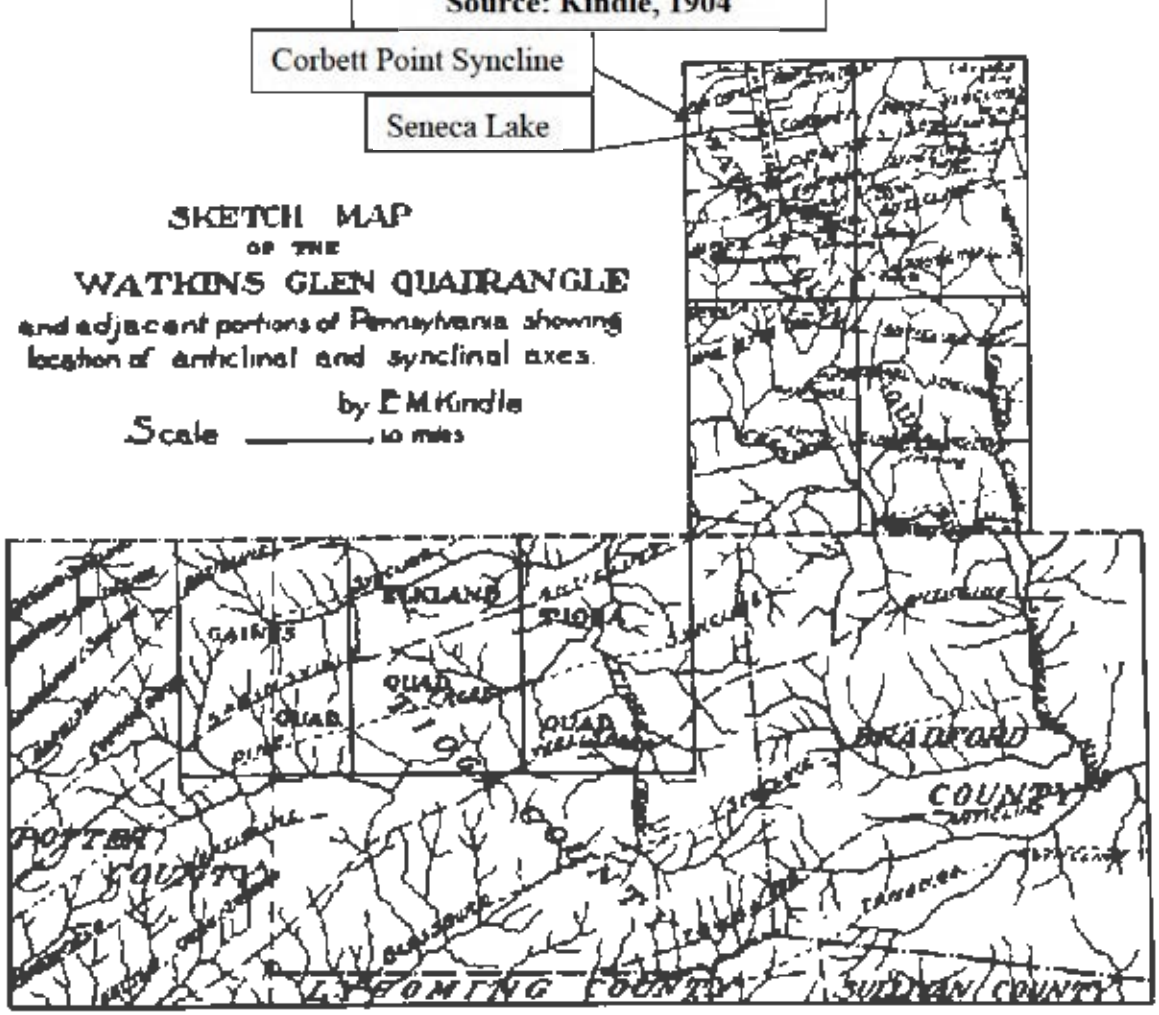
Within the Syracuse formation, salt layers are interbedded with shales and dolomites that resist solutioning, but not gravity, and fall from the walls and roofs of these caverns, leaving all the caverns here at least partially filled with rock rubble. The alternating salt and rock beds were originally laid down in a shallow interior sea that was oftentimes limited in its connection to ocean exchange—thus the salt. Devonian rocks complete the section to the surface as gently folded east-northeast trending anticlines (areas bowing up like the arch) and synclines (areas bowing down like a trough) (here the Corbett Point Syncline), the signature of Appalachian tectonism left behind. These structures in the vicinity of Seneca Lake have long been well known, and Figure 3 below illustrates their relationship to Appalachian geology to the south of Watkins Glen.

Figure 3: Map of Geology
Source: Kindle, 1904



The Syracuse Formation beneath these folds was not treated so gently. The Appalachian push from the south used the salt layers, being quite malleable, and the shale, still holding a lot of water, like a skateboard's rollers, floating the Devonian rocks over folded, thrust faulted and tear faulted Silurian beds, leaving often thickened salts and shales pushed up and over one

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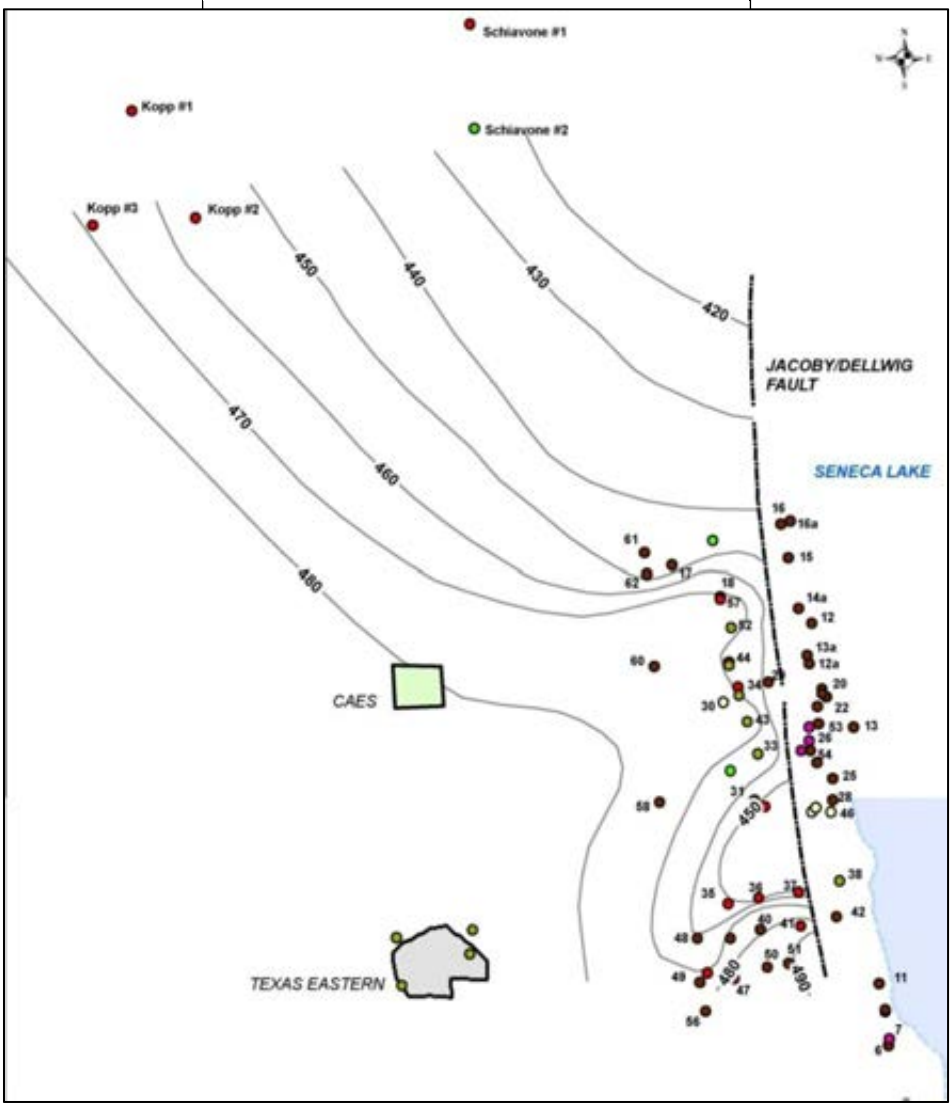
another in stacks of repeated sections, cut again by high-angle strike-slip faults (Jacoby and Dellwig, 1973). The FLLPG site-specific, thrust fault thickened, salt, and the effect of the high-angle strike-slip fault, are shown on Figure 4 below, a salt isopach (thickness) map of the vicinity from the NYSEG CAES application (PB Energy Storage Services, 2011). This is the complex that makes up the walls, floors, and roofs of the caverns in the Watkins Glen Brine Field, most of which are about a half-century old. Those walls, floors, and roofs reflect both the area's long-term geologic history and events that occurred during individual cavern development.

Figure 4: Salt Isopach Map
Source: PB Energy Storage Services,



III. Assessment of Cavern Integrity

My assessment of cavern integrity is organized around a map showing Watkins Glen Brine Field wells and gallery outlines and three cross-sections created by FLLPG to outline its

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plan. I begin with an overview of the caverns in the area, move to an examination of the cross-sections provided in the application, and then consider faulting and other geological features affecting the caverns and concerns about cavern growth. I offer observations at each stage in the context of additional information that I have obtained from public sources. My report concludes with a set of recommendations for studies, tests, and monitoring.

A. Gallery Map

[redacted] How are these caverns related or could they become related; that is, what happens to the rest if there is a problem at one? To answer that question, it is essential to understand a lot more information [redacted]—some of which I add in this report.

[redacted] There needs to be a comprehensive study of all the caverns in the brine field and development of a "state of the brine field" map that includes geology as well as information about each cavern and how it is related to others.

[redacted] Much of this added information was developed by International Salt geologist Charles Jacoby. He was able to use geologic mapping of structural grain and associated planes of weakness to plan pairs of wells, where fractures would develop along preferred pathways between the pressured and the interceptor well. Most of the caverns in the Watkins Glen Brine Field were formed by this hydraulic fracturing from one well to another, and the coalescent history has resulted in some complex, large elongate cavern shapes. [redacted]

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[6] [redacted]

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[redacted] There is a lot more about hydraulic fracturing pathways that would be good to know, and a lot more hydraulic fracturing was done or attempted at the Watkins Glen Brine Field. This missing information would illuminate weaknesses in the rocks that created the pathways for hydraulic fracture flow and may explain present cavern growth behavior.

Charles Jacoby wrote a number of papers about geology and cavern research and development, including articles with a number of examples of well behavior in the Watkins Glen Brine Field and descriptions of the geology that influenced this behavior. Table 1 below is a partial list of well pairs subject to hydraulic fracturing that were documented by Jacoby. [redacted]

Table 1: Well Pairs and Hydraulic Fracture Connections

Year	Well Pumped for Fracture	Target Well	Connected?	Well Unintentionally Connected	Note	Reference
1956	28	27	Yes			Jacoby, 1962, 1969
1955	25	23	No		Fluid pumped through Well 25 went to "vacuum"	Jacoby, 1962
	41	42	No	37		Jacoby, Dellwig, 1973
	40	39	No	42		Jacoby, Dellwig, 1973
1962	33	32	No	34 (north)		Jacoby, Dellwig, 1973, Jacoby, 1965
	29	34	No	32	Fluid traveled south along Jacoby-Dellwig Fault	Jacoby, Dellwig, 1973
1962	29	34	No	surface	Fluid reached surface 1/2-mile north, along Jacoby-Dellwig Fault.	Jacoby, Dellwig, 1973
1962	33	34	Yes		Thrust fault caused fluid to reach well at unintended location.	Jacoby, 1965
	30	31	Yes		Thrust fault caused fluid to reach well at unintended location.	Jacoby, 1969
	33	43	Yes			Jacoby, 1973
1963	35	36	Yes			Jacoby, 1969
1963	37	38	Yes			Jacoby, 1969

Jacoby's knowledge about the regional structural grain (the near east-west Corbett Point Syncline) allowed him to plan locations of connections where there had been only apparently

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random connection before. He was able to take advantage of the east-west weaknesses of folding and thrusting as long as there was not an easier path for hydraulic fracturing fluid flow. An unexplained change in the behavior of attempted fracturing, as fracture operations moved north and approached Seneca Lake, led him to recognize the role of north-south tear faulting. Several wells failed to fracture to an east-west target well and instead connected with a well to the south or north. [redacted]

Comparison of geophysical logs from wells near this change in fracture path described a vertical fault plane with about 1200 feet of horizontal displacement (and related smaller faults), as well as thrusts (Jacoby and Dellwig, 1973). This tear fault, or high angle strike-slip fault, is the Jacoby-Dellwig Fault, shown in Figure 4, above). East of the Jacoby-Dellwig fault, thrust development of the salt section is reduced. [redacted] The significance of this tear fault is in part that, when fracturing Well 29, fluid travelled along this fault and flowed out at the surface a half-mile north of the initial fracture.

[redacted]

[redacted]

B. Cross-Sections of the Caverns

The FLLPG Reservoir Suitability Report includes three cross-sections. The first, cross-section AA', shows caverns along the southern border of the FLLPG property and includes Cavern 58, or FLLPG Gallery 2. The second, cross-section BB', is through the caverns of

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[7] [redacted]

For example, the salt isopach map in Figure 4 shows the detail of the section in the area of this cavern project, and that cumulative salt thickness, built by thrust faulting, should be shown The significance of the thrust faults in this region is that, as nearly horizontal bedding plane features, they represent horizontal planes of weakness that have functioned as pathways for hydraulic fracture fluid flow. The faults, related hydraulic fracture connections, and the differences in salt, shale, and dolomite layer properties influenced the creation of all of the caverns of the Watkins Glen Brine Field, including the caverns that FLLPG storage proposes to use for storage. The salt caverns here are not solutioned out of a homogeneous and isotropic mass, and the caverns reflect this geology. The differences in the salt and rock remain, along with the folds, fractures, and faults that are part of the walls and roofs of these caverns.

Showing rock and salt layers as solid, intact materials, where a cavern in fact is filled with broken rock, is inaccurate and misleading. It is important to know what these cavern systems look like, how and where these caverns are connected, and how the geology may affect the system including these caverns.

Each of the three cross-sections is examined below, with reference to mark-ups attached to this report as Exhibits B–D.

1. Cross-Section AA' (revised 8-28-14)

This west-to-east cross-section begins at the left edge of the diagram with Cavern 58, or FLLPG Gallery 2, and then depicts the subsurface along the southern border of FLLPG property, incorporating the Arlington natural gas Caverns 30, 31, 28, and 27. The inset on the lower left shows the stratigraphic context of the interbedded salt and rock in the detailed cross-section at the top. The letters with subscripts on the left edge and near the right edge name the interpreted

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layers of salt (shown as white), and the interbedded rock layers (shown as a red pattern). Typically, rock core description data and/or geophysical logs are superposed or referenced on a cross-section to support the interpretations and allow independent verification, but that is not the case here. The addition to cross-section AA' of the log data developed by Jacoby (in his published papers) and the logs for Well 58 (included in the application, *e.g.*, 2010 Reservoir Suitability Report, Exs. 5 and 6) would be helpful.

Cavern 58 will be discussed in more detail later, but some basic information requires immediate correction. Two rock layers are depicted abutting Cavern 58 in unlikely locations. One layer is shown a third of the way up in the new cavern being solutioned above the collapsed original and passing through the 2011 and 2013 sonar outlines (likely a drafting error). The other rock layer, shown beneath and apparently supporting the new Cavern 58, conflicts with the underlying information in the application. The implied structural support beneath the new Cavern 58 raises an important question: Is the layer real, making its future over the previous Cavern 58 rubble pile somewhat precarious? Or, is the new Cavern 58 floored on the rubble of the lower Cavern 58 roof collapse, and the continuous bed pictured an error? According to the well status report in the Reservoir Suitability Report, the base of the new Cavern 58 is "top of rubble,"[8] making the depiction as solid rock an error. The phrase "top of rubble" here and at several places on the cross-section indicates that there is rubble between the old and new cavern floors and that, as Cavern 58 has been solutioned, the relatively insoluble interbedded rock has fallen and filled the base of the cavern. A complete cross-section should show the volumes now filled by this rock. The rubble-filled historic cavern outline for Cavern 58 is shown on Exhibit B.

a. Caverns 27, 28, 30, 31, and 46

Moving to the east on cross-section AA', the galleries of Caverns 30 and 31and Caverns 28 and 27 are part of the Arlington natural gas storage expansion project recently approved by the Federal Energy Regulatory Commission. This proposal was the subject of detailed comments, and most of the comments and FERC's responses are available for review. FERC has asked for "a new sonar survey of Gallery 2, through all three cavern wells, to obtain the current size of the gallery, the size and shape of the rubble pile, and the shape of the roof around each well."[9] That is, for the gallery involved with the 400,000-ton roof fall described by Jacoby, Arlington not only must develop measurements of the currently open cavern, but also must obtain measurements that fully characterize the size and shape of the rubble pile at the bottom of the complete gallery. The latter measurement likely will require seismic testing, because sonar cannot penetrate the rubble.

Information missing from cross-section AA' is available from Jacoby studies of these specific caverns. The 1967 cross-section of these caverns (Jacoby, 1969), shown below in

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[8] 2010-5-14, BSK to DEC – NOIA Response Reservoir Suitability Report (redacted) (Ex. 9 at 2).
[9] FERC, Order Issuing Certificate and Reaffirming Market-Based Rates, 147 FERC ¶ 61,120, at ¶ 31 & Engineering Condition 3 (May 15, 2014).

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Figure 5, below, was developed after their initial hydraulic fracture connection. It provides a clearer picture of the actual situation here, in contrast with the current open space measured by recent sonars above beds depicted as continuous on FLLPG cross-section AA'. The information on this Jacoby cross-section should be disclosed on cross-section AA', but it is not.

Figure 5 shows the outlines of the caverns, the hydraulic fracturing connections between caverns, thrust faulting and tear faulting, in addition to the more detailed stratigraphy here that Jacoby developed from core samples and geophysical logs. The notation in the middle of the rectangular shape at the base of Cavern 30, "Fallen Rock Mass," describes a 400,000-ton block that fell from the roof (outlined by sonar). I have sketched the cavern outlines developed from the 1967 sonars on cross-section AA' and have attached the marked cross-section as Exhibit B to this report, to allow comparison.

Figure 5: Wells 27, 28, 30, and 31
Source: Jacoby 1969

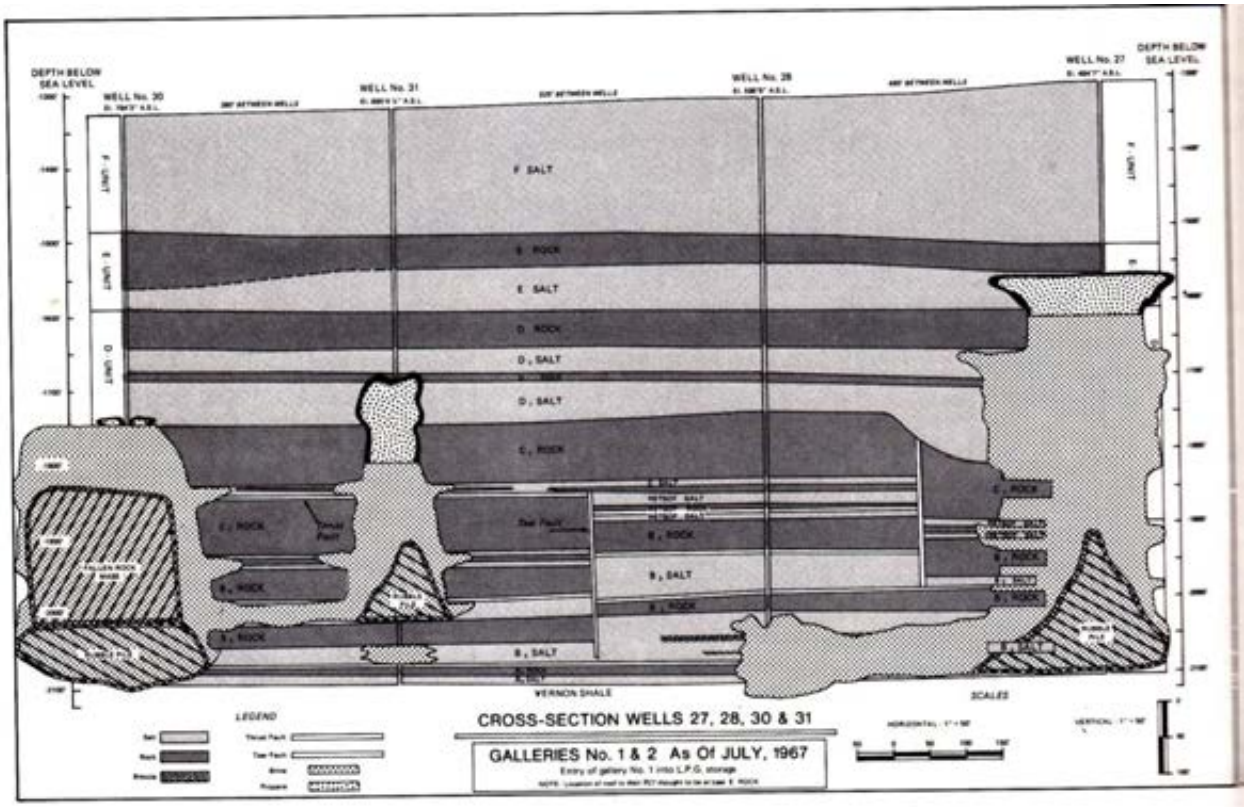

Figure 3.

Also, on FLLPG cross-section AA', note the "Top of Rubble" arrows between Caverns 30 and 31 and the "Estimated Location of Pressure Connection" arrow between the two caverns—two features that help to reconcile the Jacoby cross-section with cross-section AA'(in addition to the depths shown on the Jacoby cross-section). Corresponding locations of "Top of Rubble" and "Estimated Location of Pressure Connection" appear on cross-section AA' for

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Caverns 28 and 27, enabling the match with the Jacoby cross-section there, as well. Additional published sonar measurements (Jacoby, 1973) of Cavern 27 provide information about the upward path of the cavern roof.

There is a cautionary tale about Cavern 27, the basis for the Jacoby research paper related to this additional sonar. Cavern 27 sonar was used to guide the drilling of Well 46 to recover LPG that had migrated upward, as roof fall developed out and away from the original Well 27. He noted that additional LPG might be trapped above weakened rock leaves of the then-present cavern roof. This rock is now part of the rubble pile noted on AA'.

Figure 6: Wells 46 and 27
Source: Jacoby, 1973

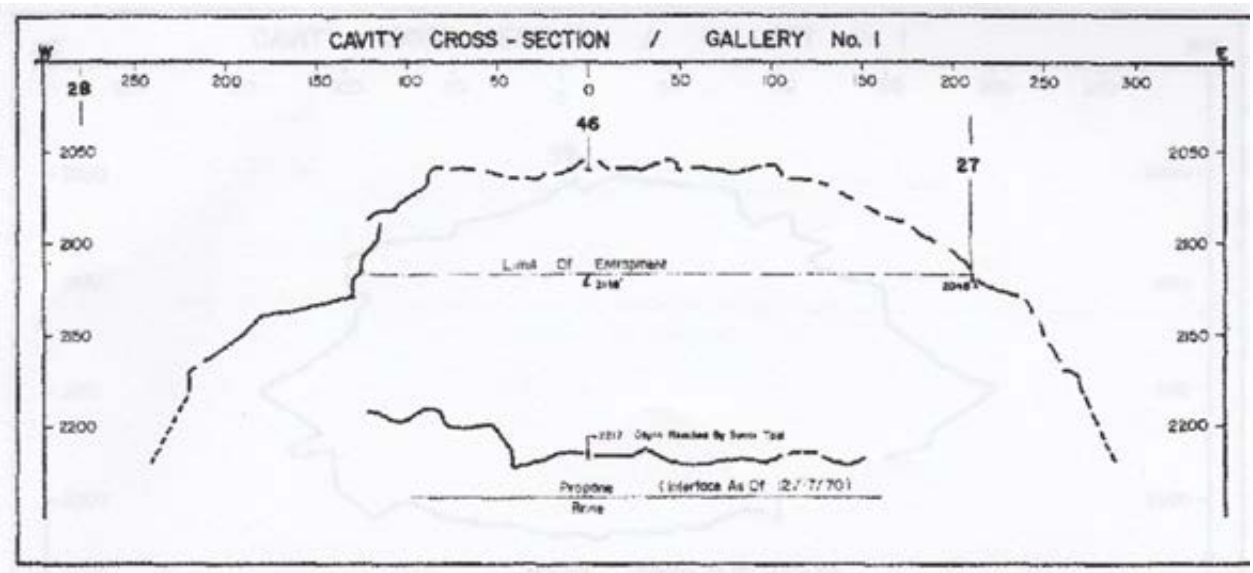

Figure 8. Cross section of the salt storage cavity through Gallery No. 1 (E-W).

Figure 6 (Jacoby 1973) shows Wells 46 and 27. Well 46 was drilled to recover trapped LPG and likely did not extend to the depth shown on cross-section AA'. Cross-section AA', with the addition of information from these sonar studies, would provide a picture of the cavern advancing from Jacoby's initial work, through the Well 46 experiment, and on to the present roof outline.

My mark-up of cross-section AA' in Exhibit B shows cavern outlines and the Jacoby-Dellwig Tear Fault, shown in Figure 3 above between Caverns 31 and 28 and in Figure 4 parallel to the shore of Seneca Lake. Thrust faulting shown on the Jacoby cross-section and discussed in his 1973 article with respect to the thickened salt in Well 27 also should be added to cross-section AA'. The locations of the thrust faults were developed from the repeated signatures shown on gamma logs from Wells 27, 28, 30, and 31 and discussed in several Jacoby papers. Jacoby discussed subsidiary faulting related to both of the major faults shown on his cross-section, and that faulting should be recognized and plotted on cross-section AA'. The original sonar information and the geophysical logs that were the basis for Jacoby's cross-sections and

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interpretations—and that are necessary to provide a complete account of the geology in the area covered by cross-section AA—are likely in salt company files available to FLLPG. Once completed, the revised cross-section AA' should show the thrust faults and tear faults that explain the variations in salt and rock layers shown on the 8/28/14 cross-section AA' now in the application.

In response to a Notice of Incomplete Application with questions from DEC about faults, FLLPG discussed only the Camillus shale above the interbedded salt and rock layers and repeated the conclusion that thrust faults do not involve the Camillus.[10] But the thrust faults and tear faults that are part of the overall geology, [redacted] The appropriate time to present interpretations of beds above and below the deformed salt is after all the geological information is presented visually in the cross-sections.

b. Cavern 58

Figure 7 below is my mark-up of the portion of cross-section AA' depicting Cavern 58, which is FLLPG Gallery 2. This cavern has been a focus of concern for a long time. It could be described as the combination of two caverns: (1) the new one with its roof at the Camillus shale, the upper bound of the interbedded salt and rock layers, and with its base outlined by the 2009 sonar, with a "morning glory" shape, and (2) the original attempt at cavern development, below the new one, as outlined by the 1997–1999 sonars, which now is filled with rubble, the result of a roof collapse and consequent abandonment. FLLPG shows them as isolated on cross-section AA', but in fact they are connected, as I show on Exhibit B.

[10] 2010-05-14, BSK to DEC – NOIA Response (redacted) at 8.

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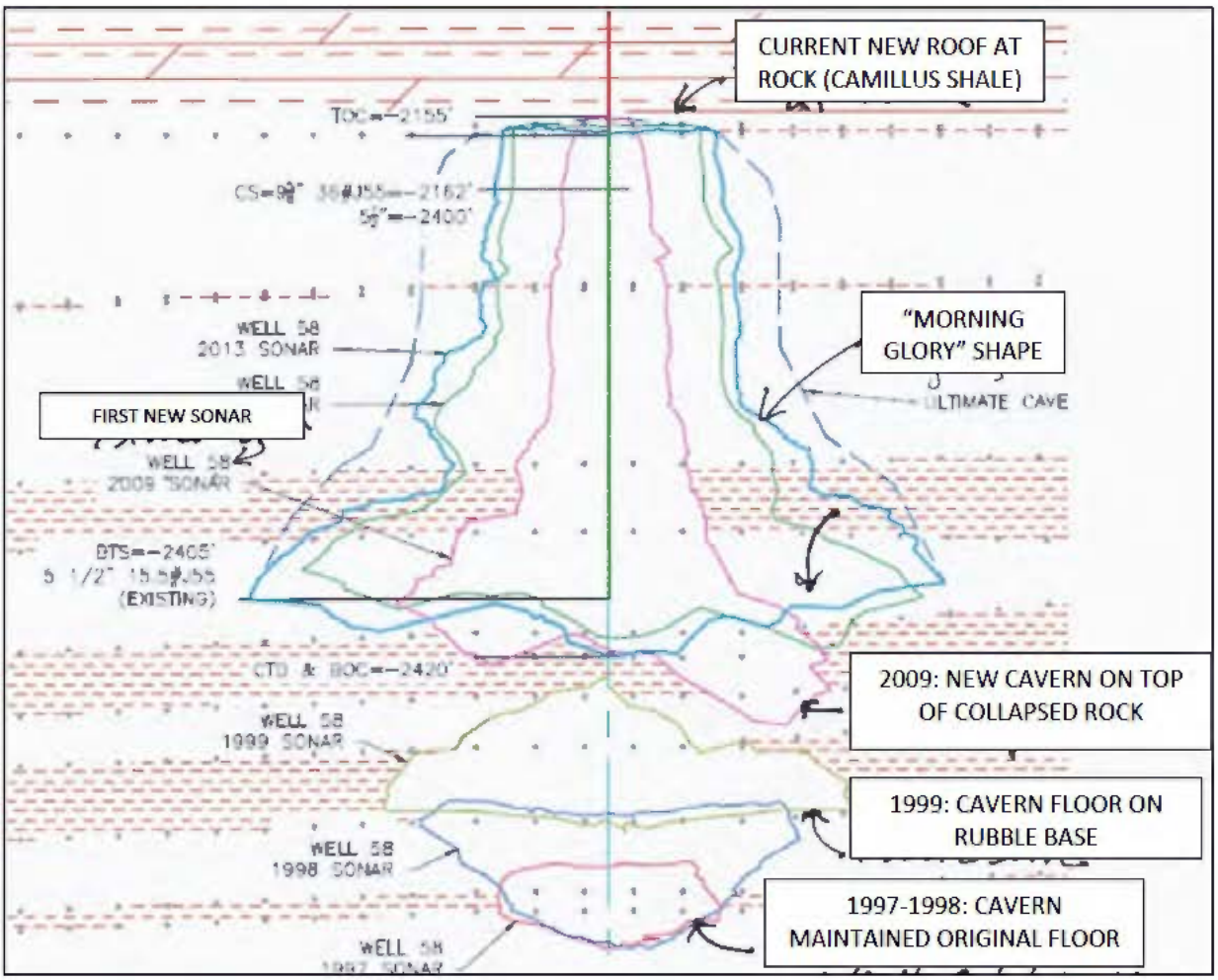
Figure 7: Clark Mark-Up of Cavern 58 Cross-Section
Source of Cross-Section: FLLPG (filed Oct. 23, 2014)



[redacted] The 1997 sonar survey (lowermost outline on Figure 7) captures the status of the cavern's solutioning at that time. The open cavern sequence continued as shown on successive sonars from 1998 and 1999. The base of the 1999 sonared cavity was flat, illustrating the accumulated rubble from the collapsed rock layers (red pattern) and that cavern development was progressing upward from that rubble base as solutioning continued. The next routine sonar logging attempt found a catastrophic change—outlined in a series of documents describing the situation and summarized in a letter dated May 24, 2001, from US Salt to DEC:

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[11] [redacted]

> Reports and conversations with Larry Sevenker prior to the last loggings appeared that the cavern at Well 58 was progressing normally. The latest logging indicated that the roof of the cavern had collapsed and filled with rubble. Mr. Sevenker further reported that it appeared that the upper formations may have been in a fractured and faulted zone and that a small magnitude earthquake could have damaged the cavity.

Other (partially redacted) documents disclosed by DEC pursuant to a Freedom of Information Law Request (but not included in the documents released to the public for this proceeding) make it clear that the Cavern 58 project ended because of concerns that questionable geology ("fractured and faulted zone") in the immediate vicinity made it unwise to place a cavern there.[12] The cavern had collapsed, and continued to collapse each time they pulled up tubing and tried to work again, so the well was plugged and sealed.

FLLPG attempts to discredit Mr. Sevenker [redacted] This explanation fails for several reasons. First, the cavern developers were "[u]nable to sonar survey due to cavity conditions" (Jan. 8, 2001 report); [redacted] Second, the presence of open hole from the top of the abandoned area to the top of the salt was known at the time and disclosed on the plugging report. [redacted] Cross-section AA' shows the "original" cavern at its original position; what is there now has been solutioned above the original cavern. [redacted] Exhibit B demonstrates that neither alternative is correct; rather, the new cavern was solutioned above the old. The serious questions remaining about the integrity of Cavern 58, given its earlier catastrophic collapse, cannot be explained away by impugning the reputation of a geologist with first-hand knowledge of the event.

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[12] These documents include the letter quoted above; page 3 of a report dated January 8, 2001, on the inability to use sonar in Well 58 (apparently from the files of DEC petroleum geologist William Glynn), and the 2003 plugging report and cover letter from the consultant, Mr. Sevenker. These documents are collected and attached to this report as Exhibit E.

[13] [redacted]

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Moreover, there is evidence not only of past cavern failure but also of current roof instability. The sonars in cross-section AA' show that the roof in 2009 is higher than in 2011 and that, by 2013, the roof is visibly sagging. [redacted]

The sagging occurs even as the extent of the roof grows, adding to the risk of collapse. Finally, Cavern 58 extends to the Camillus shale; there is no salt layer to provide support for the roof.

c. Summary of Cross-Section AA' Issues

Summarizing the review of FLLPG cross-section AA': the depiction of rock and salt layers beneath sonar outlines of Caverns 58, 30 and 31, and 28 and 27 as continuous is incorrect and misleading; there are rubble-filled caverns here that have been solutioned upward through time, and this area should be shown not as a continuous red pattern and white area meant to characterize intact rock layers, but rather with a rubble symbol, [redacted]

[redacted]. The fact that there is [redacted], but no such attempt with respect to Caverns 30 and 31 and 28 and 27, increases concerns about FLLPG's misrepresentation of conditions in the caverns.

My concerns about a broader analysis of the caverns bordering proposed FLLPG Gallery 2 mirror my concerns, [redacted] and are reflected in FERC's insistence upon further study of the rubble piles and conduits as a condition of approving Arlington's gas storage expansion. Complete and accurate information about caverns bordering the FLLPG project is crucial because the Arlington caverns holding and cycling compressed natural gas could fail—in turn jeopardizing the integrity of the adjacent FLLPG caverns. Exhibit B shows the southern border of the proposed LPG storage caverns to be far more complicated and potentially compromised than shown in cross-section AA'. DEC should analyze the new information that FERC has required from Arlington before determining whether to grant FLLPG a permit for LPG storage.

Finally, more study is needed not only of Cavern 58's rubble-filled base but also of its unsupported rock roof. FLLPG has gone to some length to demonstrate the healing power of salt, but it now has at least two caverns with flat or sagging rock roofs. FLLPG's claim that thrust faulting does not appear to affect the Camillus shale [redacted]—two things not expected in a uniform shale. [redacted] Thus, FLLPG's own records about the rock roof raise serious and unanswered questions about Cavern 58's suitability for LPG storage. DEC's permit determination should be deferred until after it has a full and correct understanding of Gallery 2 and the bordering caverns, and until that additional study is complete, the application lacks sufficient data to show that the reservoir is adaptable for storage purposes.

C. Cross-section BB' [redacted]

[redacted]

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[14] [redacted]

[redacted]

1. FLLPG Gallery 1

[redacted] Specifically, the Jacoby (1973) cross-section, reproduced above as Figure 1, illustrates the early history of the cavern originally created when Well 33 was hydraulically fractured to Well 43, [redacted]

First, the Jacoby cross-section in Figure 1 shows a thrust fault cutting (at depth 2449) just above the cavern that existed at the time, which was formed by the connection of Wells 33 and 43. That fault forced the rock and salt beds up and over one another within the Silurian section, [redacted] The thickened salt mass found in Well 34 was noted by Jacoby (1969) in discussing the northern involvement of thrust faulting. [redacted] While the fault and folds shown in Figure 1 are largely now part of the rubble pile, they are also part of the walls of the cavern. [redacted] these faults are planes of weakness that could serve as fluid pathways or influence future cavern deformation.

[redacted] The Jacoby cross-section clarifies that, as salt was dissolved, the rock layers above the former salt were no longer supported and fell to the bottom, forming the rubble shown. That process began at the base and moved up, [redacted] with accumulated rubble below.

[redacted]

Jacoby shows the top of the original cavity as 2490 total depth at Well 33, Figure 1 also shows an apparently well cemented casing at Well 43, but void space around the casing at Well 33 from the cavity as it existed then up to about 2010 depth.

Beginning with the area beneath Cavern 44, the Well Status and Condition Report lists "Top of rubble, bottom of existing cavern" as 2423 feet for Well 44, For Cavern 34, the Well Status and Condition Report lists the "Top of rubble, bottom of existing cavern" as 2383 feet,[16]

[15] 2010-5-14, BSK to DEC – NOIA Response Reservoir Suitability Report (redacted) (Ex. 9 at 2).
[16] *Id.* at Ex. 9 at 1.

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The discussion in the previous paragraphs raises a question about the connections of the mega-cavern in the upper open cavern space. Where and how did they all become connected in the first place? The answer is: at the level of the rubble pile "tunnel" and not intentionally. The Jacoby (1973) cross-section discussed earlier shows the base of the cavern connecting Wells 33

[17]

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and 43, near the base of the Syracuse, and then subsequent solution up from there. The hydraulic fracture that connected Well 33 to Well 43 was apparently a second event. Here, Jacoby (1965) described an unintended fracture connection where Well 33 fractured to Well 34, rather than the intended target, Well 32.

> Well # 33 was an injection well with an intended target of Well # 32 across a distance of 735 feet. Unexpectedly, it connected with Well # 34, or almost due north, a distance of 745 feet. Within 24 hours after the fracture had been initiated, brine was being produced by the target well. The volume of brine produced quickly reached a point where it was proportional to the volume of water injected. The quality of brine with respect to calcium and magnesium chlorides was extremely high, thus being relatively poor for the production of evaporated salt. Pump pressures remained extremely high despite the fact that large quantities of salt were extracted. No second plateau ever developed.
>
> It was surmised that fracturing fluid had passed horizontally along a faulted zone with at least a portion of the travel route being in shale layers.

Jacoby's articles demonstrate that there was a hydraulic fracturing operation that connected Wells 33 and 43 (illustrated in Jacoby, 1973) and an operation that connected Well 33 to Well 34 (described in Jacoby, 1965). Both of these fracture pathways were near the base of the Syracuse, but they had to have taken independent routes in order to develop pressure for each connection. These routes were involved with the zones of weakness related to faulting.

Jacoby wrote more about the role of faulting between Wells 33 and 34, describing the pressure variation experience:

> In fracturing Well 33 to 34, alternate buildup and recession of pumping pressures indicated that the solution channel was being *closed by rock movement from time to time*. In the light of subsequent geologic information, the occurrence of intermittent collapse should have been unexpected, inasmuch as in this area of the brine field the *major thrust has broken up*, into and through the No. 3 salt. Faulting above the cavity created by solution between Wells 33 and 34 *may have resulted in a weakness* which led to the *observed periodic collapse and pressure buildup*. It is over this area that the major thrust bifurcates at several points, creating a series of planes of weakness in the section overlying the solution zone.

(Jacoby, 1973) (emphasis added).

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Observations such as these, made by the US Salt geologist involved with the creation of these caverns, make it clear that a time sequence describing the role of geology in the history of each cavern is necessary in order to give an accurate portrayal of the current situation. Information like the presence and position of the major thrust fault and bifurcated thrust faults, along with the rubble-filled caverns developed in a time sequence and other information, [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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similar modeling of other features of Gallery 1 should be done as well. Without more study, the data on Gallery 1 is insufficient to demonstrate that the reservoir is suitable for LPG storage.

2. Gallery 10

> **DEC Comment 9b.** Page 9 of the May 14, 2010 Reservoir Suitability Report states "there was no pressure encountered on well 52 . . . ." In other parts of the application (i.e., Gallery 1 & Gallery 2), Finger Lakes says that encountered pressure during well re-entry is an indication of tightness for the proposed storage galleries. Conversely, is "no pressure encountered" an indicator of Gallery 10 not being tight?
>
> ***Finger Lakes Response:*** *It is assumed that the cavern does leak and will be monitored as explained in response to DEC Comment 9d below.*[22]

Well 52 presents additional challenges. In response to DEC's question about the cavern at Well 52, FLLPG replied:

[redacted]

[redacted]

[redacted]

[redacted].

A professional geologist examining a project expects to see accurate, clearly identified, and consistent data on cross-sections that can be traced to underlying information; [redacted]

[redacted]

[redacted]

more data is needed to show that the Gallery 1 reservoir is safe for LPG storage.

D. Cross-section CC'

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Cavern 29 is the cavern close to or in the Jacoby-Dellwig Fault, This cavern was the injection well that was supposed to create a hydraulic fracture connection with Well (now Cavern) 34. Instead, Well (now Cavern) 29 fractured both to what is now Cavern 32, some distance to the south (toward the viewer perpendicular to the cross-section), and to the ground surface about a half-mile north (away from the viewer perpendicular to the cross-section). This north-south fracture, considered in light of geophysical logs, mapping of the salt thickness, and Appalachian-related features in the area, led Jacoby to identify a near vertical strike-slip fault with about 1200 feet of offset—the Jacoby-Dellwig Fault (Jacoby 1973). The fault, along with related north-south tear faults, is a zone of weakness, it has served as a fluid transmission pathway in the past, and it may do so again. It therefore is important that the major and minor faulting be fully characterized, that its role as a fluid pathway be evaluated, and that the Jacoby-Dellwig fault be included in the cavern system monitoring plan.

FLLPG addresses the Jacoby-Dellwig Fault as follows:

Either ongoing or periodic pressure tests would be valuable sources of information, if a problem occurs.

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[redacted] Whether a fault exists is determined by examination of regional data, and there are multiple studies of the Jacoby-Dellwig Fault (Jacoby and Dellwig, 1973; Jacoby, 1965; Jacobi, 2002; FERC Arlington, 2014). That the Jacoby-Dellwig Fault is not sealed is indicated by the movement through it of fracture fluid a half-mile north and a half-mile up to the surface. Moreover, the hydraulic fracture pathway from Well 29 to Well 32 had to pass through the Jacoby-Dellwig Fault, which is located between the two wells. If the fault is sealed and cannot account for the uncontrolled hydraulic fractures from Well 29, then we lack an explanation for the fluid movement. Either there are other yet unidentified pathways from the well or fluid escaping a cavern can travel randomly and emerge anywhere there is a pressure differential (including to the ground surface); neither alternative is comforting, and both cry out for additional study.

[redacted] If Cavern 29's development was influenced by the north-south Jacoby-Dellwig Fault or related faults, there may be other linear features nearby—and the linear east side of a large part of Gallery 1 is certainly one feature that should be investigated. All the relevant sonar surveys should be made available for this purpose. The characterization of the Jacoby-Dellwig Fault and related faults is important since it represents an area of weakness and a potential fluid pathway.

IV. Conclusion and Recommendations

The caverns that FLLPG proposes for LPG storage are part of the geology from which they've dissolved—and over their history, each has responded to that geology. Galley 1 (the mega-cavern of connected Caverns 33, 43, 34, and 44), was solutioned a half-century ago [redacted] Gallery 2 (Cavern 58), collapsed once and is being solutioned again above the rubble of what was there before.

[redacted] All of these issues, summarized here and described in more detail in this report, have been the subject of concerns expressed by DEC in repeated NOIAs, and FLLPG's responses have only raised more questions that require further inquiry.

The deficiencies identified in this report can be addressed only through the submission of revised documents, including maps and cross-sections reflecting complete and accurate information, which will require additional data collection and performance of technical studies. At least the following documents should be filed:

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- A comprehensive and accurate map of the Watkins Glen Brine Field.

- Revised cross-sections, with complete and correct depictions of the underlying geologic and cavern information. Preparation of the cross-sections will require:

    - (i) collection and compilation of relevant historical information about the wells and caverns and their geological context, including information from published literature and information in affiliated company files;

    - (ii) performance of additional technical studies, including seismic surveys (modified refraction, reflection, and vertical seismic profiling), to fill data gaps identified in this report, such as the shape and volume of rubble-filled portions of all caverns; [redacted] the relationship between Cavern 29 and the Jacoby-Dellwig Fault, and the pathway from Cavern 29 to the ground surface;

    - (iii) incorporation of that information into cross-sections that accurately illustrate geologic features and fully characterize the caverns, including the rubble piles and conduits, with comprehensive Keys to all features displayed; and

    - (iv) submission of all data underlying the cross-sections [redacted] in well-organized and meaningfully labeled electronic files.

  Specifically, the cross-sections should provide full historical comparison of all sonar information, superposed on common axes (derived from underlying full sonar histories of each cavern developed using historical data superposition), and the data displayed should enable the reader to ascertain: the total extent of caverns, including hanging ledges and areas created by solutioning or hydraulic fracturing that are now under rubble; cavern growth over time; fault involvement with well and cavern development; intended and unintended hydraulic fracture paths; and other factors or anomalies that may be disclosed during additional study. All thrust and high-angle strike-slip faults, including the Jacoby-Dellwig Fault, should be located, characterized, and identified on the cross-sections.

- Documentation showing the full three-dimensional extent and historical development of the caverns, to supplement the cross-sections—that is, the detailed information underlying the representative cross-section diagrams. Several full sonar surveys have been made over the lifetime of each cavern. Each of these surveys involves synthesis of sonar data points into a series of vertical and horizontal slices that provide a three-dimensional picture of the particular cavern at that point in time. Often, the sonar acquisition firm provides not only the current sonar data, but also superposes the sonar slices with historical sonar data for the same slices, allowing comparison and evaluation of trends over the time period of the surveys. Examples of the value of these comparisons can be seen for the vertical sonar slices shown on the cross-sections and noted historically by line color and the date next to each. All of the sonars for all of the caverns should be produced for the record and expert review.

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- A revised Reservoir Suitability Report or other narrative comprehensively and accurately describing the facts underlying the completed and corrected cross-sections and the three-dimensional studies.

- A written plan for monitoring all thrust and high-angle strike-slip faults and for addressing any anomalies or problems identified through review of the cross-sections and three-dimensional studies.

Ideally, the issues conference would be postponed until the foregoing documents are filed, members of the public (including experts) have an opportunity to review them, and the new information can be incorporated into petitions for party or amicus status. Without the revised documents, FLLPG has not provided sufficient data to demonstrate that the Galleries it proposes to use are appropriate for storage, the serious cavern integrity risks that I have identified cannot be ruled out, and therefore DEC should refuse to issue FLLPG a permit for LPG storage.

If the revised documents are submitted, and a permit ultimately is issued, DEC should require additional monitoring of the storage facility. The present monitoring plan focuses on periodic measurements, mostly of the condition of the wells and the effects of moving LPG and brine in and out of the caverns, and the caverns are to be evaluated by occasional pressure tests and sonars of the open portion of the caverns. This is 2015, and technology is available for making continuous measurements that will signal a problem before it becomes a disaster. Further, real-time monitoring measurements should be recorded and made available to DEC and the public. Below is a list of recommended monitoring requirements, which should be added as conditions of the permit, to ensure that any changes in the caverns that increase the risk of leakage or other problems are identified and addressed as soon as possible.

- Install borehole seismic sensors similar to those being used at Bayou Corne to track and study events related to the failed cavern there, to measure other caverns, the rock chimney, and gas and fluid movement in the subsurface. These sensors could be installed in cavern wells considered for plugging or wells developed specifically for monitoring. Install recording strain gauges (sensitive tape or material that can be locked against a cavern wall to measure the tiniest flexure or strain) in these or additional deep boreholes.

- Measure pressures, salinity (or chloride concentration), temperature, and other easily measured variables at injection and withdrawal and monitoring wells.

- Install gas sensors in the aquifer(s) above the caverns.

- Install active sonar and other means to monitor cavern changes (like roof, wall, and floor creep). Install means to monitor rock and salt fall.

- Expand the leveling network to include the caverns of the comprehensive map. Add dedicated subsidence measurement monuments designed to minimize effects such as weather. Add horizontal and tilt measurements over FLLPG Gallery 1. Add active, continuous level monitoring for extended periods—like the subsidence monitoring done in the Houston subsidence province.

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Without the addition of these monitoring requirements as permit conditions, DEC cannot ensure that emerging cavern integrity problems will be timely identified and therefore should not issue the permit.

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https://www.dot.ny.gov/conferences/itgaum/repository/2H_Gowan_Cause%20of%20the%20Retsof%20Collapse.pdf

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http://www.thelivingmoon.com/45jack_files/03files/Endangered_Earth_Sinkhole_Hutchison_Kansas.html

Tersanne and others
http://arxiv.org/ftp/arxiv/papers/1302/1302.2582.pdf

Gulf Coast cavern problems
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Big Hill
http://prod.sandia.gov/techlib/access-control.cgi/2003/030703.pdf

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Exhibit A

Markup of Gallery Map

NYSDEC OHMS Document No. 201166576-00026

NYSDEC OHMS Document No. 201166576-00026

Exhibit B

Marked Cross-Section AA'

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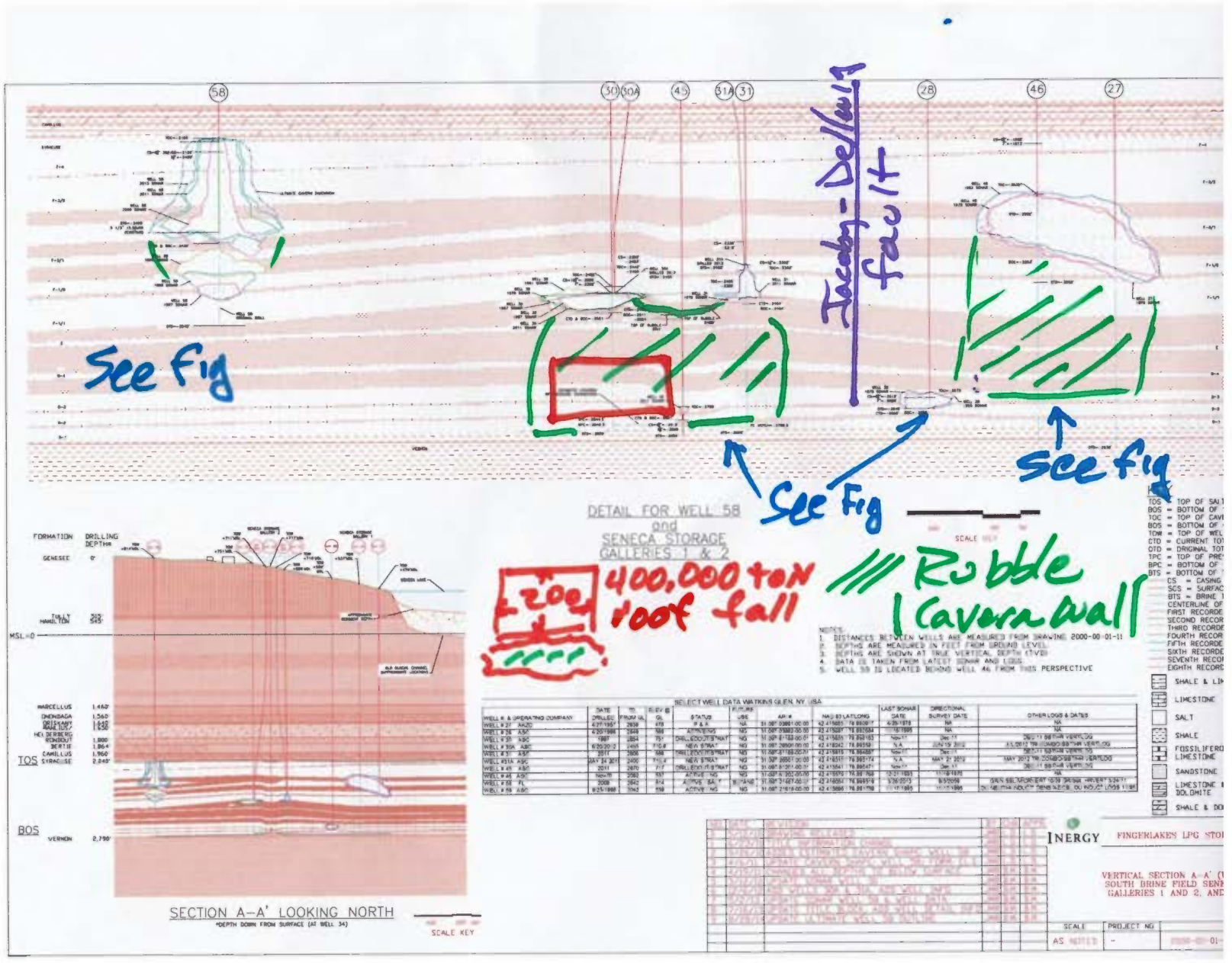

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Exhibit C

Marked Cross-Section BB'

NYSDEC OHMS Document No. 201166576-00026

NYSDEC OHMS Document No. 201166576-00026

Exhibit D

Marked Cross-Section CC'

NYSDEC OHMS Document No. 201166576-00026

NYSDEC OHMS Document No. 201166576-00026

Exhibit E

Documents Released Pursuant to DEC Freedom of Information Request

NYSDEC OHMS Document No. 201166576-00026

Well 58 (Planned Storage Well) Unable to sonar survey due to cavity conditions

Date	01-08-01
Elevation	813'
Top of Salt	2144'
Top of Cavity	[redacted]
Cavity High Point	NA
7" Casing	2472'
4-1/2" Casing	2477' pulled for sonar, then re-set
Total Depth	2478'
Deepest Depth	2478'
Max Avg Diameter	NA' at NA depth
Sonar Volume	[redacted] (old sonar surveys, now cavity filled w/ shale rubble)

Well 58 was the well drilled to develop a future gas storage cavity. The cavity was in the mid-stages of development and progressing in the creation of a cylindrical cavity from the earlier sonar surveys. The cavity had new cavity development and the older cavity of October 1998 had been nearly filled with shale and salt rubble in the shut period between earlier sonar surveys. The hanging casing were cut off and re-positioned above the rubble. Well 58 operated with injection only in the 7" casing, as the 7" and 4 1/2" casings were above the rubble pile and close together. This adjustment produced a higher saturation and reduced the demand to be re-injected in the 3 - 4 gallery.

The well 58 cavity had a cylindrical configuration with a nearly flat rubble bottom and a domed cavity roof. The cavity bottom had been at the depth of the flat cavity roof of the October 1998 sonar. [redacted] of cavity has been filled with shale and salt rubble. The hanging casings were set near mid cavity to allow for more rubble fill and improved brine concentration produced from well 58.

After starting up the well, both the flow rate and brine concentration had improved. The present attempted sonar survey shows a cavity volume to be complete filled with shale and salt rubble. Development of the cavity has terminated. Review of the core description and earthquake activity in the area, it is believed that a disturbance in the formations resulted in the faulted shale and salt rubble to completely fill the cavity and render the cavity useless for development for storage. A protective pad in the roof of the cavity would not have stopped the rubble in the fault zone from filling the cavity. During the work-over the 4-1/2" tubing was pulled and re-set and again lifted off bottom and re-set. As soon as the tubing was withdrawn or raised and lowered again, a 1 11/16" gamma ray tool could not enter any cavity, as the cavity filled with rubble after each movement of the tubing. The sonar tool could only indicate rubble material behind the 7" casing. Only near the top of the rubble pile at [redacted] a small void was noted behind the casing for several degrees of rotation. The rubble filled in after withdrawing the tubing and then re-setting. Upon completing the work-over the wellhead was reinstalled and the piping connected, but the valves were closed.

The top of salt was recorded at 2144' and the top of the rubble pile at [redacted] which leaved [redacted] of roof salt remaining for cavity support. A 9 5/8" cemented casing had been set at 2167' depth. The remaining salt roof should not be mined and mining operations have been terminated. The well will be further evaluated and consideration given to the plugging and abandonment of the well 58. The 4 1/2" and 7" hanging casings should be withdrawn before starting any plugging operations. A 9-5/8" bridge plug should be planned to be set near the top of salt and the well plugged using 2/7/8" tubing for placement of cement and withdraw the tubing in stages to completely fill the casing with cement for plugging.

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USSALT

May 24, 2001

New York State Department of Environmental Conservation
Division of Mineral Resources
Bureau of Oil & Gas Regulation, Room 290
50 Wolf Road
Albany, New York 12233-6500

Attn: Kathleen F. Sanford
Chief, Permits Section

RE: Solution Salt Mining Well No. 58
API #31-097-21467

Dear Ms. Sanford:

I must apologize for not replying earlier, but vacation times and availability of people to cover these periods caused the delay.

Reports and conversations with Larry Sevenker prior to the last loggings appeared that the cavern at Well 58 was progressing normally. The latest logging indicated that the roof of the cavern had collapsed and filled the whole cavern with rubble. Mr. Sevenker further reported that it appeared that the upper formations may have been in a fractured and faulted zone and that a small magnitude earthquake could have damaged the cavity.

We have enclosed seismic local log that Mr. Sevenker obtained indicating small earthquake activity.

Our intentions for this well are to plug and abandon on the advice of our consultant, Mr. Sevenker. He clearly states in his report that the roof movement is unusual and renders the cavity unusable for continued development or storage. We will submit the Notice of Intention to Plug and Abandon form as soon as we have planned dates for these operations.

RECEIVED
MAY 29 2001
BUREAU OF OIL & GAS REGULATION

Sincerely,

Alan Parry
Plant Manager

AP:s
Enclosure

P.O. Box 110 Salt Point Road Watkins Glen, NY 14891 (607) 535-2721 Fax (607) 535-2953

Bob Tran - ext. 220

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF MINERAL RESOURCES

NYSDEC OHMS Document No. 201166576-00026

PRINT OR TYPE IN BLACK INK

PLUGGING REPORT

THIS APPLICATION IS A LEGAL DOCUMENT.
READ THE APPLICABLE AFFIRMATION AND ACKNOWLEDGEMENT CAREFULLY BEFORE SIGNING.

NAME OF OWNER (Full Name of Company, Organization or Individual): U S Salt Company

LEASE OR UNIT NAME AND NUMBER: Well #58

TOTAL DEPTH: 2478'

PLUGGING PERMIT NO: 02-13101P

COUNTY: Schuyler

TOWN: Reading Center

API WELL IDENTIFICATION NUMBER: 31-097-21467

LOCATION DESCRIPTION (7½ Quad): Reading Center

LATITUDE: 880,470' FT. S of

LONGITUDE: 414,560' FT. W of

PLUGGING PERFORMED BY: Universal Cementing

DATE OF PLUGGING: 10-14-03

DIVISION OF MINERAL RESOURCES WITNESS: prior to plugging Debbie Rathbun

DATE WITNESSED: 10-09-03

DETAILS OF PLUGGING

Filling Materials and Plugs	DEPTH-FEET From	DEPTH-FEET To	CASING RECORD Size-in.	Weight#/ft.	Put In Well-ft.	Pulled Out-ft.	Left In Well-ft.
4-1/2"	2477	Surf	4-1/2"	10.5	2477'	2218'	259'
7"	2472'	Surf	7"	20.0	2472'	2215'	257'
9-5/8"	2167'	Surf	9-5/8"	36.0	2167'	0'	2167'
13-3/8"	169'	Surf	13-3/8"	61	169'	0'	169'
9-5/8" Bridge Plug	2154	---	9-5/8"	36	2154'	0'	2154'
Class A Cement	2154	Surf	9-5/8"		2154'	0'	2154'

	YES	NO
Have pits and other excavations been filled?	X	
Have the following been removed? Equipment	X	
Debris	X	
Has casing been cut off below plow depth?		X
Has well-site been restored to condition similar to adjacent terrain?	X	

If any of these questions are answered NO, give timetable for completion of reclamation.

REMARKS: Due to rubble filling the cavity the 4-1/2" hanging casing was cut off at 2218' and the 7" hanging casing cut off at 2215'. From these depths the 4-1/2" and 7" casing were removed. A 9-5/8" bridge plug was set at 2154'. Cementing with 800 sacks Class A through 2-7/8" tubing being withdrawn in stages was the method of plugging the well from the bridge plug to the surface. The cement filled the 9-5/8" casing to the surface. The 9-5/8" wellhead flange will remain as an elevation survey bench mark. The area is to be returned to the surrounding conditions and the concrete pad filled in after plugging is complete.

FOR USE BY INDIVIDUAL:
I hereby affirm under penalty of perjury that information provided in the report is true to the best of my knowledge and belief. I am aware that false statements made in this report are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

X [signature] — Signature of Individual

Larry Sevenker — Print or Type Name of Individual

10-17-03 — Date

FOR USE BY ORGANIZATION OTHER THAN AN INDIVIDUAL:

I hereby affirm under penalty of perjury that I am _____ (title)

of _____ (organization), that I am authorized by that organization to make this report, that this report was prepared under my supervision and direction, and that the information provided in this report is true to the best of my knowledge and belief. I am aware that false statements made in this report are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

X _____ Signature of Authorized Representative

_____ Print or Type Name of Authorized Representative

_____ Date

NYSDEC OHMS Document No. 201166576-00026

LARRY SEVENKER

Consulting Engineer

4148 Loire Dr.
Kenner, LA 70065

(504) 468-1909

October 17, 2003

Mr. Frank Pastore
US Salt Company
P.O. Box 110
Watkins Glen, NY 14891

RE: Cement Bond Log Evaluation Well 58

Dear Frank:

Well 58 was drilled and completed on October 17, 1992 for operation as an individual well for gas storage. At the completion of the required cavity size and before converting the well to natural gas storage, an earthquake in the area resulted in shale filling the entire cavity with rubble. The cement bond log was run prior to plugging and abandonment to confirm the isolation of the cavity from any fluid migration behind the casing into the formation above the cavity or from the surface. Before the bridge plug was set in the 9-5/8" casing below the top of the salt, the 4-1/2" and 7" hanging casings were cut off and removed and then the well plugged to the surface. The bridge plug was set at 2154' and plugging was by the pumping cement down the 2-7/8" tubing and withdrawing the tubing from the cement in three 543' stages and the last 525' stage. After the tubing was withdrawn the cement was returned to the surface to complete the plugging operation. Universal pumped 800 sacks of Class A cement to plug well 58 to the surface. Universal's cementing ticket number 533749 is attached. Good circulation with cement returns were observed at the surface.

US Salt plans to push in the earth and rock berm around the concrete pad to restore the well 58 site to the surrounding conditions. The cement in the 9-5/8" casing settled back top to 6" above the concrete pad floor. The well 58 elevation survey bench mark will be re-established on the 9-5/8" casing flange for subsidence surveys and well location.

The following is a summary of the well construction and cement bond evaluation.

Well 58 API# 31-097-21467
Drilled: October 17, 1992

Elevation:			813'	
Conductor Casing:	13-3/8"	61.0#	169'	Cemented w/ 150 sacks Class A
Top of Salt:			2144'	
Surface Casing:	9-5/8"	36.0#	2167'	Cemented w/ 775 sacks Pozmix
Top of Cavity:			[redacted]'	Cavity filled with rubble

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Protection Casing:	7"	20.0#	2472'	Hanging Casing
Hanging Casing:	4-1/2"	10.5#	2477'	Hanging Casing
Total Depth:			2478'	
4-1/2" Casing Pulled			2218'	
4-1/2" Casing Left in Hole			259'	
7" Casing Pulled			2215'	
7" Casing Left in Hole			257'	
Cement Bond Log	October 13, 2003			

Well 58 has excellent to very good cement bond above the salt interval to provide protection and isolation of the salt brine from the surface formations. Also the conductor string of casing was cemented from setting depth to the surface for added protection. Bed rock was encountered at 2' depth and no water bearing formation was detected below the surface.

Well 58 Cement Bond

Cement Bond Evaluation

2300' - 2183'	Open hole	9-5/8" casing at 2183'
2183' - 2150'	Excellent bond	Top of Salt at 2150'
2150' - 1660'	Excellent bond	
1660' - 1578'	Excellent bond	Marcellus Shale
1578' - 1372'	Excellent bond	
1372' - 1360'	Very good bond	
1360' - 1200'	Excellent to very good bond	
1200' - 1188'	Very good bond	
1188' - 1129'	Excellent to very good bond	
1129' - 1110'	Fair to poor bond	
1110' - 1010'	Excellent bond	
1010' - 974'	Good bond	
974' - 965'	Excellent bond	
965' - 938'	Good bond	
938' - 914'	Good to fair bond	
914' - 810'	Excellent to very good bond	
810' - 746'	Good to fair bond	
746' - 730'	Good bond	
730' - 722'	Fair to poor bond	
722' - 678'	Very good bond	
678' - 640'	Excellent bond	
640' - 590'	Very good bond	
590' - 505'	Good to fair bond	
505' - 485'	Poor bond	
485' - 464'	Very good bond	
464' - 430'	Poor bond	
430' - 324'	Very good bond	
324' - 288'	Good bond	

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288' -	222'	Poor bond
222' -	150'	Excellent to very good bond 13-3/8" casing at 169'
150' -	100'	Good bond
100' -	40'	Excellent bond
40' -	Surf	Above fluid level

Due to the cavity being filled with shale rubble, the hanging 4-1/2" and 7" casing required cutting at 2218' and 2215' respectively in order to be pulled from the well. The Baker bridge plug was set at 2154' depth. Plugging and abandonment was from the bridge plug to the surface.

There is excellent to good cement bond above each fair to poor bonded section to provide isolation from the surface or the cavity. The bridge plug was set in the salt section of the 9-5/8" casing and cemented through the 2-7/8" tubing, which was withdrawn in stages to completely fill the casing with 800 sacks of Class A cement.

Plans are to fill in the concrete containment pad with dirt and rock from the surrounding berm and restore to the existing surface grade. An elevation bench mark is to be established in the 9-5/8" casing flange for elevation surveys.

Baker Oil Tool, Allegheny Wireline, I&S Well Service and Universal Cementing crews conducted an safe and excellent preparation and plugging operation on well 58. The project should be classified as a text book example for plugging and abandonment of a salt brine well.

If you have any questions or comments please contact me.

Sincerely,

Larry Sevenker
Consulting Engineer

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Exhibit F

Curriculum Vitae of H.C. Clark

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H.C. Clark
2300 Bolsover
Houston, Texas 77005
hcclark@rice.edu

Consulting Geology and Geophysics
Rice University [1966-1989], Geology and Geophysics, retired faculty

PhD, Geophysics, Stanford University, 1967
MS, Geophysics, Stanford University, 1966
BS, Geology and Geophysics, University of Oklahoma, 1959
Teaching: courses in geophysics and geology, geologic hazards, engineering geology and geophysics
Research Interests: Current - Geophysical techniques applied to the study of shallow features, geophysical measurements and hydrogeologic problems, sustainability and agriculture; Past - paleomagnetism, geophysical measurements and crustal studies, analysis of geologic hazards
Texas Registered Professional Geoscientist 1977.
Municipal Solid Waste and Resource Recovery Advisory Council of the Texas Commission on Environmental Quality, 2003-2013, representing the Public Director of Student Advising at Rice in 1979 and served in various combinations with Susan Clark until retiring in 1989.
Organizations: American Geophysical Union, Society of Exploration Geophysicists [and Near Surface Section], Houston Geological Society, Geophysical Society of Houston, Board of Directors-Houston Urban Gardeners

Consulting Projects

Browning Ferris CECOS Gulf West Hazardous Waste Landfill, Chambers Co., Seismic study of active fault, groundwater geology
BFI 521 Municipal Landfill, Fort Bend Co., Texas, Geology, groundwater, active faulting and salt dome
BFI McCarty Road Municipal Landfill, Harris Co., Texas, Geology, active faulting
BFI Stratton Ridge Injection Well, Brazoria Co., Texas, Geology, fracture potential
CECOS Livingston Hazardous Waste Landfill, Livingston Parish, Louisiana, Geology
BFI Galveston County Landfill, Galveston Co., Texas , Resistivity study, baseline data
City of Houston, Crystal Chemical Injection Well, Harris Co., Texas, Active faulting, geology of reservoir
Rice Center for Community Design and Research, Chambers County Natural Factors Study, Chambers Co., Texas, Geology components
Texas Coast Project, Two County Tier, Texas, Geology components
Metropolitan Transit Authority Project, Harris Co., Texas, Composite fault map metropolitan area
Citizens, Willis, Montgomery Co., Texas, Municipal Landfill, Geology and groundwater
Citizens and County, Matagorda Co., Texas , Phillips 66 Landfarms, Landfills, Contaminated Water Ponds, Geology, groundwater, systems design
Fayette County Resource Watch, Fayette Co., Texas, Cummins Creek Lignite Mine Geology, geophysics and groundwater
Citizens, Katy, Texas, CMI Municipal Landfill, Cypress Creek, Geology, faulting
Citizens, East Houston, Texas, Municipal Landfill—Negev, now Bluebonnet, Geology, faulting
Citizens, North Houston, Texas Municipal Landfill—Atascocita, Geology, geophysics
Citizens and Power Systems Equipment, Chappel Hill, Washington Co., Texas Municipal Landfill, Geology, geophysics, groundwater
CASE, Beaumont-Port Arthur, Jefferson County, Texas, CWMI Injection Well
Campbell, Foss, and Buchannan, Inc. Eureka, Nevada, Mine Exploration
Magnetic measurements and interpretation Norse-Windfall Mines, Eureka, Nevada

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Magnetic and seismic refraction measurements and interpretation
Anderson and Frierson, Geologists Central Texas Oil Exploration
Gravity and magnetic measurements and interpretation
U S Army Corps of Engineers, Galveston, Texas Galveston Bay Sand Supply Study
Data compilation and interpretation
U S Air Force, Office of Ballistic Missile Research Micro-blast rapid tunnel excavation. Sunburst Recovery Seismic recording, CSM Experimental Mine, Golden, Colorado
Tenneco Oil, Exploration and Production, Houston, Texas
Magnetic ranging system for detection of well blowout, patent
Allied Chemical, Norfolk, Virginia, Magnetic survey, steel tank construction site
SanJacinto Development Corp., Landslide and groundwater influence, downstream Livingston Dam; San Jacinto Co., Texas
Vinson and Elkins, Attorneys, Houston, Fault study. West Houston
Keplinger Associates, Petroleum Engineers, Houston, Oil Mining Study, Ohio, Geophysical measurements and interpretation Mining Prospect, Alaska, laboratory magnetic measurements and interpretation
Universal Savings Association, Houston
Hazardous waste study—former pipeline terminal and sludge storage pits
Soil borings, monitor well installation; soil, sludge, groundwater
sampling, interpretation of chemical test results
Hazardous waste study—former manufacturing facility
Waste disposal audit, supervision of testing program
Active surface fault study—former manufacturing complex Field surface study and interpretation of surface, photo, and subsurface data
Hazardous waste study—office park and landfill area
Soil borings, monitor well installation; soil, sludge, groundwater sampling, interpretation of chemical test results
ERM Southwest, Houston, Texas, Pesticide Manufacturing Plant, Dallas County, Texas
Seismic refraction interpretation
Testing Unlimited, Houston, Texas, Conroe Jail, Montgomery County, Texas, Seismic study, basement heave
General Dynamics, Fort Worth, Texas Air Force Plant 4, Fort Worth, Texas, Seismic reflection study, groundwater problem
McClelland Engineers, Houston, Texas, Bosque Dam Construction Planning, Seismic refraction study, outlet works
Police Jury, Calcasieu Parish, Louisiana Chemical Waste Management Hazardous Waste Landfill, Lake Charles Facility-Geologic and hydrologic study
Commissioners Court, Matagorda County, Texas -Phillips 66 Landfarm- geohydrologic study of landfarm operation
Citizens of Security, Texas-Montgomery County Contractors Type 1 Landfill, geology and geohydrology—Permit amendment for special wastes
Texas Environmental Coalition, Concerned Citizens of Winona-Land Banned Waste Exemption Petition - WDW 186, Gibraltar Chemical Resources, Winona, Texas
Citizens, Fort Bend County, Texas-Fort Bend County Landfill - proposed expansion
Resolution Trust Corporation-Former Industrial Facility - ground water contamination
Fault study - seismic reflection profile study-splay faults and contaminant transport
City of League City, Texas-Waste oil processor-Hazardous waste and ground water
Calhoun County Resource Watch, Texas-Union Carbide Plant Hazardous Waste Landfill Faulting, geology, and ground water; British Petroleum Plant-Hazardous waste landfill geology and performance
Mitchell Development Corporation-Bald Head Island Beach erosion and relationship to Wilmington Channel Dredging

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Allen County [Ohio] Citizens for the Environment Workshop on deep well injection
Louisiana Department of Environmental Quality-Workshop on deep well injection
Law Engineering, Houston, Texas-Workshop on landfills
Citizens, Fort Bend County, Texas-Fort Bend County Landfill - methane migration and groundwater
Citizens, Waco, Texas-City of Waco Landfill Expansion, geological and geophysical analysis
City of Petronila, Nueces County, Texas Texas Ecologists Hazardous Waste Disposal
Analysis of application for two injection wells
Numerous groups in Texas, Louisiana, Ohio: Critical comments on hazardous waste injection wells including: Gibralter Chemical; Chemical Waste Management, Port Arthur and Corpus Christi, Texas; Vickery, Ohio; DSI, Empak, Waste Water Inc, Dupont, Celanese, American Cyanamid, Cecos, Rollins, BP Green Lake, IMC Fertilizer, BP Lima Harris County, Texas-Westbelt Landfill, geological and geophysical analysis; American Envirotech Hazardous Waste Incinerator, geological and geophysical analysis
City of Houston and Harris County-Hunter Industrial Facilities salt dome storage of hazardous waste, geological and geophysical analysis
City of Wilmer, Texas Laidlaw Wilmer Landfill Remand Hearing, geological analysis
Citizens, Lacy-Lakeview (Tirey Trust) Lacy-Lakeview Landfill Expansion, groundwater and geology
CASE-CWMI Port Arthur Landfill-audit of landfill documents-geologic analysis
Citizens, Fairview (COFF), McKinney Landfill Expansion, geological and geophysical analysis
Lower Colorado River Authority-Tricil Landfill, Altair, Texas geological and geophysical analysis
City of Del Rio-CWMI Dryden Landfill, Dryden, Texas
CONTROL [Citizens of Justin, Texas] Sentry Landfill Proposal, Denton, Texas-geological analysis
West Harris County MUDS-Madden Road Landfill geological and geophysical analysis
Sierra Club, Eagle Pass, DOS Republicas Coal Mine, geological and agricultural analysis of alluvial valley floor
Citizens Live Oak County, Texas IEC Injection Wells 156, 159, geological and geophysical analysis
Citizens Winnsboro, Texas East Texas Landfill, geological analysis
Citizens East Fort Worth, Laidlaw Landfill, MSW 2145, geological analysis
City of Lancaster, Texas WMX Skyline [Ferris] Landfill, 42-C, geological analysis
Citizens Walker County, Texas DDI Landfill, geological analysis
Citizens Palo Pinto County and Fawcett XO Ranches-Blue Flats Landfill, geological analysis
MOSES [Mothers Organized to Stop Environmental Sins] Injection Wells 186 and 229, Smith County, Texas-injection well, geological and geophysical analysis
Citizen groups Jefferson County NORM facility, geological and geophysical analysis
CCAP Wharton County-Hazardous waste caverns, injection, geology and geophysics
Baggett, McCall & Burgess, Lake Charles PPG Plant contamination plume
ABLE, Canyon, Texas-BFI Canyon Landfill expansion proposal geological analysis
Frost Family Farms, Liberty County Class I [non-hazardous] injection well proposal, geophysical and geological analysis
Spring Cypress Landfill Coalition, Harris County-Type IV landfill, geology and hydrogeology
Sierra Blanca Legal Defense Fund, Hudspeth County, Texas, Low Level Nuclear Waste Disposal license application, geophysical analysis
Citizens groups, Kinney County, Adobe Landfill proposal, geophysical and geological analysis
Bill Sutton family, Fort Bend County Long Point Dome landfill, geophysical and geological analysis
North Texas Municipal Utility District 121 Landfill design team, geological and geophysical measurements
Raytheon [McBride Ratcliff Engineers], Active fault and BMC Software complex, Houston
Limestone County, Texas-Hansen Aggregates quarry design and hydrogeology analysis
Citizens, Hays County, Texas-Aquasource water treatment and discharge facility, geology and hydrogeology
BFI-Blueridge Landfill expansion, geology and hydrogeology

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McFadden Family-Dupont Beaumont no-migration exemption renewals for injection wells, analysis
Frost, FPL Farming Ltd-Amendment to injection well permits WDW316 and 317
Chambers County, TSP Cypress Point Industrial Landfill, geologic issues analysis, industrial rules analysis
Citizens Fort Bend County, Juliff Type IV Landfill application
Individuals, various LPST and drycleaner contamination cases
BVSMA, Grimes County, landfill application
O'Connor Ranches, Victoria, groundwater resources in South Texas and analysis of issues
BFI-McCarty Landfill expansion
BFI-Blueridge Landfill expansion
State of Nevada, Agency for Nuclear Projects, Yucca Mountain, repository geology and geophysics
Sierra Blanca Ranch, Hudspeth County, quarry site reclamation, geologic issues
Lafitte's Cove Nature Society, Galveston, comments on hurricane sever potential related to cut and fill development
Cooke County citizens, Salt Water Disposal well and Barnett Shale operations
Erath County citizens, Salt Water Disposal Well and Barnett Shale operations
Goliad County, geologic hazards and uranium exploration project
TJFA as protestant, Williamson County Landfill Expansion
TJFA as protestant, Comal County Landfill Expansion
Goliad County, UEC uranium mining application opposition
Montgomery County citizens, Type IV Landfill application analysis
Texans For Sound Energy Policy, Victoria nuclear power plant review
Lewisville, Camelot Landfill geology and hydrogeology review
Pescadito Environmental Resource Center, Webb County, Type I landfill application
NoCoal Coalition Matagorda County, White Stallion power plant water well application
Goliad County GCD, UEC uranium mine aquifer exemption discussion
Earthjustice, New York salt cavern storage of LNG and CNG in Watkins Glen brine field FERC
BlackburnCarter, Matagorda County contamination—salt water disposal well[s]
BlackburnCarter, Harris County contamination—gas well/injection well/disposal well
Goliad County citizens—uranium mine aquifer exemption analysis and EPA comments
Quintana LNG Terminal proposal, geologic issues including Stratton Ridge FERC
BlackburnCarter, Bayou Corne, LA, salt cavern collapse and sinkhole

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Exhibit 2

Quantitative Risk Assessment

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NYSDEC OHMS Document No. 201166576-00026

Independent High-Level Quantitative Risk Analysis
Schuyler County Liquid Petroleum Gas Storage Proposal

January 15, 2015

D. Rob Mackenzie, MD, FACHE

NYSDEC OHMS Document No. 201166576-00026

Independent High-Level Quantitative Risk Analysis
Schuyler County Liquid Petroleum Gas Storage Proposal

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January 14, 2015

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Quantitative Risk Analysis:
Schuyler County Liquid Petroleum Gas Proposal
January 14, 2015
D. Rob Mackenzie, MD

Executive Summary

An independent, high-level quantitative risk assessment (QRA) was performed to evaluate the major risks associated with a proposal by Finger Lakes LPG Storage, LLC to store liquid petroleum gas (LPG) in dormant Schuyler County solution-mined salt caverns. The risks of events associated with LPG rail transport, pipeline transmission, and salt cavern storage were evaluated using standard methodology, a twenty-five year exposure interval, and publicly available sources.

The incremental likelihood of serious or extremely serious rail transport events is between 2 and 3 percent over 25 years. This level reflects risk mitigation efforts over several decades, but further risk reduction efforts should be still considered because of possibly extreme consequences. The likelihood of moderate baseline pipeline transmission events is between 20 and 25 percent over 25 years. While pipeline risk reduction efforts should always be considered because of possible moderate consequences, there is little if any incremental risk as pipeline infrastructure will remain nearly unchanged. The probability of serious or extremely serious salt cavern storage events is more than 40 percent over 25 years, including both baseline and incremental risks. The significant possibility of major salt infiltration into Seneca Lake with extreme consequences, and the fact that the salt cavern is located in bedded salt strata rather than salt domes, add to this risk.

From the perspective of community safety based on this analysis, continued salt cavern storage in Schuyler County carries a baseline unacceptable risk that would rise even higher under this proposal. Risk mitigation efforts in salt cavern storage have thus far proven unsuccessful in significantly reducing the frequency of serious and extremely serious incidents. Therefore the application for the proposal should be denied and strong consideration given to safer forms of gas storage to meet demand.

Introduction

Risk assessment work starts with a prioritization process, based on the likelihood and consequences of identified untoward events.[1] For events of extreme seriousness and high likelihood, the risk is ordinarily deemed unacceptable, and efforts are made chiefly to reduce or eliminate the risk. For events of minor consequence and low likelihood, the risk may be deemed acceptable, and a response plan is developed. A matrix is commonly used to display the combination of consequence and likelihood:[2] [3]

MATRIX FOR RISK ASSESSMENTS at NTNU

CONSEQUENCE						
	Extremely serious	E1	E2	E3	E4	E5
	Serious	D1	D2	D3	D4	D5
	Moderate	C1	C2	C3	C4	C5
	Minor	B1	B2	B3	B4	B5
	Not significant	A1	A2	A3	A4	A5
		Very low	Low	Medium	High	Very high
		LIKELIHOOD				

Principle for acceptance criteria. Explanation of the colours used in the risk matrix.

Colour		Description
Red		Unacceptable risk. Measures must be taken to reduce the risk.
Yellow		Assessment range. Measures must be considered.
Green		Acceptable risk Measures can be considered based on other considerations.

Figure 1—Sample Risk Matrix

In a high-level quantitative risk analysis (QRA) I have applied this process to evaluate the risk of the Schuyler County liquid petroleum gas (LPG) storage proposal submitted by Finger Lakes LPG Storage Company, LLC (FLLPG).[4]

Hazard events were scored as either “major accidents” or not, using the methodology of the Marcogaz European Underground Gas Storage Study

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[1] Rob Mackenzie, M.D., FACS, FRCS(C), FACHE was until 2013 the President and Chief Executive Officer at the Cayuga Medical Center, Ithaca, NY where he led statewide CEO taskforces to improve safety performance, leading to 2010 recognition by Consumer Reports as New York State’s safest hospital. His safety and risk assessment experience includes being the Chair of VHA-Empire State Healthcare CEO Safety Network; organizational, community, hospital, and industrial safety and risk assessments (both quantitative and qualitative); training in high-reliability science and on-site evaluations of safety practices at high-reliability medical and industrial sites including Sentara, Palo Verde nuclear facility, NASA. See C.V. attached hereto as Attachment 1.

[2] This typical example is from http://www.ntnu.no/innsida, a Norwegian university.

[3] *Guidelines for Chemical Transportation Safety, Security, and Risk Management*, Center for Chemical Process Safety, John Wiley & Sons, 2008.

[4] *See* New York State Department of Environmental Conservation *Finger Lakes LPG Storage, LLC, Underground Storage Facility - October 2014*, at http://www.dec.ny.gov/permits/71619.html.

database, derived from Appendix VI of the European Union's SEVESO II Directive 96/82 on the control of major-accident hazards involving dangerous substances.[5] If such "major accidents" per Marcogaz criteria had multiple casualties, multiple evacuations longer than 30 days, or permanent environmental damage they were scored as "extremely serious events;" all other major accidents were scored "serious events." Non-major accidents were scored "moderate," "minor," or "not significant" (see Marcogaz criteria with examples in Attachment 2), and not analyzed further since they were unlikely to significantly impact health and safety.

Likelihood categories were derived by applying the probability definitions of ISO Standard 17776(2000), Petroleum and Natural Gas Industries,[6] to the number and longevity of U.S. underground gas storage industry's facilities. By this standard, an event rate of "very low likelihood" is less than 0.1%/year, "low likelihood" between 0.1–1.0%/year, and "medium likelihood" up to 5–20%/year Probabilities were reported using an exposure interval of 25 years (see methodology and examples in Attachment 2).

Crestwood's predecessor company, Inergy Midstream, commissioned its own QRA, reported in 2012.[7] That analysis evaluated the frequency, severity, and consequences of potential equipment-related gas releases at the facility in great detail, and concluded that the hazards and risk to on-site and nearby individuals were acceptable and "similar to those of LPG storage, transport, and processing facilities worldwide."

However, that QRA did not analyze risks associated with transport to or from the site, even though the transport stage of the energy chain is responsible for a volume of fatalities and injuries several orders of magnitude higher than the facility stage.[8] It did not analyze the potential for or consequences of geologic salt infiltration induced by facility operations, even though such infiltration may have major public health consequences and cause irremediable environmental damage (see *Salt brine Infiltration,* below).

That QRA also greatly underreported salt cavern incidents: It cited a European study that determined the *structural* failure rate to be one in 100,000. Yet that study included depleted oil and gas wells (which have a much better safety track record than salt caverns), while omitting facility infrastructure events and many known salt cavern incidents. The *annual* probability of incidents with casualties *in salt cavern facilities* which, by this methodology, would be scored "serious" or "extremely serious" events is actually 1.5 in 100 (or 37.5% over 25 years)—a

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[5] European Union Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances.

[6] International Organization for Standardization, *ISO 17776:2000 Petroleum and natural gas industries – Offshore production installations – Guidelines on tools and techniques for hazard identification and risk,* at http://www.iso.org/iso/catalogue_detail.htm?csnumber=31534.

[7] 2012-02-16, Quantitative Risk Assessment, Quest Consultants.

[8] Evans, D.J. Health and Safety Executive of the United Kingdom, *An appraisal of underground gas storage technologies and incidents, for the development of risk assessment methodology* (2008).

hundred and fifty times more likely than Inergy's QRA suggests (see *Salt Caverns*, below).[9]

Brief summary of LPG storage proposal:
FLLPG's application for a Schuyler County liquid propane and butane gas storage facility, as most recently revised on December 2, 2014,[10] calls for 1785 inbound and/or outbound rail tank cars per year to deliver propane or butane to or from storage in a US Salt cavern from which salt is no longer being solution-mined. The plan calls for most inbound and all outbound propane to be transported by pipeline.

RISK ANALYSIS

This analysis pertains to three contingencies. Stated as questions:
(1) Is LPG transportation by rail an acceptable overall and incremental risk?
(2) Is LPG transmission by pipeline an acceptable overall and incremental risk?
(3) Is salt cavern storage of LPG an acceptable overall and incremental risk?

Rail Transportation Risk:
LPG rail ingress from the south would proceed north from the southern tier corridor at Corning on the Norfolk Southern Railroad on Class II ("regional") track.[11] It would cross Watkins Glen State Park gorge on a trestle constructed in the 1930's and terminate at a proposed new rail siding at the FLLPG site.

The most serious risk in LPG rail transportation is derailment with overturned tank cars, when puncture and leakage of fuel is common.[12] In the decade from 1995-2004 there were 17 serious incidents of U.S. train derailment, tank fracture, hazardous gas release, or chemical reaction, resulting in 9 dead, 5000 injured, and 10,000 evacuated.[13] It has been stated that if a similar accident were to occur on the trestle over the state park, the relatively heavy propane gas would flow like a liquid down the gorge or the hill in two to four minutes and spread out in the town below, and that ignition from vehicle exhaust, etc., would then almost certainly cause an explosion, propagate a blast wave, and start fires.[14]

In my literature review and in discussions with fire officials I found this

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[9] This risk assessment is based on, among other things, an extensive literature review of serious gas storage incidents involving salt caverns. The author is not offering an opinion on the integrity or lack of integrity of the proposed LPG storage caverns that FLLPG wishes to use, nor the current or historic causes for the high salt levels in Seneca Lake. Instead, this assessment documents the probability and potentially serious consequences of a storage or transportation accident involving salt caverns and summarizes relevant literature on the risks.
[10] 2014-12-02, Product Transportation Allocation – Revised December 2014, letter and attachment.
[11] www.nys.dot.gov.
[12] Lee's Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control, Elsevier Butterworth-Heinemann, 2005.
[13] Evans, 2008 (Table 14).
[14] Michael Lausell, county legislator, at a meeting of the Schuyler County Legislature held on 7/14/14.

catastrophic scenario credible, but quite rare. One instance would be the small-town LPG railroad tank-car derailment that occurred in Viareggio, Italy in 2009.[15] In that horrific case there were many flattened buildings and 30 fatalities. Computer modeling after the fact indicated that it likely took the propane gases 100 seconds to reach the furthest-away incinerated house, even with flat local terrain and under calm weather conditions. Because of the fast spread of gas, emergency response in Viareggio was limited to evacuation and after-the-fact injury care. These types of events would be scored **"extremely serious"** on the ISO risk matrix. Lesser events (such as derailment with overturnment but without leakage) were ignored because the consequences would be minor or not significant.

From industry-published rates, the incremental probability of rail tanker derailment with overturnment within the county over twenty-five years is between 2 and 3%, assuming an average of 150 additional trains yearly.[16] This estimate could be further refined by looking at speed, number of cars, class of track, and the integrity of bridges and other rail infrastructure.

Recent rail disasters have highlighted concerns about rolling stock, infrastructure, and current inspection protocols whereby the rail company, not the regulator, inspects track and trestles, and the reliability of inspection data has recently been questioned both by New York State auditors[17] and the media.[18] With a caution about the lack of independent data, rail risk would be placed in cell E1, **very low likelihood**. This cell indicates "assessment range," so ways to further mitigate should be still considered **because of the possibly extreme consequences** (Figure 2, next page).

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[15] Brambilla, Sara, Roberto Totaro, and Davide Manca, *Simulation of the LPG release, dispersion, and explosion in the Viareggio railway accident,* at www.aidic.it/CISAP4/webpapers/36Brambilla.pdf.

[16] The Canvey report from 1978 cited in Lee's Loss Prevention, 2005, appendix 7/9 gives the frequency of rail tank car derailment as 1 x 10^{-6}/ km (= 1.6 x10^{-6}/mi), and the probability of overturning (when rupture is most likely to occur) as 0.2. This frequency is lower than US data from the 1970s, but the US data has dropped and is now similar, at 2 x 10^{-6}/mi. I used the lower Canvey data, and ignored return-trips with empty tankers, the risk of which would be of lower consequence. GoogleMaps shows the rail distance from the south county border to the Crestwood site to be about 12 mi. FLLPG estimates between 6.8 and 32 cars per trip, and between 56 and 261 trips per year; I based my calculation on an average 150 trips per year. Calculation: 1.6 x 10^{-6} derailments/km x 0.2 overturnments/derailment x 12 mi/trip x 1.6km/mi x 1 trip/day x 150 days/yr x 25 years = 0.0230 = 2.3%.

[17] New York State Department of Transportation, *Railroad Bridge Inspection Program*, at http://www.osc.state.ny.us/audits/allaudits/093014/13s5.pdf (Dec. 2013).

[18] Tate, Curtis, *Trains Plus Crude Oil Equal Trouble Down the Track,* at http://www.mcclatchydc.com/static/features/Trains+Oil/Trouble-down-the-track.html?brand=mcd.

CONSEQUENCE					
Extremely serious	TRAIN RISK	E2	E3	E4	E5
Serious	D1	D2	D3	D4	D5
Moderate	C1	C2	C3	C4	C5
Minor	B1	B2	B3	B4	B5
Not significant	A1	A2	A3	A4	A5
	Very low	Low	Medium	High	Very high
			LIKELIHOOD		

Color	Description
Red	Unacceptable risk. Measures must be taken to reduce risk
Yellow	Assessment range. Measures must be considered
Green	Acceptable risk. Measures can be considered based on other considerations

Figure 2—Incremental Train Risk

Pipeline Transportation Risk:
LPG pipeline transportation would occur via the existing network of Schuyler County liquid hazard pipelines.[19]

The most serious risks in U.S. pipeline transportation in 2013 were: pipe disruption caused by failure of material or welds (43%), excavation damage (23%), corrosion (13%), natural force damage (7%), other outside force damage (7%), incorrect operation (3%) or other causes (3%).[20] In the decade from 2004–2013 such disruptions in pipelines carrying highly volatile, flammable, and toxic liquids such as propane and butane resulted in 278 significant incidents with 7 fatalities, 27 injuries, and more than $95 million in property damage, according to industry sources.[21]

These "significant incidents," however, were distributed over a pipeline network of approximately 63,000 miles.[22] Because of the lower proximity to population centers in this case, the relatively low potential for evacuation, and the moderate number of casualties, such events would be scored as a **moderate consequence** on the ISO risk matrix. Over a 25-year exposure interval the event risk for Schuyler County's 21 miles of LPG pipeline is approximately 23 percent, or **medium likelihood**.[23] However, because no significant additional pipeline construction is planned, this would be considered baseline risk, not incremental risk. This baseline risk is in the "assessment range," so ways to reduce risk further should be still considered **because of the possible consequences** (Figure 3, next page).

[19] National Pipeline Mapping System map for Schuyler County, New York, at: https://www.npms.phmsa.dot.gov/PublicViewer.
[20] Pipeline and Hazardous Material Safety Administration, U.S. Department of Transportation, *Pipeline Safety Stakeholder Communications - Significant pipeline incidents by cause*, at: http://primis.phmsa.dot.gov.
[21] Calculation: 28 significant incidents/yr/63,000 miles pipeline x 21 miles Schuyler County pipeline x 25 years = 0.233.
[22] *Id.*
[23] *Id.*

CONSEQUENCE					
Extremely serious	E1	E2	E3	E4	E5
Serious	D1	D2	D3	D4	D5
Moderate	C1	C2	PIPELINE RISK	C4	C5
Minor	B1	B2	B3	B4	B5
Not significant	A1	A2	A3	A4	A5
	Very low	Low	Medium	High	Very high
			LIKELIHOOD		

Color	Description
Red	Unacceptable risk. Measures must be taken to reduce risk
Yellow	Assessment range. Measures must be considered
Green	Acceptable risk. Measures can be considered based on other considerations

Figure 3—Baseline Pipeline Risk

Salt Cavern Risks:

This risk assessment is based on, among other things, an extensive literature review of serious incidents involving LPG or gas storage in salt caverns. The author is not offering an opinion on specific risks of FLLPG's proposed LPG storage facility, nor the salt caverns at issue in this proceeding. I have relied upon the conclusions of expert Hydrologist Tom Myers, Ph.D. and expert geologist Dr. H.C. Clark regarding certain of the specific risks of the proposed project, and also have summarized certain of the relevant literature on the risks.

Event rates

As of 2013 there were 419 underground gas storage facilities in the US.[24] Most are in depleted oil and gas fields; a few are in aquifers, and 40 are in "salt cavern" facilities.[25] Most salt caverns have been developed over several decades from naturally occurring, globular so-called "salt domes" in the Gulf states. Nine have been added since 2007.[26] A few salt caverns are in "bedded salt" deposits like Schuyler County's, which itself has been used in the past for LPG and natural gas storage. Safety oversight of underground gas storage is performed by both federal and state agencies.

Despite this supervision, between 1972 and 2012 there have been at least 20 serious or extremely serious incidents in salt cavern storage facilities located in the United States.[27] [28] [29] [30] [31] [32] With the average number of salt cavern storage

[24] http://www.eia.gov/dnav/ng/ng_stor_cap_a_EPG0_SAD_Count_a.htm.
[25] http://www.eia.gov/dnav/ng/ng_stor_cap_a_EPG0_SA5_Count_a.htm.
[26] http://www.eia.gov/dnav/ng/hist/na1393_nus_8a.htm.
[27] Evans, 2008 (Appendix V and Table 14).
[28] Warren, J.K. *Evaporites: Sedimentology, resources and hydrocarbons*, Springer (2006, Chapter 12).
[29] Hopper, John M., *Gas Storage and Single Point Risk,* in Natural Gas, at http://gasfreeseneca.com/wp-content/uploads/2011/06/Gas-Storage-Explosions.pdf.
[30] Warren, J.K. *Evaporites: Sedimentology, resources and hydrocarbons*, Springer (2015 in press): pp 1136–1144,at http://gasfreeseneca.com/wp-content/uploads/2015/01/Warren-J.K.-Evaporites-Ch.13-Solution-Mining-and-Salt-Cavern-Usage-Storage-cavern-problems-pp-1136-1144-2015-in-press.pdf.
[31] Inergy Midstream, *Inergy Midstream Issues Statement on Bath* Incident (March 10, 2008) (describing an incident at Inergy's LPG salt cavern facility in Bath, NY).

facilities in operation through most of the last two decades close to 30,[33] the US incidence between 1972 and 2012 is more than 65 percent (compared to 40 percent worldwide[34]), and the frequency more than 1.6% per year. Causes of failure have included corroded casings, equipment failure, brine erosion leading to breach, leakage into other geologic formations, and human error. Worldwide, the percentage of incidents *involving casualties* at salt cavern facilities as a percentage of the number of facilities operational in 2005 was 13.6 percent, compared to 0.63% for gas and oil fields, and 2.5% for aquifers.[35]

Ten of the salt cavern incidents were accompanied by large fires and/or explosions. Six involved loss of life or serious injury. In eight cases evacuation of between 30 and 2000 residents was required. Extremely serious or catastrophic property loss occurred in thirteen of the 18 cases. In one incident involving the current permit applicant's other New York State salt cavern facility in 2008, a drilling rig hired to perform work on an existing inactive salt cavern storage well caused release of gas which ignited at the surface, resulting in injuries to four persons.[36]

The likelihood of a serious or extremely serious event over twenty-five years is more than 40 percent.[37] Per ISO methodology this is at least a **medium likelihood**, with the potential for at least **serious** consequences, and, as discussed below, likely **extremely serious** consequences. It thus constitutes an **unacceptable risk**. (See further discussion below on the risks and baseline versus incremental risks).

Salt brine infiltration

As set forth in the report of Hydrologist Tom Myers, whom I have relied upon for information on LPG-related risks of salt brine infiltration, in the early 1900s Seneca Lake waters had moderately more chloride than other Finger Lakes,[38] as would perhaps be expected due to the commencement of solution salt-mining on the shores of the lake in 1893,[39] and/or because much of the bed of Seneca Lake intersects bedded salt planes.[40] Chloride levels in Seneca Lake rose gradually

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[32] Events collected from sources 25–28 were categorized as "major accidents" or not by Marcogaz criteria. Major accidents were then scored as serious or extremely serious according to the additional criteria in Attachment 2.

[33] http://www.eia.gov/dnav/ng/hist/na1393_nus_8a.htm shows a stable salt cavern count at approximately 30 fields from 1999 until further growth to 40 started more recently (2007), and http://www.eia.gov/dnav/ng/hist/na1394_nus_8a.htm shows stability in the total storage field count over the prior ten years.

[34] Per Evans (2008, p. 115), the lower world-wide incidence is thought by some to reflect under-reporting in Europe and the former Soviet Union.

[35] Evans, 2008 (Table 2).

[36] Inergy Midstream, *Inergy Midstream Issues Statement on Bath* Incident (March 10, 2008) (describing an incident at Inergy's LPG salt cavern facility in Bath, NY).

[37] Calculation: 1.66% incidence per year x 25 yrs = 41.6%.

[38] Finger Lakes Inst. et al. Seneca Lake Watershed Management Plan (March 2012).

[39] Jacoby CH & Dellwig LF, Appalachian foreland thrusting in Salina salt, Watkins Glen, New York. 4th International Symposium on Salt. Northern Ohio Society.

[40] Wing, M.R., et al., Intrusion of saline groundwater into Seneca and Cayuga Lakes, New York, Limnol. Oceanogr., 40(4), 1995.

from less than 50 ppm in 1905 to approximately 115 ppm in the mid-1960's, in parallel with increased salt mine production at Seneca Lake, strongly suggesting an anthropogenic rise.[41] Seneca Lake chloride levels then surged dramatically, from approximately 110 ppm to more than 180 ppm in the latter half of the 1960s.

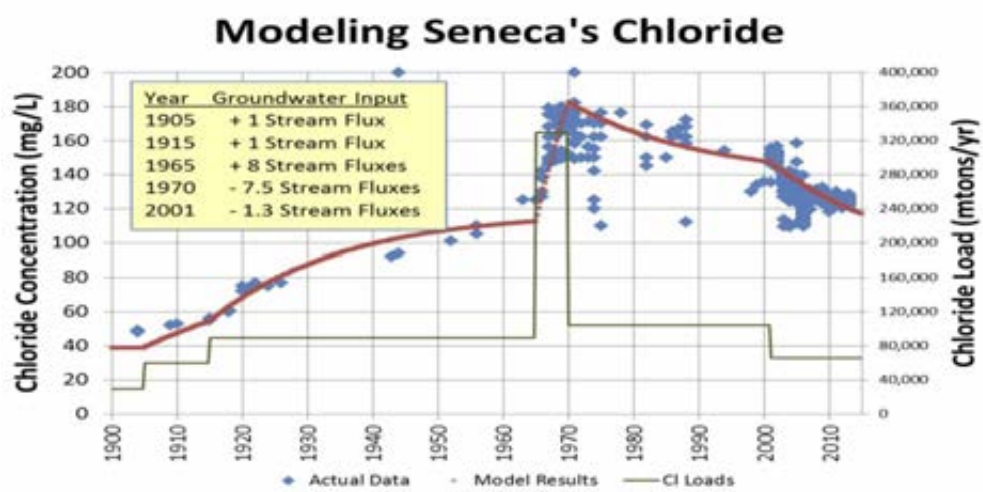

Figure 4. from Halfman, 2014

Ion flux studies show that documented industrial salt waste discharges and road salt stream drainage, taken together, are insufficient by an order of magnitude to explain this exponential chloride increase.[42] [43] This suggests that the onset of gas storage in repurposed salt caverns on the southwest shore of the lake in 1964 greatly accelerated natural seepage of salt brine into the lake.[44]

If further expansion of salt cavern gas storage on Seneca Lake again produces a spike in salinity similar to that seen in the 1960s, that new spike would start from a higher baseline of 120–130 ppm Cl. The chloride content of Seneca Lake—New York's largest body of fresh water wholly within its borders—could then rise dangerously close to the level that could render the lake water dangerous for aquatic life (230 ppm)[45] and uncomfortably close to the level that would violate New York State drinking water regulations (250 ppm).[46] In that event, remediation for large-scale salt contamination could well take decades or be

[41] Halfman, John, Geneva, NY 2-page memo to Federal Energy Regulatory Commission re Arlington Storage Co, LLC, proposed request to expand gas storage near Watkins Glen (Docket Number: CP13-83), March 18, 2013.
[42] Halfman, John, A 2014 Update on the chloride hydrogeochemistry in Seneca Lake, New York, 12/10/2014, at: http://people.hws.edu/halfman/Data/PublicInterestArticles/An%20Update%20on%20Major%20Ion%20Geochemistry%20in%20Seneca%20Lake,%20NY.pdf.
[43] The company has said it cannot explain the sudden spike in salinity (Barry Moon, Plant Manager, Finger Lakes LP Storage, to Government Operations Committee, Yates County Legislature, October 6, 2014). A local engineer suggested that brine waste from the Morton Salt Himrod salt mine may have been responsible (Dennis Fagan to Timothy Dennis, *RE: Proposed Yates County Resolution Opposing the LPG Project in the Town of Reading,* October 9, 2014), but the spike in salinity predated construction of the Himrod mine by several years.
[44] *See* January 2015 Technical Memorandum of Tom Myers, Ph.D., Hydrologic consultant.
[45] Ambient Water Criteria for Chloride, EPA 440/5-88-001,1988.
[46] New York State Department of Health Drinking Water Regulations Part 5, Subpart 5-1.

impossible, jeopardizing the source of drinking water for about 100,000 people.[47] Other long-term water sources could be needed, or else large populations would be obliged to move.

Indeed, some persons in the watershed are already advised to seek alternative water supplies, because Seneca Lake's sodium level of 75 ppm is three to four times the 20 ppm level which the NYS Department of Health indicates should not be used for drinking by people on severely restricted sodium diets nor newborn infants.[48]

Even lesser disasters, such as failure of brine pond containment, may not be as benign as some have assumed.[49] Few if any other salt caverns are adjacent to a large lake. A disaster resulting from accelerated geologic brine or salt infiltration, or some other failure of the proposed LPG storage facility, would have **extreme consequences** because Seneca Lake provides drinking water for approximately 100,000 people and numerous businesses, and numerous people recreate on and in the lake. When considered together with the other extremely serious incidents, it raises the consequence of salt cavern events into the **extremely serious** range.

Geology

As discussed in the expert report of Geologist Dr. H.C. Clark, much concern has also been raised about the geology of the solution-mined caverns proposed for natural gas storage. There has been a great deal of discussion over faults, large roof collapses, rubble piles, undiscovered uncapped wells, and so on. I do not have the expertise to evaluate such concerns, reassurances, rulings, or requirements, but have relied upon Dr. Clark's assessment of some of these risks.

However, it is not necessary to get into significant geologic detail for this level of risk analysis. From the risk assessment perspective it is enough to recall that standard and additional regulatory recommendations, routine mechanical integrity testing, and every other careful industry precaution have failed to prevent the eighteen recent serious or extremely serious salt cavern incidents in the United States. Some have been quite recent, and some have occurred in caverns with fairly long safety track records before the accidents.[50] The available literature provides no good reason to assume that regulation, testing, or oversight in today's resource-constrained environment will be more successful in preventing such incidents tomorrow than it was in preventing them yesterday.

Furthermore, salt caverns created in bedded salt deposits like Schuyler County's are known to be less stable, with a higher risk of failure, than the salt domes

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[47] Halfman, John D., *Water Quality of Seneca Lake, New York: A 2011 Update.*
[48] New York State Department of Health Drinking Water Regulations Part 5, Subpart 5-1.
[49] SEQR Documents, Accepted DSEIS, Final DSEIS Text at 38–44.
[50] See narratives of specific cases in Evans (2008, Appendix V) and Warren (2006, Chapter 12).

common in the Gulf.[51] The most instructive incident in this connection occurred at the Yaggy salt cavern facility seven miles northwest of Hutchinson, Kansas, a town of 44,000. Gases that escaped from the salt cavern due to human error traveled along sedimentary layers, erupted in the town itself, and resulted in fire, explosion, two deaths, one injury, and more than 250 evacuations. (See detailed summary, map, and photos in Attachment 3). The unfavorable geology and irregular cavern shapes generally associated with bedded salt deposits, and the fact that failures are much more common in salt caverns than other storage places, push the likelihood of salt cavern events here somewhat higher in the **medium likelihood** category.

Risk tolerance

This level of consequences per facility over twenty-five years—major fires, explosions, collapses, catastrophic loss of product, evacuations—is an unusually high level of risk. Most other regulated industry sub-segments with a persistent serious to extremely serious facility incident rate of this magnitude would be shut down or else voluntarily discontinued, except in wartime. In my view, this is an unacceptable level of risk, and the proposed LPG facility should not be permitted.

Baseline risk versus incremental risk

The company's position appears to be that although the location is not ideal, the baseline risk of salt cavern gas storage adjacent to Seneca Lake has already implicitly been accepted,[52] and that incremental risks from this proposal for additional storage are negligible. Regarding baseline risk, however, as shown above, past regulatory approvals are no guarantee against catastrophic risk. In particular, documented experience in salt cavern storage adjacent to a large lake (i.e., this one case) is hardly reassuring, because of the current high salt levels in Seneca Lake and the huge salt flow into the lake in the 1960s when LPG storage last took place in the salt caverns. Regarding incremental risk, there also appears to be a direct correlation between the number of salt caverns used for storage per facility and the likelihood of serious and extremely serious events. For example, Mont Belvieu, Texas, the largest gas storage depot of salt caverns in the country, has had more events than any other U.S. facility.[53] Put simply, the use of any salt cavern is very risky; these particular salt caverns seem unusually risky; and the more caverns are used, the higher the risk becomes.

To be sure, there have been advances over the years in assessment, extraction, storage, and transportation technology in salt caverns used for natural gas storage. And there have been scattered reports and articles praising the safety of underground salt cavern storage. Yet those advances and reports have not yet led to a significant reduction in the rate of serious and extremely serious

[51] Warren (2006, Chapter 12).
[52] McKinley, J., *What Pairs Well with a Finger Lakes White? Not Propane, Vintners Say, New York Times* 12/25/14.
[53] Evans, 2008 (Table 14).

incidents.[54] Experience from NASA, nuclear power plants, car manufacturing, and healthcare consistently shows that to improve safety the critical requirement is not better technology but cultural change.

CONSEQUENCE					
Extremely serious	TRAIN RISK	E2	SALT CAVERN RISK	E4	E5
Serious	D1	D2	D3	D4	D5
Moderate	C1	C2	PIPELINE RISK	C4	C5
Minor	B1	B2	B3	B4	B5
Not significant	A1	A2	A3	A4	A5
	Very low	Low	Medium	High	Very high

LIKELIHOOD

Color	Description
Red	Unacceptable risk. Measures must be taken to reduce risk
Yellow	Assessment range. Measures must be considered
Green	Acceptable risk. Measures can be considered based on other considerations

Figure 5—Train, Pipeline and Salt Cavern Risks

Safer options

As shown above, *gas storage in depleted oil and gas reservoirs has a safety track record twenty times better than storage in salt caverns*. Some salt cavern storage proponents claim that it can offer shorter cycle times with facilities located closer to market, providing better "spot coverage" for demand spikes. But it cannot do so reliably, as illustrated most recently by the failure of the Toddhunter, Ohio salt cavern propane storage facility due to gas leakage.[55]

Simply locating underground storage in something other than a salt cavern would be much safer, as would choosing a location that is not adjacent to the drinking water supply for 100,000 people and numerous businesses. One such alternative, which can meet spot coverage for demand spikes, is to use an excavated, lined rock cavern closer to the market. A safer alternative would also be to use a depleted oil or gas reservoir located closer to the market. While other forms of storage can be in some cases more expensive, other storage locations will have a much more acceptable environmental footprint, be reliably safer, and more easily located as close to market as needed.

Other risks:

Diesel air pollution, noise pollution, loss of jobs in tourism and wineries from "industrialization," and many other risks have been discussed widely in community forums. They are not included in this analysis because they seem somewhat unlikely to require emergency response, but they will have health and other consequences.

[54] Industry sources cite a reduction in incident frequency in the 1990's, but this reversed with a spate of incidents in the early 2000s.

[55] LP Gas, *Tracking the Latest Developments in U.S. Propane Supply*, December 2013

Risk summary and Conclusion:
The incremental risk of extremely serious rail tanker events within the county over twenty-five years remains between 2 and 3 percent following the risk mitigation efforts of the last several decades. Ways to further mitigate this risk should be considered because of the possibly extreme consequences.

The baseline risk of pipeline events of moderate consequence within the county over twenty-five years is between 20 and 25 percent. Ways to further mitigate this risk should always be considered.

The risk of a salt cavern facility event of serious or extremely serious consequence within the county in the next twenty-five years, including both baseline and incremental risks, is more than 40 percent. Worst-case scenarios are not hard to imagine. They would involve some combination of loss of life, loss of the lake as a source of drinking water, and/or temporary or permanent evacuation. Each of these scenarios has happened in other salt cavern facilities. Fortunately for the nation, but of no help to Schuyler County, most of the other events occurred in locations more isolated from population centers than this one.

From the perspective of health and safety, based on this independent analysis, I conclude that continued and/or expanded operation of LPG storage in the bedded salt caverns adjacent to Seneca Lake carries an unacceptable risk of extremely serious consequences, that FLLPG's proposal should be denied, and that safer gas storage alternatives should be considered.

Rob Mackenzie, MD, FACHE

NYSDEC OHMS Document No. 201166576-00026

ATTACHMENT 1

NYSDEC OHMS Document No. 201166576-00026

C.V.

Rob Mackenzie, M.D., FACS, FRCS(C), FACHE

Home Address:

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Trumansburg, New York 14886
607 387-3660 home
607 592-2508 cell
rmackenzie@zoom-dsl.org

PROFESSIONAL EXPERIENCE

2003 to 2013 — President and Chief Executive Officer, Cayuga Medical Center, Ithaca, NY

Led this 204-bed, $130M revenue, benchmark independent community medical center in Ithaca, New York. Led statewide CEO taskforces to improve safety performance, leading to 2010 recognition by Consumer Reports as New York State's safest hospital.

Safety and risk assessment experience includes:

- Chair of VHA-Empire State Healthcare CEO Safety Network
- Organizational, community, hospital, and industrial safety and risk assessments (both quantitative and qualitative)
- training in high-reliability science
- on-site evaluations of safety practices at high-reliability medical and industrial sites including Sentara, Palo Verde nuclear facility, NASA

2002 Oct-Dec — Chief Operating Officer, Cayuga Medical Center, Ithaca, NY

Responsible for hospital operations during three-month transition period prior to becoming President / CEO.

1993 to 2002 — Vice President for Medical Affairs, Cayuga Medical Center. Ithaca, NY

Responsible for quality assurance, utilization management, credentials, regulatory compliance, strategic planning, and physician liaison functions.

1991 to 2002 — President, Finger Lakes Management Associates, Inc. (MD Org.), Ithaca, NY

Founding member of 150-member, for-profit association of independent physicians to address health care quality, medical business, hospital relations, and third-party reimbursement issues.

1995 to 2002 — Medical Director, Cayuga Area Plan, Inc. (MD-Hospital Org.), Ithaca, NY

Founding leader of physician-hospital organization to address health care quality, do joint strategic planning, and unify payer negotiations.

1984 to 2002 — General and Vascular Surgeon, Surgical Associates of Ithaca, P.C., Ithaca, NY

Senior partner until 2002 retirement in an esteemed four-member general, vascular, and thoracic surgery private practice.

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EDUCATION

BA	Harvard College, Cambridge, Massachusetts, 1975
MD	Albany Medical College, Albany, New York, 1979
Internship / Residency	University of Toronto general surgery internship, residency, Toronto, Ontario 1979-1984

LICENSURE AND BOARD CERTIFICATION

Diplomate, National Board of Medical Examiners
Diplomate, American Board of Surgery
Diplomate, Royal College of Surgeons of Canada
Diplomate, American College of Healthcare Executives
Medical License: New York 1984

ACADEMIC AFFILIATIONS

Instructor in surgery, Weill Medical College of Cornell University, 1993-2002

PROFESSIONAL ASSOCIATIONS

Albany Medical Center Class of 1979, President
Alpha Omega Alpha Medical Honor Society
American College of Healthcare Executives
American College of Physician Executives 1993-2007
American College of Surgeons, Fellow
American Red Cross, Tompkins County, Board of Directors 1997-2000
Cayuga Medical Center Medical Staff President, 1993
Cornell University College of Veterinary Medicine Advisory Council 2006-2012
Governance Institute, Editorial Board 2003-6
Health Planning Council, Tompkins County, Advisory Board 2003-2012
Iroquois Healthcare Association, Board of Directors, Vice Chair 2011
Legacy Foundation of Tompkins County, Board of Directors 2006-2010
Lifetime Healthcare Companies, Board of Directors 2004-2011
Medical Society of the State of New York
Medical Society of the County of Tompkins, Board of Directors 1997-2012
Paleontological Research Institution, Board of Directors, President 2010-11
Royal College of Surgeons (Canada), Fellow
Tompkins Health Network, Board of Directors
VHA Empire-Metro, Board of Directors Chair 2006-9
VHA CEO Safety Network Chair 2008-9

Born September 14, 1953

Retired January 1, 2013

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ATTACHMENT 2

NYSDEC OHMS Document No. 201166576-00026

Methodology

A. CONSEQUENCE

The most widely used criteria for reporting major-accident hazards involving dangerous substances were promulgated by the European Union in Appendix VI of the SEVESO II Directive (Dir. 96/82 in 1999. These were adapted in 2000 by Marcogaz, a consortium of eight companies involved in underground storage activity, for use in a database for major accidents. The scope of the Marcogaz database is concerned with all parts of the infrastructure at storage plants, i.e. wells, compressors, treatment & measuring facilities and pipework systems that have led to any particular incident. The criteria are as follows:

1. Fire, explosion or accidental discharge involving at least 10 tons of gas (5% of 200 tons).
2. One death or,
    a. injuries inside establishment or,
    b. 1 injury outside establishment or,
    c. housing damaged or made unavailable outside establishment or,
    d. evacuation or confining of people for more than 2 hours (persons x hours >=500) or,
    e. interruption of drinking water, electricity, gas or telephone supply for more than 2 hours (persons x hours >= 1000)
3. Effects on environment
    a. permanent damage: 0.5 hectares of a protected area or 10 hectares of a larger area
    b. significant damage: 1 hectare of a groundwater aquifer, 10 km or more along a river, 1 hectare or more of a lake, or 2 hectare or more of a coastal area or sea
4. Material damage
    a. More than 2 Million Euros inside establishment
    b. More than 0.5 Million Euros outside establishment
5. Transboundary damage

For this study hazard events were scored as either “major accidents” or not using these criteria. If “major accidents” had multiple casualties, multiple evacuations longer than 30 days, or permanent environmental damage they were scored as “extremely serious events”; all other major accidents were scored “serious events.” For examples:

Extremely serious case examples:

1. Brenham, Texas: LPG leak in April 1992 causing fire and explosion, 3 dead, 23 injured, 50 evacuated, 26 homes destroyed, 33 homes damaged.
2. Conway, Kansas: Propane leakage into groundwater and domestic wells between 1980 and 2002 required purchase of 30 homes and relocation of 120 people.
3. Hutchinson/Yaggy, Kansas: Natural gas leak in January 2001 causing fire and explosion, 2 dead, 1 injured, >250 people evacuated for more than two months.

Serious case examples:

1. Mineola, Texas: Propane leak from casing in 1995 causing blowout and fire.
2. Mont Belvieu, Texas: Propane leak from casing in 1984 causing fire and explosion and several million dollars damage.
3. Moss Bluff, Texas: Natural gas fire and explosion in 2004 causing evacuations

Non-major accidents were scored “moderate,” “minor,” or “not significant” and rejected for further analysis, as being unlikely to have significant health and safety implications.

B. LIKELIHOOD

Likelihood categories were derived by applying the probability definitions of ISO Standard 17776(2000), Petroleum and Natural Gas Industries, to the number of U.S. underground gas storage industry’s facilities, using an average of 30 facilities over the past six decades, the current number of about 40 facilities, and a ten to twenty-year operating history for an average company:

A: Very low likelihood (or has rarely occurred in industry)—for example, twice in sixty years among an average of 30 UGS facilities = 2/60/30 < 0.1% /year or < 2.5% /25 years.

B: Low likelihood (or happens several times per year in industry)—for example, four times a year among current 40 UGS facilities = 4/40 = 0.1-1% /year or 2.5-25% / 25 years.

C: Medium likelihood (or has occurred in operating company)—for example, once or twice in ten to 20 years = 5-20% /year or many times in 25 years.

No hazard events were scored higher than medium likelihood over 25 years.

C. EXPOSURE INTERVAL

While cumulative risk is a function of time, choice of a particular exposure interval for reporting is somewhat discretionary. In this report, an exposure interval of twenty-five years was chosen because (a) it is expected that the community likely will be subject to the various risks described for at least twenty-five years, (b) use of the caverns in question has changed and may continue to change over time, (c) the expected life of the LPG storage facility may be longer than 25 years but I wanted to use a relatively conservative time estimate for this analysis; and (d) risks may be more likely to change over longer intervals.

D. ACCEPTANCE CRITERIA

Standard community health acceptance criteria as shown in the figures were used:

MATRIX FOR RISK ASSESSMENTS at NTNU

CONSEQUENCE						
	Extremely serious	E1	E2	E3	E4	E5
	Serious	D1	D2	D3	D4	D5
	Moderate	C1	C2	C3	C4	C5
	Minor	B1	B2	B3	B4	B5
	Not significant	A1	A2	A3	A4	A5
		Very low	Low	Medium	High	Very high
		LIKELIHOOD				

Principle for acceptance criteria. Explanation of the colours used in the risk matrix.

Colour		Description
Red		Unacceptable risk. Measures must be taken to reduce the risk.
Yellow		Assessment range. Measures must be considered.
Green		Acceptable risk Measures can be considered based on other considerations.

For example, using such criteria Schuyler County would accept the risk of an extremely serious event, (such as happened in Hutchinson, Kansas, with deaths, injuries, and long-term evacuations) if the 25-year risk is less than 2.5%, but not if it were as much as 25%.

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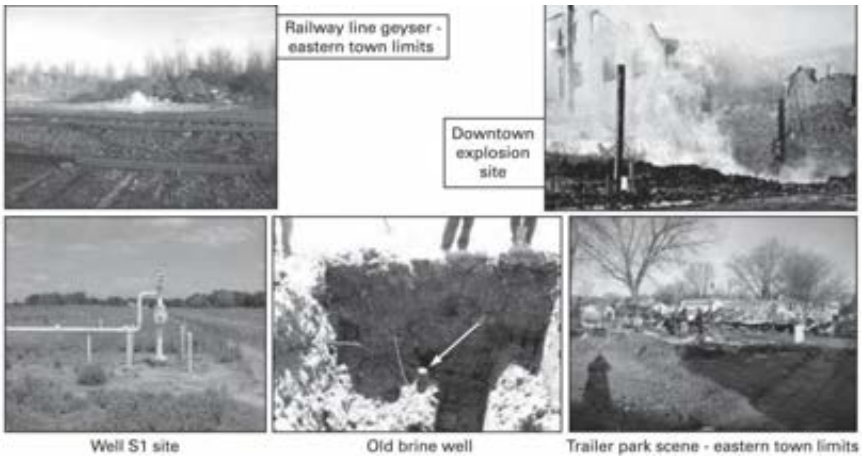
ATTACHMENT 3

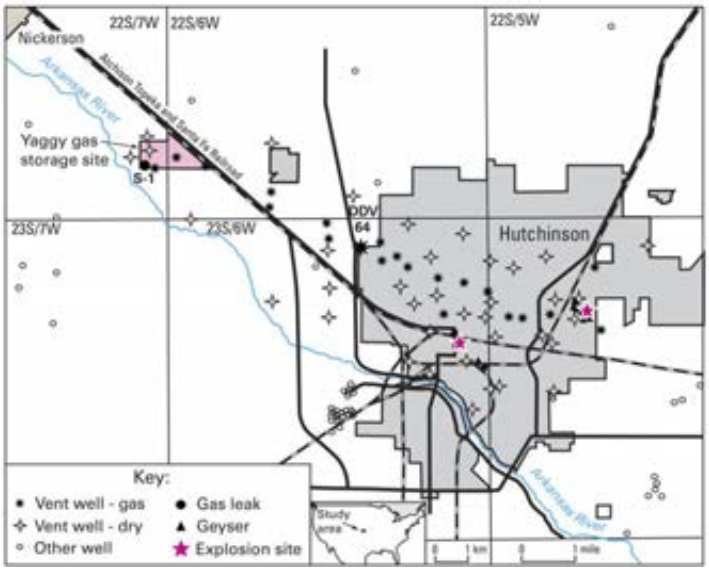
Hutchison/Yaggy Event

On January 17, 2001, a gas explosion and fire destroyed two businesses in downtown Hutchinson in central Kansas. The next day in the Big Chief mobile home park 3 miles away another explosion occurred and 2 residents died of injuries received. The explosions were tied to geysers spewing gas and water, and their appearance caused the excavation of hundreds of Hutchinson residents.



(photos, map, and diagram from Evans, 2008)

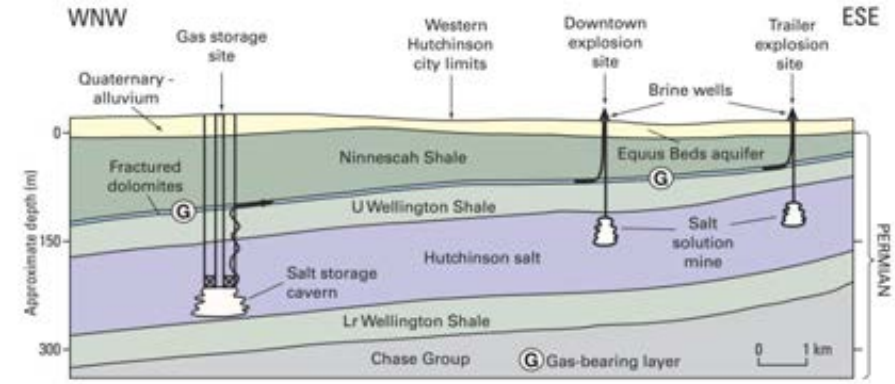
The January 17–18, 2001 eruptions of gas and brine, driving 30-ft geysers in the town, resulted from the loss of 3.5 Mcf of gas from the Yaggy natural gas storage facility located 7 miles down the road from the town community of 40,000 people.



The Yaggy field of salt caverns was originally developed in the early 1980s to hold propane. Because the company had difficulty making a financial success of the operation, the storage wells were filled with brine and then plugged by partially filling them with concrete. However, a second company acquired the facility in the early 1990s, converted it to natural gas storage, and the plugged wells were drilled out to return the caverns to use.

It is thought that cavern over-pressurization cause rupture through a previously undocumented area of damage to a well casing. The route followed to the surface by the escaping gas is

thought to be a fractured shale layer that facilitated drainage to the crest of the anticlinal culmination that underlies the town of Hutchinson, where gas escape to the surface via old unplugged brine wells:



After Hutchinson Fire Department, Kansas Geological Survey, CUDD Drilling and Shannon Pope of RPC Inc) BGS©NERC. All rights reserved

Like Seneca Lake, the Hutchinson region had been an area of solution mining since the late 1800s with numerous unplugged brine wells, long ago drilled and abandoned without appropriate documentation. Likewise, it has a mix of bedded salt and permeable rock formations with natural dissolution irregularities similar to those in Seneca County, which facilitated the escape of gas to the surface and the subsequent fires, explosions, deaths, injuries, and evacuation.

(from Evans, 2008 and Warren, 2006)

NYSDEC OHMS Document No. 201166576-00026

Exhibit 3

Seneca Lake Hydrology Report
Tom Myers, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

Technical Memorandum—Review of Finger Lakes LPG Storage, LLC, Proposed LPG Storage Facility

January 15, 2015, Corrected January 21, 2015

Tom Myers, Ph.D., Hydrologic Consultant

PUBLIC VERSION

NYSDEC OHMS Document No. 201166576-00026

FINAL: **Technical Memorandum—Review of Finger Lakes LPG Storage, LLC, Proposed LPG Storage Facility**
Date: **January 15, 2015, Corrected January 21, 2015**
Prepared by: Tom Myers, Ph.D., Hydrologic Consultant
Prepared for: Earthjustice, New York

EXECUTIVE SUMMARY

Finger Lakes LPG Storage, LLC, (FLLPG) proposes to store liquid petroleum gas (LPG) in two mined-out salt caverns in salt beds below ground on the west shore of Seneca Lake, near Watkins Glen, NY. Salt caverns in the formation that FLLPG proposes to use for LPG storage were previously used for LPG storage (starting in 1964). During that time, in the mid-1960s and continuing for several years while LPG storage was active in the salt caverns, there was a very large slug of highly-concentrated chloride (Cl) discharged into Seneca Lake. Because of Seneca Lake's very long "retention time", this spike drove Cl levels throughout Seneca Lake much higher, and this effect took several decades to subside somewhat (although the Cl levels in Seneca Lake are still relatively high).

In my opinion, the Cl discharges in the mid-1960s were caused by the LPG storage activities taking place at that time (in the same salt beds FLLPG now proposes to use for LPG storage). The scientific mechanism for the Cl discharges is explained in this paper. Simply put, the changes in pressure inherent in LPG storage—where higher pressure brine displaces LPG when you want to remove LPG from the caverns, and where lower pressure LPG displaces brine when you want to add LPG into the caverns—exert pressure on the salt formation. The salt formation slopes upward as you travel north up Seneca Lake, until the salt beds intersect with sediments directly under Seneca Lake. The pressure from the LPG activities is transmitted along the salt formation until it essentially squeezes out high-Cl groundwater into the bottom of Seneca Lake. The Cl discharges in the mid-1960s were extremely high, and greatly increased the overall CL concentration in the lake. The currently-proposed LPG storage in the salt beds would, in my opinion, do the same thing. Since there is no real way to monitor or prevent these discharges, as explained below, FLLPG's proposed LPG storage should not be permitted in the salt beds.

SUMMARY

The salt formations that FLLPG proposes to use for LPG storage are about 1000 feet below the bottom of Seneca Lake at this location, but these salt beds slope upwards to intersect with sediments beneath the lake bottom north of the site (and, from there, continue to intersect with sediments immediately beneath the lake bottom all the way to the northern end of the lake).

PUBLIC VERSION

This proposed project is similar to an LPG storage project that occurred at the site from 1964 to 1984. This earlier project coincided with and caused a massive spike of chloride (155,000,000 kg Cl/year for at least five years) to enter Seneca Lake, starting around 1965. It caused the chloride (Cl) concentration in Seneca Lake to increase by about 70 mg/l in a short time period. Other potential sources of chloride, such as road salt, discharges from salt mines, diffusion from groundwater, and leakage of brine from salt caverns, have affected Seneca Lake salinity over time but are insufficient to explain the large spike in concentration starting in the mid-1960s.

In my opinion, the pressure changes caused by LPG storage—LPG is pumped into the salt caverns, displacing brine that is already there and causing pressure changes, with the process reversed to remove LPG from storage (brine is pumped into the caverns and displaces the LPG stored there)—drive pressure changes that change groundwater flow rates into the lake from the high-salt (or saliniferous) sediments beneath the lake. The literature on Cl concentrations in Seneca Lake agrees that the most significant source of chloride entering the lake is deep groundwater that intersects with the salt beds below the lake floor. My research indicates that LPG storage in the salt mines—as is proposed here—can cause significant discharges of additional salt into Seneca Lake. The mechanics of this "advection" process are that pressure causes strain to propagate which increases fluid pressure under the salt-containing sediments. The increased fluid pressure increases the pressure drop, or gradient, across the sediments, which increases the flow rate through the sediments. My calculations indicate that even relatively small changes in pressure from LPG storage at the site will cause salt discharges into the lake. This salt release would occur primarily in the northern two-thirds of Seneca Lake where the salt beds intersect the sediments beneath the lake. My calculations do not depend on any assumptions of cavern integrity.

The advection process is extremely complex and representative data is very difficult to collect, so it would be very difficult for FLLPG or others to complete analyses that would suggest that LPG storage over the next 50 years could be done safely and without causing massive salt influxes to Seneca. For the same reasons, I also do not believe that FLLPG can adequately monitor or prevent serious adverse water quality changes from additional chloride discharges into Seneca Lake through its LPG storage operations. The risk of a saline influx to the lake from LPG storage is very high and should be avoided, especially since (i) Seneca Lake already has much higher overall chloride concentrations than the other Finger Lakes and (ii) Seneca Lake has a very slow discharge rate (by my calculations it would take 33 years for the lake to empty

out from its discharge; Wing et al. (1995) estimate the retention time to be 18 years)[1] meaning that a load of salt in Seneca Lake will require a long time to flush out.

INTRODUCTION

I was asked to prepare this technical memorandum analyzing the potential effect that developing the liquid petroleum gas (LPG) site near Watkins Glen will have on salinity in Seneca Lake. I have a Ph.D. and M.S. in Hydrology/Hydrogeology[2] from the University of Nevada, Reno, and a B.S. in Civil Engineering from the University of Colorado. I have approximately 20 years of experience consulting and researching hydrogeology, including unconventional natural gas development including fracking and coal-bed methane development, contaminant transport, mine dewatering, and groundwater modeling. My curriculum vitae is attached as Appendix I to this memorandum.

Proposed Action

FLLPG proposes to store LPG (liquid butane and propane) in salt caverns created by salt mining on the west side of Seneca Lake north of Watkins Glen, NY. FLLPG would inject LPG to displace the existing brine, which consists of water containing as high as 400,000 mg/l of total dissolved solids (NYSDEC 2011).[3] Recovering the LPG occurs by injecting brine back into the cavern to remove the LPG. The primary question addressed in this report is whether this LPG storage could cause large quantities of salt to discharge into Seneca Lake, thereby degrading the water quality of the lake.

The memorandum provides a detailed summary of the findings with details provided in seven appendices, as follows:

APPENDIX A: ANALYSIS OF OBSERVED SURFACE AND GROUNDWATER FLOW AND WATER QUALITY
APPENDIX B: SALINITY AND SALT LOADING TO SENECA LAKE
APPENDIX C: ANTHROPOGENIC SOURCES OF SALT TO SENECA LAKE
APPENDIX D: GROUNDWATER FLOW AND ADVECTION INTO THE LAKE
APPENDIX E: DETAILS OF HYDROGEOLOGY OF THE SENECA LAKE AREA
APPENDIX F: DETAILS OF VISCOELASTIC FLOW OF SALT NEAR SALT CAVERNS

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[1] See Appendices A and B.
[2] Hydrology is the science that encompasses the occurrence, distribution, movement and properties, including physical and chemical, of the waters of the earth and their relationship with the environment within each phase of the hydrologic cycle. Hydrogeology is an emphasis on water beneath the ground surface. http://water.usgs.gov/edu/hydrology.html.
[3] See SEQR Documents (Final DSEIS Text at 6, 7, 32).

APPENDIX G: DETAILED DESCRIPTION OF FINGER LAKES' PROPOSED PROJECT AND APPLICATION
APPENDIX H: REFERENCES
APPENDIX I: CURRICULUM VITAE OF TOM MYERS

Previous Storage of LPG in Salt Caverns near Seneca Lake

Salt mining in salt formations in the Finger Lakes region began in the late 1800s (NYSDEC 2011).[4] The mining essentially involved freshwater being injected into the salt beds to dissolve the salt, with the resulting very salty water, or brine, being pumped back to the surface to recover the salt. This salt mining process resulted in caverns being created as salt dissolved into brine. It is a process that has created thousands of caverns around the world (Berest et al. 1996).

Beginning in 1964, the International Salt Company began to store liquid petroleum gas in previously-mined salt caverns at Seneca Lake (Jacoby 1973, 1970), in a process similar to that currently being proposed; [redacted][5] This LPG storage process would have caused significant pressure changes in the salt beds and adjacent stratigraphic layers (Berest et al. 1996).

Salinity in Seneca Lake

Seneca Lake has higher salinity levels, expressed as sodium (Na), chloride (Cl), or total dissolved solids (TDS) than the other Finger Lakes (Wing et al. 1995). This comparison is shown in Figure 1, below, which indicates that Seneca Lake had much higher Cl levels than the other Finger Lakes in 1963, 1978, and 1994 (Figure 1). The salinity trend is up for all of the Finger Lakes over time, as shown in Figure 1—except for Seneca and Cayuga, the lakes with the highest concentrations. Seneca and Cayuga Lakes obviously receive salt load from sources not common to the other Finger Lakes. This memorandum focuses on Seneca Lake, although some of the same processes affecting Seneca Lake may cause the higher salinity in Cayuga Lake (Wing et al. 1995). The rising Cl levels in Seneca Lake are discussed below.

[4] Id. p 67.
[5] See [redacted]

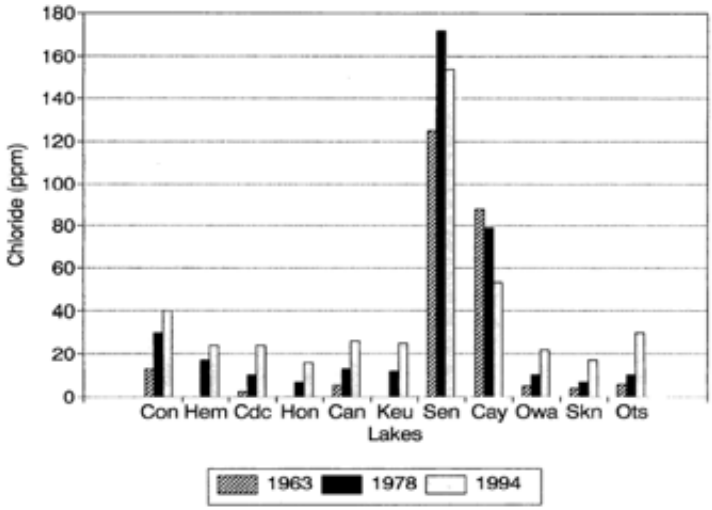

Fig. 1. Chloride concentrations (ppm) in 11 Finger Lakes spanning three decades: 1963 data from Berg (1963); 1978 data from Schaffner and Oglesby (1978); 1994 data from this study. Abbreviations: Con—Conesus Lake; Hem—Hemlock Lake; Cdc—Canadice Lake; Hon—Honeoye Lake; Can—Canandaigua Lake; Keu—Keuka Lake; Sen—Seneca Lake; Cay—Cayuga Lake; Owa—Owasco Lake; Skn—Skaneateles Lake; Ots—Otisco Lake.

Figure 1: Snapshot of Fig. 1 from Wing et al. (1995) comparing chloride among the various Finger Lakes with time. Wing et al. indicate that 1963 data is from Berg (1963), 1978 data is from Schaffner and Ogelsby (1978) and 1994 data is their own. Same as Figure B3 in Appendix B.

The salinity of Seneca Lake, as represented by Cl concentrations, one of the dominant anions (Hobart and William Smith Colleges et al. 2012), has varied substantially over the past 110 years, but primarily has trended higher (Figure 2). Appendix B provides a detailed description of the Cl changes in Seneca Lake over the years, some of which can be summarized as follows:

> The Cl concentrations rose from about 50 mg/l to 110 mg/l, from 1905 to about 1964. Between 1965 and the early 1970s, the concentration jumped to about 180 mg/l. Since that time to about 2004, the concentration dropped from 180 to about 145 mg/l. Between 2004 and 2008, the concentration dropped to about 120 mg/l (see description in Hobart and William Smith Colleges et al. 2012, p 89). Chloride concentration during a sampling event in October 2014 was about 132 mg/l.

As shown in Figure 2 below, Cl concentration in Seneca Lake started trending higher after 1905 or so. In 1965 there was a very large jump in Cl concentration in the lake caused by a significant inflow Cl load of 155,000,000 kg/y for several years. As is discussed below, this load coincides with the beginning of the time that LPG storage was taking place in salt caverns located in the same formation currently proposed for LPG storage by FLLPG. As explained below, in my opinion the former LPG storage activities that started at the site in 1964 caused this dramatic increase in Cl discharges, and overall Cl concentration, in Seneca Lake.

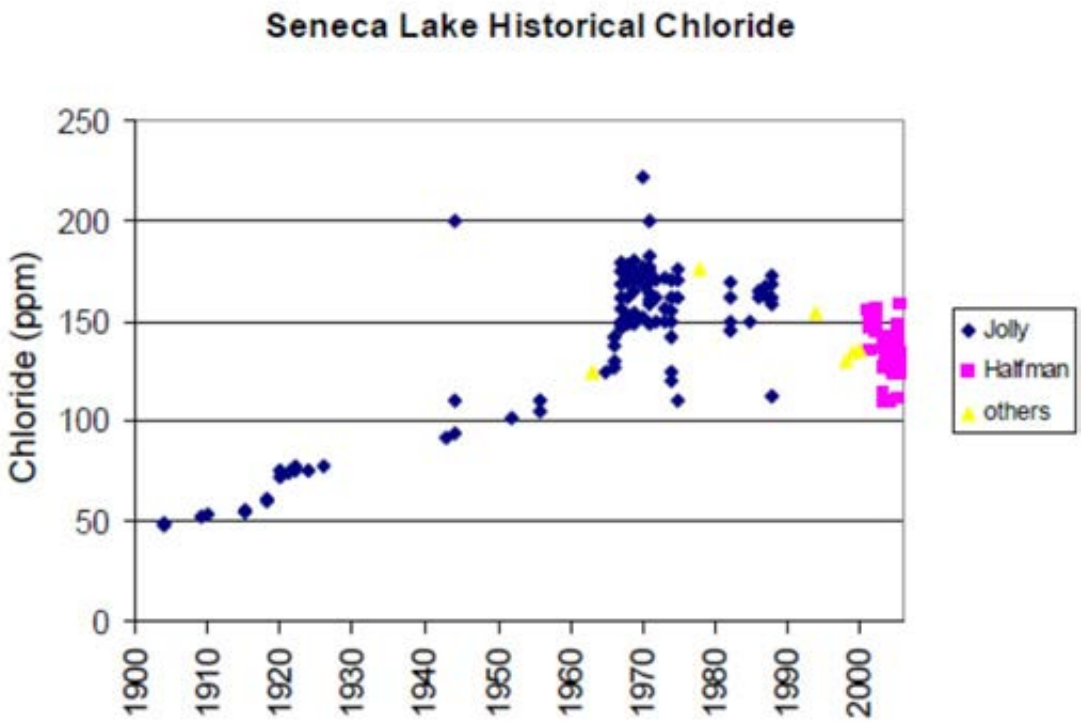

Figure 2: Trend of observed and model chloride data for Seneca Lake, snapshot from Hobart and William Smith Colleges et al. (2012). The figure shows an upward trend in concentration from less than 50 mg/l in 1905 to about 110 mg/l in 1960. After that the concentration spiked to more than 180 mg/l after which it slow decreased to less than 150 mg/l.[6]

The average flow from Seneca Lake equals approximately 590 cfs (Appendix A) based on gages on the Seneca River, the outlet from Seneca Lake. Seneca Lake volume equals 12,500,000 acre-feet (af) which is almost 33 years of 590 cfs outflow.[7] Such a large volume to outflow ratio indicates that significant water quality changes on a short-term basis require a substantial slug (contaminant load) of materials, and that changes to Seneca Lake's water quality can take decades to subside.

[6] Cayuga Lake also saw Cl concentration reach a peak in the mid-1960s at the same time as the Seneca Lake Cl spike, although the Cl concentration in Cayuga Lake decreased much faster than did Cl concentration in Seneca Lake. It cannot be ruled out that the Cl increases in Cayuga Lake have been affected by the LPG Storage in the Salt Caverns in the 1960s (because the same Syracuse salt formation under Seneca Lake also underlies Cayuga Lake). However, Halfman (2014) indicates that Cl concentrations in Cayuga Lake decreased significantly from the mid 1960s through the 1970s because the Cargill Rock Salt plant in the Cayuga watershed changed its disposal methods for salt tailings so that they no longer reach the lake. Discharges from the Cargill plant were limited to the Cayuga watershed and therefore could not have affected Seneca Lake.

[7] Wing et al. (1995) estimate the retention time to be 18 years, which is still an extremely long retention time, but do not actually estimate a flow rate. See Appendix B.

Seneca Lake's volume fluctuates within a small range. Appendix B shows that the range is just 2.2% of the total lake volume. Overall changes in Seneca Lake volume are such a small proportion of the total volume that they are not a significant factor controlling or contributing to the lake's overall salinity.

Method of Analysis

This technical memorandum assembles available data from all known sources, including the US Geological Survey (USGS) and academic literature, to analyze the water and mass balance of Seneca Lake. Ultimately, although the available data are too sparse to assign detailed mass fluxes on either steady state or transient bases, the net loading was determined by examining the difference in total load in the lake determined from concentration and lake volume. The changes in load were assessed with a literature review of sources that document various discharges into the lake that could have affected the overall load in the lake. Finally, significant literature was reviewed to assess the mechanical process that would result from LPG storage beneath the lakeshore that will cause salt spikes into the lake.

Regional Hydrogeology

Seneca Lake is located in a humid region with short warm summers and cold winters. Precipitation exceeds evaporation by approximately one foot per year, which causes a gain in water to Seneca Lake of about 43,500 af/y, or 60 cubic feet per second (cfs) (Appendix A).

The bottom of the lake is glacially carved into bedrock formations of the Silurian Group,[8] including the salt-filled (saliniferous) Syracuse formation (Figure 3 and Appendix E, Figure E1). The bottom of the lake is filled with up to several hundred meters of sediment. The northern 2/3rds of the lake, or tens of miles of the lake bottom sediments, intersect with the salt-filled Syracuse formation that underlies the lake because the formation slopes upward heading north from the project area. This salt-filled Syracuse formation is the same formation that has been previously developed as salt mines in the Finger Lakes area and is proposed for LPG storage by FLLPG (2010).

As shown in Figure 3 below, reproduced from Appendix E, the Syracuse formation is the salt formation proposed for LPG storage. Towards the left of the drawing are, at approximately 42° 25' N (at the south end of the lake), the location of the proposed LPG storage caverns. At that location, the Syracuse formation does not directly intersect with the lake bottom. However,

[8] Different references describe the stratigraphy differently. For this report, I have adopted the nomenclature of NYSDEC (2011) (SEQR Documents (Final DSEIS Text)) and refer to the Syracuse formation as one of the formations within the Silurian group.

the Syracuse formation slopes upward as you head north until it intersects with the porous glacial sediments on the lake bottom.

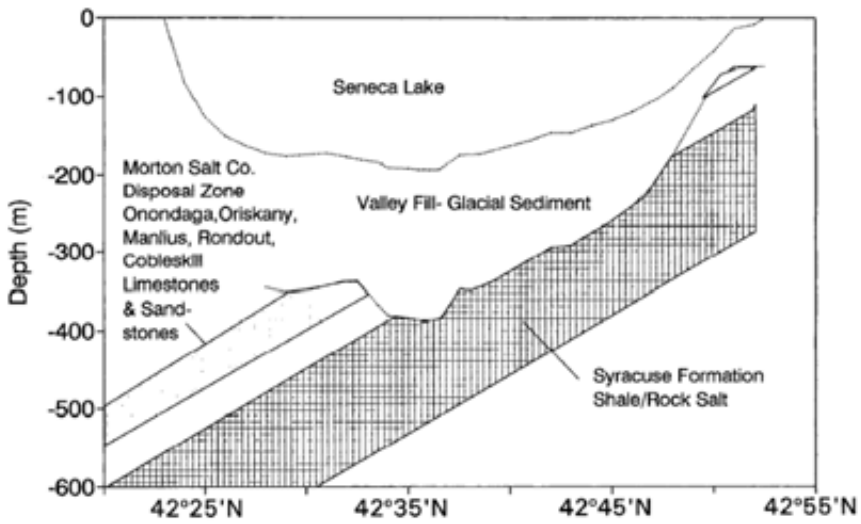

Fig. 6. Schematic longitudinal bedrock profile of Seneca Lake at maximum depth.

Figure 3: Snapshot of Figure 6 in Wing et al. (1995) showing general stratigraphy from south to north. Same as Figure E2 in Appendix E.

Both Halfman et al. (2006) and Wing et al. (1995) determined that groundwater inflow to the lake through the sediments was a significant source of salt in Seneca Lake. "Deep saline seepage from these rock units through the sediments and into the water column is thus likely" (Wing et al. 1995, p 797).

Salt Loading to Seneca Lake

The total Cl load in the lake may be determined as the product of the lake volume and concentration. The net change in total load is the difference in inflow and outflow loads (Thomann and Meuller 1987). Inflow or outflow load is the product of the flow rate and concentration for any inflow or outflow. Appendix B contains the details of the estimates of total and net loads in Seneca Lake. The total load in the lake increased from about 745 million kg in 1905 to about 2.72 *billion* kg in 1970 (Figure 4). The average net inflow load ranged from 3.1 million kg/y around 1930 to 18.6 million kg/y through the 1940s. During the late 1960s, the inflow load spiked to about 155 million kg/y (Figure 4). After 1970, the total began to decrease as the net load became negative—ranging from negative 15,000,000 to negative 40,000,000 kg/y—until 2010 because the outflow load exceeded the inflow load.

Surface water has a low Cl concentration, and provides only a small inflow of Cl. Shallow groundwater may have localized high concentrations of Cl but the flux of Cl from any of these

sources would barely be measureable in Seneca Lake. Appendix A outlines the measured natural sources of salt to Seneca Lake. Other sources, both anthropogenic (caused by humans) and natural, must explain the larger fluctuations of groundwater into the lake.

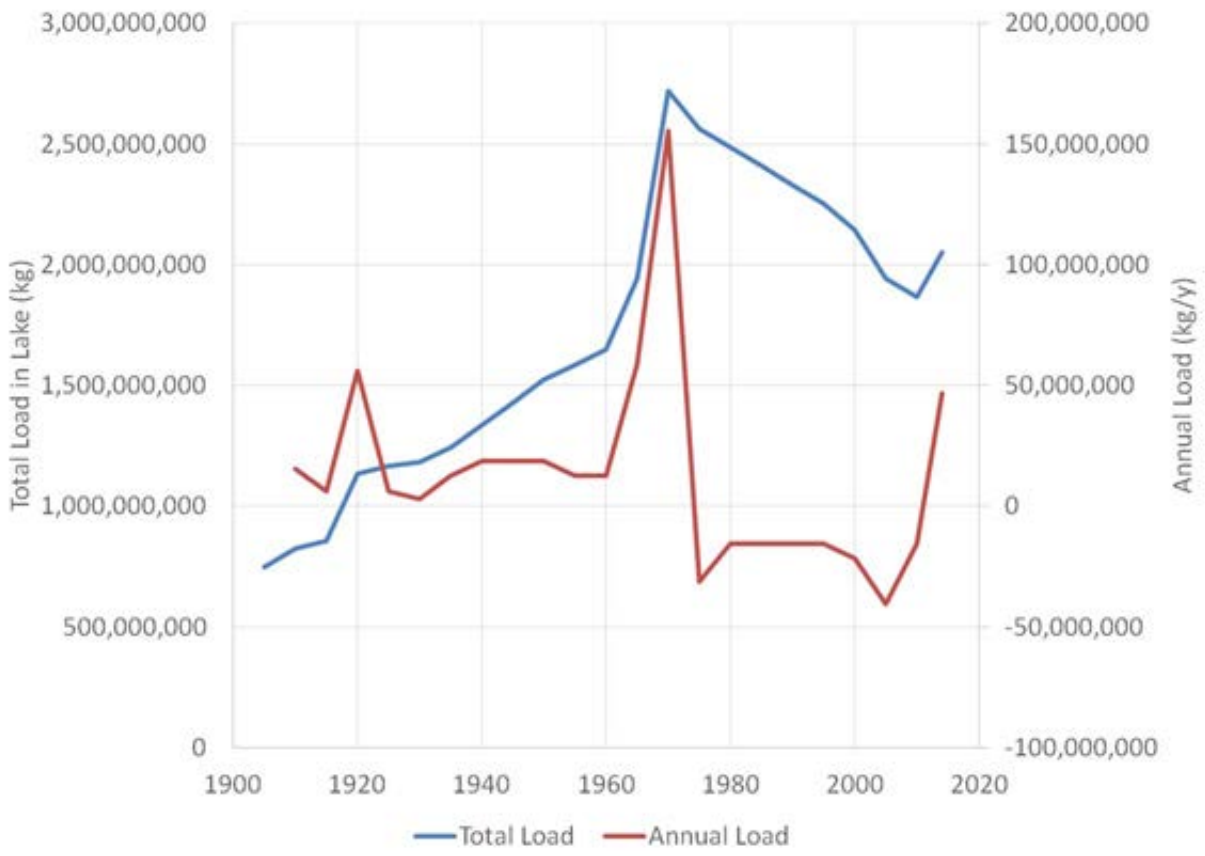

Figure 4: Total Cl load (kg) in Seneca Lake and net annual load necessary to reach that level (kg/y). Total load is the product of concentration from Figure 2 and lake volume. Annual load is the difference in total load over five-year time steps. The largest spikes in concentration in the 1960s caused the spikes in total load on the graph. Same as Figure B2 below.

Anthropogenic (Human) Sources of Salt to Seneca Lake

There are numerous potential sources of salt loading to Seneca Lake: natural, anthropogenic, and a combination of both. Appendices A and C discuss the sources in detail.

Salt mines near Seneca Lake are permitted to discharge salt into the lake, and the average annual discharge may be as much as 12,000,000 kg, which could explain much of the increase in load prior to the 1960s. But the loads from salt mines are far too low to explain the large spike

observed in the late 1960s. Total salt production from the lake area also correlates weakly and negatively (Halfman 2014) with the net load of salt reaching Seneca Lake, which means that more discharge of salty waste occurred when production of salt was lower than when it was higher, but the correlation was low. The negative correlation further confirms that salt mining does not cause a substantial amount of salt load in Seneca Lake.

Halfman (2014) documented a leak of 1.1 million tons of salt into the lake during the late 1960s through early 1970s. This leak could have added 10 mg/l in a year and certainly contributed to maintaining high concentrations through the 1970s, but it was not large enough and occurred too late to have caused the earlier inflow of salt and the spike in the mid-1960s.

Road salting has been increasing over the previous century and explains much of the increases in Cl in other Finger Lakes, but not in Seneca Lake. Cl concentration correlates weakly with road density in other Finger Lake watersheds, which supports the hypothesis that road salting explains much of the level of and variation of Cl in the Finger Lakes, other than Seneca and Cayuga (Halfman 2014, Hobart and William Smith Colleges 2012).

Wing et al. (1995) documented that a salt company had pumped approximately 1,000,000,000 kg salt into a deep disposal well in the 1970s. This disposal does not coincide with a significant increase in Cl in Seneca Lake, and the disposal well was located in sandstone far below the lake bottom about ten miles south of where the salt formations intersect the lake bottom. Figure 3 shows the location of the disposal well. Use of the disposal well in the 1970s also postdates the period during which the Cl increased significantly in the lake.

Deep Groundwater Sources of Salt to Seneca Lake

Two types of groundwater discharge to Seneca Lake can be responsible for additional load in the lake, as described in detail in Appendix D. These are diffusion and advection.

Halfman et al. (2006) estimated that 6,000,000 kg/y entered the lake by diffusion, based on data from Wing et al. (1995). Diffusion is the movement of salt from high concentration to low concentrations, without regard to movement of the water. The rate depends on the concentration gradient but diffusion would remain a source of salt as long as the concentration in the sediment remained higher than the concentration of the lake. It would occur regardless of the anthropogenic sources. However, this amount of diffusion is much too small to have caused the spike in the mid 1960s.

The second groundwater source of salt inflow is advection, which is simply the movement of salt along with the flow of the groundwater. Groundwater flow into the lake from the sediments beneath the lake would carry groundwater at the concentration observed in the

sediments. This flow is also known as Darcian flow and is driven by a pressure, or head, gradient across the sediments.[9] This salt flow is in addition to the flow caused by diffusion and, being natural, would be in addition to the anthropogenic sources listed in the previous section. Both Halfman et al. (2006) and Wing et al. (1995) concluded this source was the mostly likely to provide sufficient Cl to match concentrations observed in the 1990s. Evidence for such flow is the presence of mudboils and brine springs observed in the north of the lake and the driving force, or gradient, could be explained by the unloading[10] of glaciers from the area (Goodman et al. 2011) (Appendix D).

My analysis indicates that on a long-term basis at 16,000 mg/l, the necessary flow to deliver 10,000,000 kg/y Cl to the lake is about 1700 m^3/d (0.7 cfs). If flow across the sediments occurs over just half of the lake bottom area, and a conductivity of 0.1 m/d is assumed for the sediments, the necessary gradient would be 0.0002 m/m, meaning that the pressure head drop across 50-m of sediment would be less than 0.01 m. In order to deliver 150,000,000 kg/y to the lake, the groundwater inflow would be about 25,700 m^3/d (10.5 cfs) and the necessary head drop 0.14 m. Anything that could cause a relatively small head change could cause significant spikes of salt to enter the lake. In my opinion, the proposed LPG storage in the salt caverns can easily cause the necessary pressure changes to result in significant Cl discharges to Seneca Lake.

Cause of the 1960s Concentration Spike

Salt concentration spiked in the late 1960s, due to the Cl load equaling about 155,000,000 kg/y for at least five years, but the cause of this spike has not been identified from review of the available literature. My analysis indicates that the most likely source is advection through the sediments beneath the lake, because the necessary major increases or spikes from the other identified sources are very unlikely to occur. An increase in the gradient driving groundwater through the lakebed sediments would be necessary to cause the spike from these sources. The cause of such a change in gradient has not been identified in the literature. Glacial unloading[11] is a long-term, and steady process (Goodman et al. 2011), so short-term fluctuations due to the primary cause of the gradient are not likely.

The LPG storage that commenced in 1964 is the most likely source of such a pressure change, because of the temporal coincidence, the lack of any alternative explanation, and because

[9] Head is pressure expressed as the height of a water column, commonly expressed as feet or meters of head.
[10] Unloading of glaciers, or glacial unloading, occurs as a glacier melts or recedes from an area. The weight of the glacier causes pressure throughout the stratigraphic profile that is not immediately relieved when the weight is removed because the pressure is due to strain in the geologic formations that only slowly rebounds. As it rebounds, the pressure reduces but it may requires thousands of years to fully rebound during which time a pressure remains.
[11] Id.

changing the fluids from brine to LPG in the cavern results in very high pressure changes that can propagate through the salt beds. The pressure changes were not measured in 1964, but analysis of the proposed changes due to FLLPG's proposed LPG storage project indicates that [redacted] (Appendix G describes the process and discusses the expected pressures in detail). This pressure level is more than enough to cause the small changes needed to increase the pressure gradient across the sediments, with the pressure being propagated as described in the following paragraphs.

The changing pressure in the galleries would have caused strain on the granules in the formations that intersect the caverns, including both salt and shale, and increased the pressure in the brines in pore spaces. The pressure changes essentially squeeze the formations, causing elastic strain to propagate along the plane of the formations; the pressure also propagates through brine in the connected pores. Because the salt has low permeability, the strain relation is most important. Calculations of pressure changes through the formation include coupled relations between standard hydraulics and strains. The strain propagates essentially instantaneously, and it manifests by increasing pressure which squeezes fluid from the pores. This viscoelastic strain increases the pressure in the formations under the sediments that intersect the lake and thereby increases the head drop across the sediments. This increased pressure likely increased the gradient across the sediments to drive much additional salt into the lake. Appendix F presents the details of this process, including the full set of mathematical equations based on the coupled hydraulic and strain relations necessary to describe the process.

There are examples in the literature of these equations and the stress/strain relations they describe. Examples of short-term natural viscoelastic flow include earth tides, seismic activity, or earthquakes at a distance causing pressure fluctuations, strain exerted by pumping confined aquifers on the confining layers, and barometric pressure changes affecting groundwater levels (see the expanded description of these processes in Appendix F).

The pressure changes would have been much higher closer to the caverns, but relatively intact shale layers could prevent advection to the lake in this area except through fault/fracture zones. Geologic studies, including those conducted in the 1950s and 1960s by the salt company, have shown that faults do occur beneath and near the lake and that they occur both above and below the salt beds (Jacobi 2002; Jacoby 1970). This is an additional potential pathway for salt to enter the lake due to pressure changes.

Potential alternative explanations for the spike in salt concentrations in the 1960s are extremely unlikely. One alternative is that the high-concentration samples were drawn from

beneath the thermocline, where the water is saltier.[12] Some of these observations may have been from the intake of a local water company. Vertical water quality data indicate this explanation is unlikely as suggested by profiles presented by Halfman (2014) and Ahrnsbrak (1975) and data by Dietrich (2014) which show that hypolimnion water is saltier, but by only about ten percent, not the 40 percent increase in Cl loading in Seneca Lake observed in the 1960s (Appendix B).[13] These analyses indicate that the Cl in Seneca Lake is pretty well mixed throughout the lake.

Second, there is scatter around the high concentration data, which suggests that there are some errors in the data. However, the scatter is less than 10 to 20 percent, which is not unusual for water quality data. Additionally, the data in Figure 2 is not controlled for depth or location, which could cause some scatter. Despite the scatter, the spike in Cl concentration in the mid-1960s is clear, and the overall Cl levels in Seneca Lake have consistently been much higher than the other Finger Lakes.

Third, the LPG storage cycling lasted longer than the spike of salt inflow. There are several explanations for this. The salt concentration remained high for several years before beginning a slow decline (Figure 2). The advection likely slowed as a result of the salt being flushed from the sediments, so that the concentration was reduced temporarily. However, the Syracuse formation that abuts the sediments should provide a ready refill source of salt.

An alternative source of the salt spike to the lake could be the release of brine from an underground cavern to the lake through natural faults or through the lake bottom. Berest el al. (2001) noted that brine-filled caverns can fail as the pressure within the caverns increases and the cavern walls break down. If this failure occurs, it could affect salinity in the lake, but there is no evidence of any brine-filled cavern failures in the 1960s nor that any cavern could have released enough salt to cause the large spike in the mid-1960s. Moreover, such an event occurring during LPG storage operations would be linked to that storage and could recur, so it would be another risk that will be created by FLLPG's proposed storage.

The low flows during the mid 1960s also cannot account for the spike in chloride concentrations. Seneca Lake's volume fluctuates within a small range. See Appendix B. The range is just 2.2% of the total lake volume. Overall changes in Seneca Lake volume are such a small proportion of the total volume that they are not a significant factor controlling or contributing to the lake's overall salinity.

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[12] The thermocline is the transition layer between the mixed layer at the surface and the deep water layer.

[13] The hypolimnion is the dense, bottom layer of water in a thermally-stratified lake. It is the layer that lies below the thermocline. Typically the hypolimnion is the coldest layer of a lake in summer, and the warmest layer during winter.

The early to mid-1960s hydraulic fracturing that was done in connection with the LPG storage activities in the salt beds (Jacoby 1970) could not have caused the Cl spike in the mid-1960s because the hydraulic fracturing was a short-term activity, in this case designed to create a pathway to connect two wells. The process would not have occurred for a period as long as the Cl spike. Also, the high pressure used for the fracturing would have occurred in a concentrated area and not have increased pressures over the canyon wall as would have LPG storage. Hydraulic fracturing to connect caverns is not similar to the day-to-day operation of the LPG storage which increases and decreases pressure along most of the thickness of the formation where it intersects with the cavern.

Seismic activity also could not have caused the mid-1960s Cl spike because there is no record of significant activity in the Finger Lakes region during the relevant time frames (Arlington 2013).[14] Additionally, the area is currently considered to be of low seismic hazard (see map at http://earthquake.usgs.gov/earthquakes/states/new_york/hazards.php). The USGS does not list any significant earthquakes ever occuring in this area (http://earthquake.usgs.gov/earthquakes/states/historical_state.php#new_york).

Finally, Halfman (2014) documents a leak of 1.1 million tons of salt into the lake during the late 1960s through early 1970s. The amount of the leak could certainly have contributed to maintaining high concentrations through the 1970s, but it occurred too late and was not of sufficient load to have been the primary cause of the earlier spike of salt.

In my opinion, the LPG operations at the site, starting in 1964, caused the spike in Cl in Seneca Lake.

Conclusion and Recommendations

The salt levels in Seneca Lake are much higher than any of the other Finger Lakes, and additional significant salt discharges into Seneca Lake (above and beyond those currently permitted for existing salt mining operations), should be avoided. Prior operation of LPG storage at the site caused a significant spike in Cl concentration in Seneca Lake in the mid-1960s, and it took many years to recede. My analysis indicates that LPG storage at the site today would do the same thing—cause significant elevated Cl discharges to the lake—as the pressure changes inherent in LPG storage in the salt caverns increases saline groundwater flow to sediments below the lake and from there into the lake. Due to the higher overall levels of salt in Seneca Lake as compared with the other Finger Lakes, and as compared with Seneca

[14] The citation Arlington (2013) lists the earthquakes that have occurred within 150 km of the site since the 1850s. The list in Appendix 6-G shows that during the second half of the 1960s there were no earthquakes within 100 kilometers of the site.

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Lake in the early 1960s, and the very long retention time of up to 33 years, the LPG operation should not be permitted unless these types of salt discharges can be prevented. The future plans to develop salt caverns into LPG storage sites create a high risk that massive quantities of salt will once again discharge from the salt formations and sediment underlying Seneca Lake into the lake and degrade the lake's water quality. Although I do not believe that FLLPG can do so, FLLPG should not be given a permit for this project unless it can collect sufficient data and conduct sufficient peer-reviewed modeling to show that pressure changes or other LPG-related activities will not drive salt into the lake.

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APPENDIX A

Analysis of Observed Surface and Groundwater Flow and Water Quality

PUBLIC VERSION

NYSDEC OHMS Document No. 201166576-00026

APPENDIX A: Analysis of Observed Surface and Groundwater Flow and Water Quality

Concentration of salt (or other elements) increases when the entering load exceeds the leaving load, and the concentration decreases when the loads are reversed. Seneca Lake is a flow-through system meaning that inflow equals outflow, with outflow including evaporation. This appendix discusses the volume, flows, and chemistry of water in and entering Seneca Lake.

The outflow from Seneca Lake is to the Seneca River which also drains most of the Finger Lakes until it joins the Oswego River downstream from Oneida Lake. Ultimately, the Finger Lakes flow into Lake Ontario. Seneca Lake has a drainage area of about 1180.6 km^2 (Callinan 2001). The inflow to Seneca Lake comes from a number of tributaries (Catherine Creek being one of the largest) and the outflow from Keuka Lake (which sits at a higher elevation).

The US Geological Survey (USGS) has maintained gaging stations for flow *into* Seneca Lake periodically since the 1950s, but the data is meager. One of the largest tributaries, Catharine Creek, which enters at the south end of the lake, has just a three-year period of record, from 1975 to 1977, at gage #042322000. The average flow over that short period was 44.9 cubic feet per second (cfs). Three other gages operated for just a few years in the 1960s on very small tributaries. Catharine Creek provides just 9% of the flow, as represented by outflow during the earlier period. The precise amounts of inflow to Seneca Lake from other sources has not been adequately documented throughout the years, but it includes the flow from Catherine Creek and other tributaries that flow to the lake, shallow and deep groundwater, precipitation, and the outflow from Keuka Lake.

Average stream flows from 1999 to 2011 on nine tributaries varied from 0.1 to 3.2 m^3/s (3.5 to 113 cfs), with the highest being the Keuka Outlet and Catharine Creek (Hobart and William Smith Colleges et al. 2012). Average flow at the other sites (Castle, Wilson, Kashong, Plum Pt., Big Stream, Reeder, and Kendig Creeks) was less than 27% of the flow at Catharine Creek (Id.), confirming that Catharine Creek is the largest tributary draining freely from a watershed. Keuka Outlet has higher flow but it is mostly supplied by Keuka Lake. Differences in the size of the drainage areas feeding the surface water sources to Seneca Lake explained 99% of the variation in the average tributary flow (Id.).

The USGS maintains no long-term water quality measurement sites on tributaries to the lake. The USGS database included many one-time measurements that did not include flow rate, so neither a load nor time trend could be determined. The date of the measurements was also variable so the measurements do not provide a snapshot of load at any specific time.

The Catharine Creek gage had five water quality readings in 1975, but three of them occurred before the short-term flow gage station had been established. The average specific

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conductivity, chloride, and TDS was 500 uS/cm, 33.6, and 297 mg/l, respectively. The Cl value was very similar to the value used for surface inflow by Halfman et al. (2006). Flow measurements on 9/5/75 and 10/8/75 were 11 and 28 cfs, much below the average, suggesting the water quality readings are representative of baseflow conditions. Salinity parameters tend to be higher during baseflow because groundwater discharge tends to dominate unless the runoff is through a contaminated site (and there is no evidence of runoff passing through a contaminated site). Data presented by Hobart and William Smith Colleges et al. (2012) shows that only Castle Creek has salinity higher than the overall Seneca Lake average, and its discharge averages 0.4 m^3/s (14.1 cfs) so its load is a small fraction of the average load to the lake. As discussed above and herein, the Cl concentrations in the tributaries to Seneca Lake are not significant and certainly could not have caused the Cl spike in the mid-1960s.

The best record of flows into or out of Seneca Lake is on the outlet from Seneca Lake, the Seneca River, on which the USGS has operated two gages (with very little intervening drainage area). Gage #4232650, Seneca River near Lock 4, which operated from 1930 to 1979, had an average, standard deviation, skewness, maximum, and minimum flows equal to 547, 683, 1.97, 14,500, and 15 cfs, respectively. Gage #4232730, Seneca River near Seneca Falls, which operated from 2006 to 2014, had an average, standard deviation, skewness, maximum, and minimum flows equal to 636, 649, 1.39, 3290, and 0 cfs, respectively. The differences between periods are minimal and the average for the two gages is about 590 cfs.

Annual average flows considering the two gages varied from 60.6 to 1078 cfs, with the low and high years being 1965 and 1978, respectively, at the Seneca River near Lock 4 gage (Figure A1). Several low flow years occurred in the mid 1960s (Figure A1). These years also are the only years in the record that have individual daytime flows as low as 15 cfs.

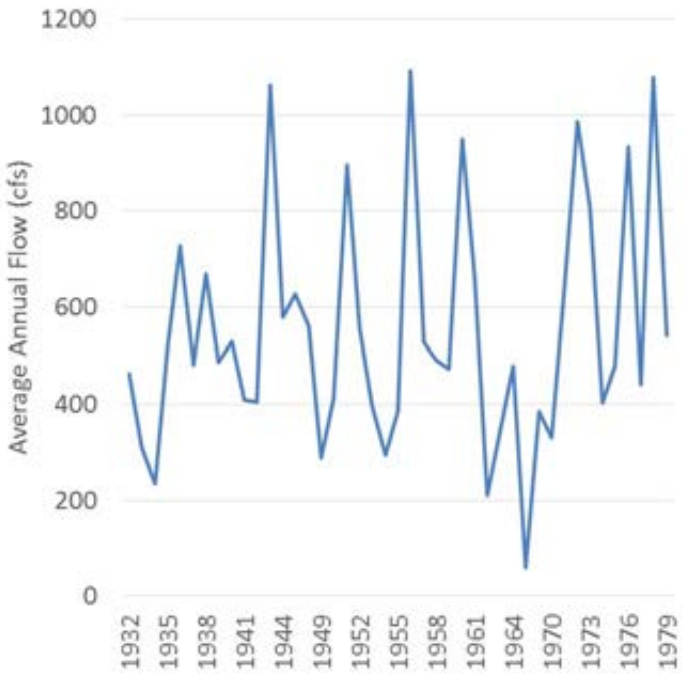

Figure A1: Average annual flow at the Seneca River nr Lock 4 gage.

Precipitation and evaporation are major components of water balance. The pan evaporation rate for Geneva was 32.75 in/y, the second highest value reported for New York (Farnsworth and Thompson 1982). The pan coefficient is commonly considered to be 0.7, so the evaporation rate from the lake could be considered to be 22.9 in/y. Precipitation at the site in Geneva has averaged 37.5 in/y, although the average precipitation for the Seneca Lake watershed ranges from 32.5 to 37.5 in/y (Hobart and William Smith Colleges et al. 2012). The high end of the range occurs over a small area on the southeast side. For these purposes, the midrange value of 35 in/y will be used. Precipitation and evaporation results in a net gain of 43,500 af/y, or approximately a foot of water over the 43,244 acre lake, or 60 cfs.

Seneca Lake's volume fluctuates within a small range. See Appendix B. The range is just 2.2% of the total lake volume. Overall changes in Seneca Lake volume are such a small proportion of the total volume that they are not a significant factor controlling or contributing to the lake's overall salinity, and thus the low flows noted in the graph in Figure A1 above during the mid 1960s cannot account for the spike in chloride concentrations seen at that time.

Since the lake stays at generally the same volume, and the discharge from the lake averages 590 cfs, the total inflow to the lake from all sources is about 530 cfs, with the other 60 cfs coming from precipitation (taking into account losses from evaporation).

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Groundwater Inflow

Salt enters Seneca Lake from groundwater inflow, both deep (Halfman et al. 2006; Wing et al. 1995) and shallow. There is only one long-term data set regarding groundwater quality, a time series of samples collected on wells shallower than 250 feet along from the mid-1970s to the mid-1980s, about midway north-south along the west side of Seneca Lake, about 12 miles north of the proposed project. Interestingly, Cl concentration varies over about four orders of magnitude and about five of ten wells experienced a general upward trend over the time period (Figure A2). Two of the sites began the period with Cl much higher than others but they did not continue to increase. Two wells (MW4 and MW6) increased by at least an order of magnitude (ten times the previous measurement). Overall, the trends are not consistent among wells, but the data shows that salinity reaching the lake increased in the early 80s. The large variability also suggests there could be significant preferential pathways for salinity. Surface sources however have relatively low concentrations which are insufficient to have significant effects on the concentrations in the lake.

The draft environmental monitoring plan for the FLLPG project shows baseline TDS concentrations for wells near the brine ponds (Male 2014).[1] The five baseline wells at the West Brine Pond had low TDS concentration, all below standard. The five baseline wells with the highest TDS are nearest the road upgradient of the proposed East Brine Pond. Downgradient of the proposed East Brine Pond, TDS remains elevated but is only half as high as that upgradient of the pond. This indicates that road salt usage, which would be seasonal in nature as salt is generally only used in the winter, is affecting the shallow groundwater that reaches the lake. Measurements by Dietrich (2014) from stream sources near the lake show also that streamflow salt concentrations increase along the streams as they enter Seneca Lake. For measurements that occur during periods when there is no runoff, they reflect shallow groundwater draining to the streams. Groundwater quality in shallow groundwater would affect the lake both by discharging into the streams and by discharging directly to the lake.

[1] 2014-11-14, Draft Environmental Monitoring Plan.

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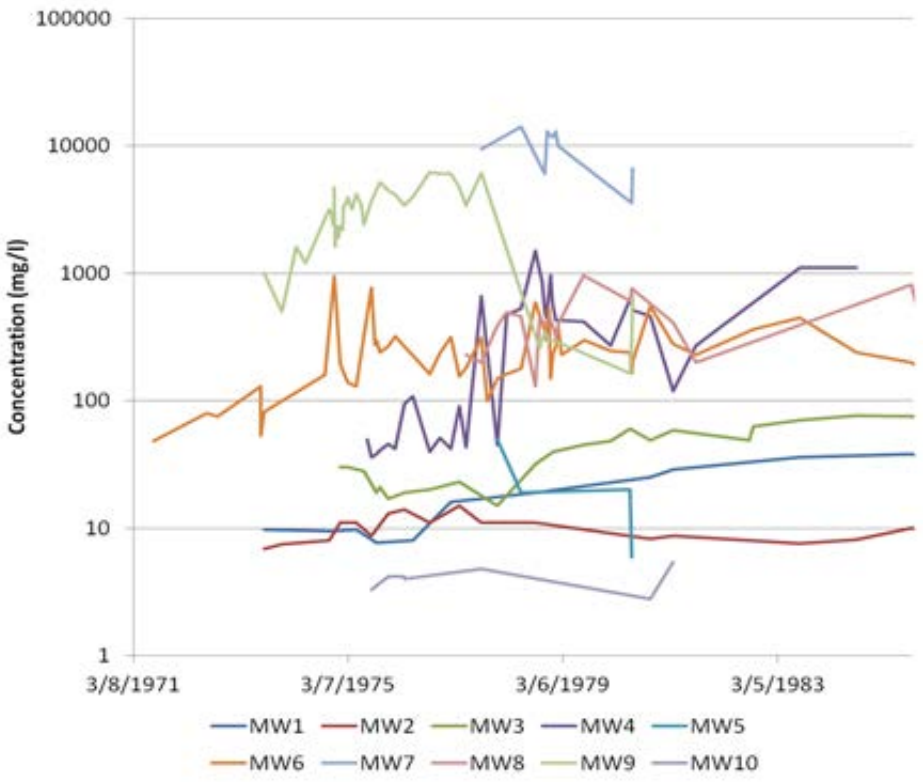

Figure A 2: Trend of chloride concentration in groundwater wells on the west side of Seneca Lake (Table A 1).

Table A 1: USGS wells used to show groundwater trend. The USGS id is latitude and longitude in degrees, minutes and seconds. The first six digits are latitude in degrees, minutes, second; the next seven digits are longitude in degrees (3 digits), minutes, seconds. The 01 means there is one well at the site.

USGS Id	Label
423539076552501	MW1
423528076560001	MW2
423524076561701	MW3
423524076562201	MW4
423527076562601	MW5
423526076563001	MW6
423524076563101	MW7
423506076561501	MW8
423541076563601	MW9
423535076564501	MW19

Shallow groundwater flow would be a small fraction of the surface water flows, and its salt concentration is not generally high, so shallow groundwater sources would be a relatively small

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percentage of the load in Seneca Lake. However, deep groundwater moving through the salt formations has been recognized in the literature as a potentially significant source of Cl into Seneca Lake (Halfman et al. 2006, Wing et al. 1995).

In summary, the volume of Seneca Lake is about 33 years of the outflow from the lake. Natural sources of salt, both surface and shallow groundwater, contributed relatively minor portions of the lake's salt load. Deep groundwater is the probable source of much of the salt in Seneca Lake.

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APPENDIX B

SALINITY AND SALT LOADING TO SENECA LAKE

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APPENDIX B: SALINITY AND SALT LOADING TO SENECA LAKE

Salinity in Seneca Lake

The salinity of Seneca Lake, as represented by chloride (Cl) concentrations, one of the dominant anions (Hobart and William Smith Colleges et al. 2012), has varied substantially over the past 110 years (see Figures 1-2 in the main body of this report). The data in Figure 2, as noted on the graph, was from Glen Jolly of the US Geological Survey (USGS) in Reston VA, and cited as Jolly (2005, 2006). The pre-1960s data was primarily from water company intake measurements.

The Cl concentrations rose from about 50 mg/l to 110 mg/l, from 1905 to about 1964. Between 1965 and the early 1970s, the concentration jumped to about 180 mg/l. Since that time to about 2004, the concentration dropped from 180 to about 145 mg/l. Between 2004 and 2008, the concentration dropped to about 120 mg/l (see description in Hobart and William Smith Colleges et al. 2012, p 89). Chloride concentration during a sampling event in October 2014 was about 132 mg/l with a standard deviation of 4.5 for 18 sites along a north-south transect with surface and bottom measurements (Dietrich 2014).

The volume of the lake is 15.54×10^9 m^3 (12,500,000 acre-feet (af)) (Halfman et al. 2006). Based on outflow estimates developed in Appendix A of 530 cfs, the lake volume equals almost 33 years of outflow. Wing et al. (1995) estimated the volume to be equal 18 years of the average inflow[1] (Wing et al. 1995), based on various estimates using tritium, stable isotopes and USGS runoff data (reference). Either volume to flow ratio is large enough to conclude that significant water quality changes—such as the salt spike in the mid 1960s—require a substantial inflow load, and that significant water quality changes can take decades to dissipate.

Over the years, the lake volume fluctuates within a small range. At the USGS stage gage near Watkins Glen (gage # 042324000) the maximum and minimum stages were 448.95 and 442.62 ft above mean sea level (amsl) from October 1956 to October 2013, respectively (Figure B1). The maximum stage in 1972 coincides with Hurricane Agnes. The volume at maximum area (43,244 acres) over this stage range is 273,736 af, or 2.2% of the total lake volume. This small range in volume indicates that changes in volume are not a significant factor contributing to or controlling the salinity concentration. The small volume range of the lake, and the large volume to flow ratio, also indicate that large loads and water quality changes will not flush from the lake quickly. There are no Cl sinks within the lake (Halfman et al. 2006) so the only Cl losses from the lake occur due to outflow.

[1] At 12.5 million af and 18 year turnover time, the average outflow is 970 cfs or 700,000 af/y.

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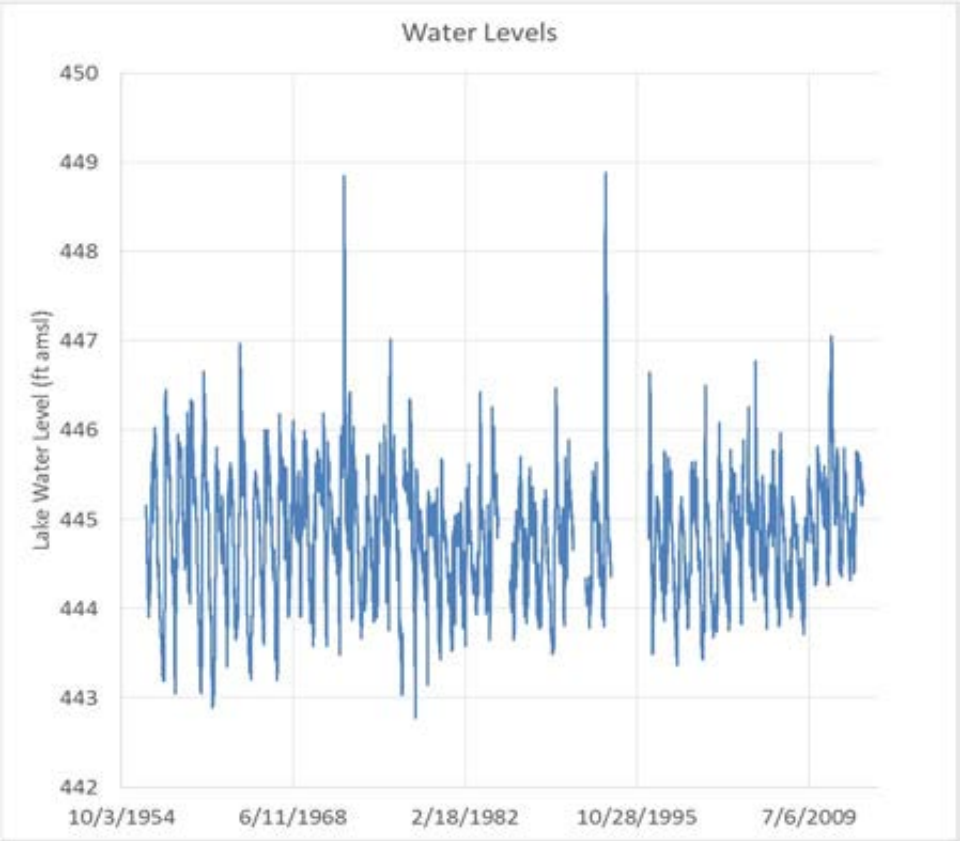

Figure B 1: Water levels at Seneca Lake, USGS gage # 04232400

Based on observed Cl concentration trends (Figures 1-2, main body of report), inflow Cl load exceeded outflow load from 1905 to 1965. In the late 1960s, when concentration spiked, there must have been a distinct short-term load into the lake. After the early 1970s, the downward concentration trend indicates that load leaving the lake exceeds the incoming load; the large load causing the later 1960s spike either stopped or was significantly reduced. The significant reduction from 2004 onward indicates the inflow load of CL has decreased substantially.

The total Cl load in the lake may be determined as the product of average concentration and total volume in the lake. The net change in load in the lake equals the change in total load and also equals the difference in inflow and outflow loads (Thomann and Meuller 1987). Figure B2 shows a graph of the total load and annual load in five-year increments. Concentrations were selected from Figure 2 (in the main body of the report) on five-year increments and annual net values were chosen as five year averages. Figure B2 shows that the total load in the lake increased from about 745,000,000 kg to about 2,720,000,000 kg in 1970. Interestingly, the Cl concentration in Seneca Lake in 1905 was 48 mg/l, a value that exceeds today's average influent streamflow Cl concentration of 33 mg/l (Appendix A). The present streamflow concentration also is probably higher than in 1905 because surface inflow Cl must have

increased due to the use of road salt. With an average Cl concentration of 33 mg/l, surface water flows into Seneca Lake are a relatively minor source of salinity in Seneca Lake.

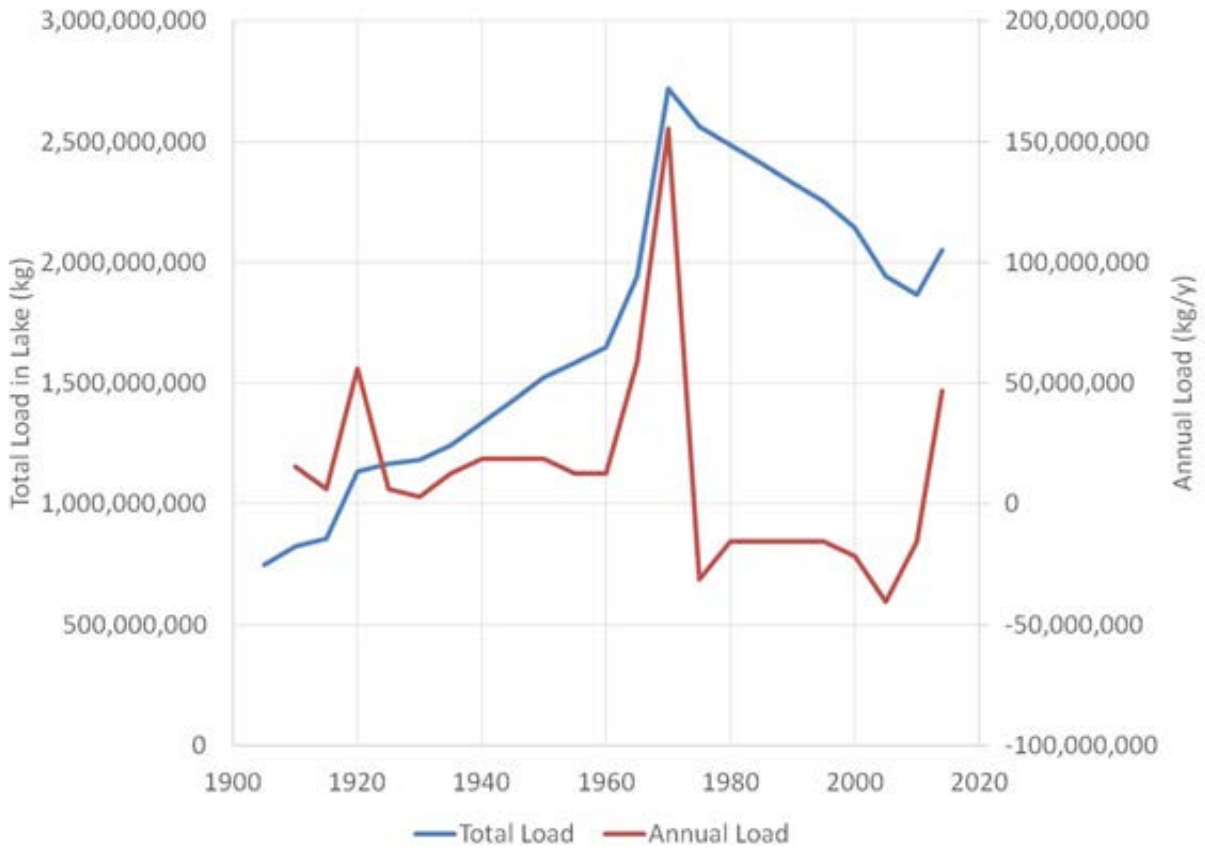

Figure B 2: Total Cl load (kg) in Seneca Lake and net annual load necessary to reach that level (kg/y). Total load is the product of lack Cl concentration and volume and annual load is the net load that resulted in the total load. In other words, net load entering the lake is the difference in total load between two points in time presented as an annual value. Same as Figure 4 above.

The average net inflow load ranged from 3,100,000 kg/y around 1930 to 18,600,000 kg/y through the 1940s. During the late 1960s, the inflow load spiked to about 155,000,000 kg/y (Figure B2, also reproduced as Figure 4 above). After 1970, the net load decreased to negative 15,000,000 to 40,000,000 kg/y until 2010, after which it has started to increase again.

In summary, Figure B2 shows that the load of Cl in Seneca Lake more than doubled from the early 1900s to 1965, and after that it almost doubled again by the early 1970s due to a very large spike of salt into the lake. After the mid 1970s, the net load to the lake became negative, which means that the outflow load, which depends on the very high concentration of the outflow, exceeds the load coming into the lake.

Seneca Lake has higher salinity levels, expressed as Cl, than the other Finger Lakes (Wing et al. 1995) during 1963, 1978, and 1994 (Figure B3, also reproduced above as Figure 1). Interestingly, the salinity trend is up with time for all of the lakes except Seneca and Cayuga, the lakes with the highest concentrations. The 1978 concentration in Seneca Lake is a result of an inflow spike that occurred in the late 1960s whereas the 1994 concentration occurs after the concentration has decreased due to decreased salt inflow. The fact that two lakes have substantially higher Cl concentrations in general indicates that these lakes may be subject to different sources or have different characteristics than the other Finger Lakes. These lakes are the two largest and deepest of the Finger Lakes. The spike that occurred in Seneca Lake indicates that that lake was individually affected by an event that caused its Cl level to spike.

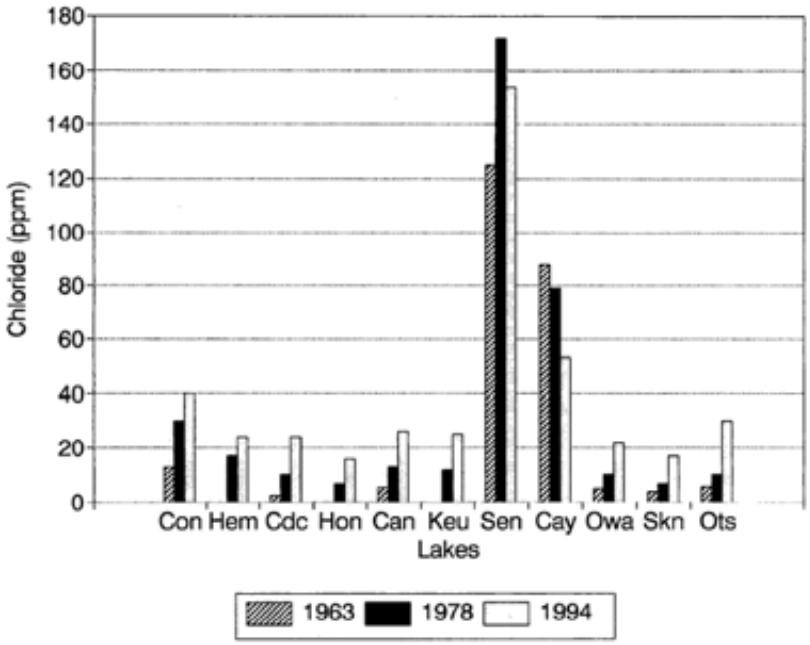

Fig. 1. Chloride concentrations (ppm) in 11 Finger Lakes spanning three decades: 1963 data from Berg (1963); 1978 data from Schaffner and Oglesby (1978); 1994 data from this study. Abbreviations: Con—Conesus Lake; Hem—Hemlock Lake; Cdc—Canadice Lake; Hon—Honeoye Lake; Can—Canandaigua Lake; Keu—Keuka Lake; Sen—Seneca Lake; Cay—Cayuga Lake; Owa—Owasco Lake; Skn—Skaneateles Lake; Ots—Otisco Lake.

Figure B 3: Snapshot of Fig. 1 from Wing et al. (1995) comparing chloride among the various Finger Lakes with time. Wing et al. indicate that 1963 data is from Berg (1963), 1978 data is from Schaffner and Ogelsby (1978) and 1994 data is their own. It is not known if the data used to develop the Seneca Lake portion of this graph is from Figure 2 in the main body of the report. Same as Figure 1 above.

Concentration varies through the lake volume due to stratification and the location of point sources, however the variation with depth is less than 10 or 20 percent. For example, the

highest specific conductance[2] observed in the Finger Lakes is 730 uS/cm in the hypolimnion[3] of Seneca Lake (Halfman and O'Neil 2009). Dietrich (2014) found the highest specific conductance values, 728 and 720 uS/cm, were at the lake bottom in the hypolimnion at sites 7 and 8, which are in the middle of the south portion of the lake, but also found a low standard deviation which indicates that Cl was well mixed through the lake. That the slightly higher values are on the bottom is expected as this reflects the fact that high TDS water (of which Cl is a portion) is denser and tends to settle, and also the volume of inflow to the epilimnion contains quite dilute concentrations of salt.[4]

Herein, for this study, the low variation in salinity throughout the vertical profile allows the lake to be assumed fully mixed as shown by previous authors (Halfman 2014; Halfman et al. 2006, Wing et al. 1995) and data (Dietrich 2014, Ahrnsbrak 1975), which means the concentration equals the total mass in the lake divided by the volume.

Concentrations of Cl, sodium, and sulfate and measures of specific conductance in Seneca Lake are much higher than in streams entering the lake (Halfman et al. 2006). The concentration in surface water reflects the added loads from road salting and other discharges but cannot account for the rise in Cl seen in the lake over the years. Halfman et al. (2006) estimated that to attain the Cl concentrations observed in 2006, the average annual total flux of Cl would have to equal 106,000,000 kg/y, based on steady state conditions. They estimate—based on their 33 mg/l average Cl from streams feeding into Seneca Lake—that the streams provide 26,000,000 kg/y, which means 80,000,000 kg/y enters from other sources. If the stream and other water sources inflow is actually 530 cfs (as estimated in Appendix A based on measured flow data), and average concentration is 33 mg/l, the inflow load from streams is 15,600,000 kg/y. Other sources would have to contribute up to 90,000,000 kg/y.

Halfman et al. (2006) suggest the other chloride source would be "extra, non-fluvial source of chloride, sodium and to a lesser degree sulfate . . . from a groundwater source interacting with the Silurian evaporates beneath the lake" (Id. p 328). I agree. My analysis indicates that the source of much of this chloride is deep groundwater. Appendices D, E, and F discuss the mechanics of how this occurs, including a discussion of advective flow of salt and groundwater, the stratigraphy of the area showing that salt beds intersect with the lake, and explain the

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[2] Specific conductance is a measure of the ability of water to conduct an electrical current, which is highly dependent on the amount of dissolved solids, such as salt, in the water. A common measurement of SC is microsiemens per centimeter (uS/cm) with the standard measure taken at 25 degrees Celsius. http://water.usgs.gov/edu/characteristics.html#Conductance.

[3] In a dense, thermally stratified lake, the hypolimnion is the dense, lower level of the lake. Cold water is denser than warm, so it sinks to the bottom of the lake.

[4] Epilimnion is the less dense, upper layer of a lake. See also SEQR Documents (Final DSEIS Text).

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mechanics of how changing pressure due to LPG storage can cause additional advective flow of salt into the lake.

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APPENDIX C

ANTHROPOGENIC SOURCES OF SALT TO SENECA LAKE

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APPENDIX C: ANTHROPOGENIC SOURCES OF SALT TO SENECA LAKE

Seneca Lake has received salt from numerous natural and anthropogenic (human-caused) sources since the late 1800s, and possibly earlier. Appendix A documented the flow rate and water quality of some natural sources, although it must be noted that surface water inflow discussed there could include anthropogenic sources such as road salt increases. This appendix discusses additional anthropogenic sources and shows they may explain early 1900s trends but cannot explain the spike in the 1960s.

Salt mines near Seneca Lake are permitted to discharge salt into the lake, but the amount is not sufficient to explain the 1960s Cl concentration spike discussed in Appendix B. Wing et al. (1995) noted there was permitted discharge into the lake of 3600 kg/d, or 1,300,000 kg/y. Halfman (2014) documents discharges of 34,000 kg/d (12,400,000 kg/y) in 1999, decreasing to 17,000 kg/d (6,200,000 kg/y) in 2006 and increasing to 30,000 kg/d (10,900,000 kg/y) by 2014 (Figure C1). Records of permitted salt discharges to the lake prior to 1999 are not available but it is reasonable to expect that similar discharges occurred prior to that time and possibly commenced in the late 1800s with the advent of salt mining. Legal controls on such discharges would have been minimal for much of the period, but it is also unlikely that the salt mines would have been discharging extreme amounts of the product they are mining and producing. Assuming that salt mines discharged 12,000,000 kg/y through the 1900s is reasonable and could explain a portion of the necessary annual load that caused the Cl concentration to increase from 1905 through 1965 (Appendix B).

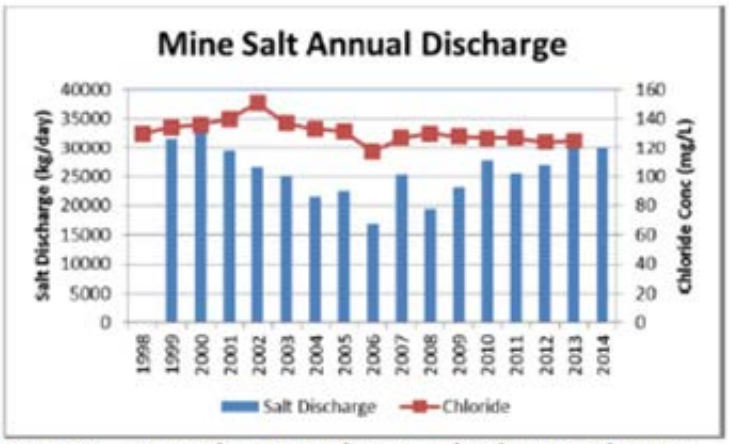

Fig. 12. Annual mean salt-mine discharge of waste chloride and sodium to the lake from the two salt mines near Watkins Glen.

Figure C 1: Snapshot of Figure 12 from Halfman (2014) showing the salt mine discharge to Seneca Lake from 1999 to 2014.

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Total salt production from the lake area correlates weakly and negatively with the net load of salt reaching Seneca Lake (Halfman 2014). This negative correlation suggests that salt mining does not add a consistent and substantial salt load to Seneca Lake beyond that documented due to measured discharges in the previous paragraph.

Halfman (2014) documents a leak of 1.1 million tons of salt into the lake during the late 1960s through early 1970s. The documentation of this event is from newspaper reports, so the quantities cited and the circumstances surrounding the leak may not be accurate. The inflow pathway was apparently through surface water, meaning a leak or discharge flowed down a stream or streams to the lake. If the reported amount is all NaCl and it entered the lake at one time and completely mixed, it would have increased the Cl by over 40 mg/l. Halfman's description is that the leakage occurred through the early 1970s, for up to five years, so the leak could have increased the Cl concentration by up to 10 mg/l [1] if it had added to other sources and could certainly have contributed to maintaining high concentrations through the 1970s. However, it occurred too late and was not of sufficient load to have been the primary cause of the earlier spike of salt.

Road salting has been increasing over the previous century, but does not explain the increases in Cl concentration in Seneca Lake. Halfman (2014) estimated that present day fluvial fluxes[2] of Cl and sodium would support concentrations of 44 and 27 mg/l, respectively. These concentrations are relatively close to the salt concentrations in the other Finger Lakes, but much less than in Seneca and Cayuga Lakes. Halfman (2014) also found a weak correlation of ion concentration with road density in the watersheds, which provides additional evidence that road salting explains much of the level of and variation in salt concentrations in the Finger Lakes, other than Seneca and Keuka. Additionally, even if there was a higher salting rate in the Seneca Lake watershed, the much higher water volume in Seneca Lake would have absorbed extra load, as previously noted. Road salt usage increases over the years are much too low to have caused the high overall level of salt in Seneca Lake, or the chloride spike in the mid-1960s.

Wing et al. also documented that the salt company had pumped approximately $1x10^9$ kg salt into a deep disposal well in the 1970s, although that also postdates the period during which the Cl increased so significantly and the disposal well location was in sandstone much below the lake bottom and about ten miles south of where the salt formations intersect the lake bottom. The data does not suggest that this deep well disposal caused a significant increase in salt in the lake.

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[1] This is based on the 1.1 million tons being spread evenly over five years.
[2] A flux is a flow and fluvial refers to being from a stream source.

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In summary, salt mine discharges and road salt probably have caused more than 12,000,000 kg/y of Cl to enter Seneca Lake through much of the 1900s and probably to the present. This may explain most of the salt increases prior to the 1960s. After the spike in the 1960s, this may again be the primary source which had allowed the Cl concentration to decrease since the 1970s, but it does not explain the large spike that caused a decade of very high Cl concentrations.

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APPENDIX D

GROUNDWATER FLOW AND ADVECTION INTO THE LAKE

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APPENDIX D: GROUNDWATER FLOW AND ADVECTION INTO THE LAKE

The bulk of the spike of approximately 155,000,000 kg/y Cl to the lake for several years in the 1960s had to result from groundwater inflow, simply because all other potential sources have been ruled out, as shown in Appendix C. As shown in Appendix B, Halfman et al. (2006) determined a non-fluvial source must contribute between 80,000,000 and 90,000,000 kg/y of Cl to Seneca Lake for the concentration to reach values seen in the 2000s.

Two types of groundwater discharge to Seneca Lake can add load to the lake—diffusion and advection—as explained in this appendix. The source of salt is the existing sediments beneath the lake. As salt is discharged from those sediments, it will be replenished by salt from the Silurian salt beds which intersect the lake sediments (Appendix E).

Sufficient salt is present in the sediment beneath the lake to provide the source for both diffusion and advection of salt into the lake. Assuming that the 175 km^2 lake bed is covered with 50 m of sediment[1] with porosity equal to 0.25 and 16,000 mg/l Cl (Wing et al. 1995), the sediments would contain 35,000,000,000 kg Cl. One year's worth of load from groundwater, 155,000,000 kg, is just 0.4 percent of the total in storage so Cl availability is not a limiting factor. Also, Cl concentration may continue to increase with depth deeper than 2.5 m into the sediment so the total salt load may be even higher.

The first groundwater source is diffusion. Diffusion is the movement of salt from high concentration to low concentrations, without regard to movement of the water. Halfman et al. (2006) estimated 6,000,000 kg/y enter the lake by diffusion, based on data from Wing et al. (1995). Wing et al. (1995) reported the concentration of Cl in the sediments was several times that of seawater, reaching 16,000 mg/l at 2.5 m beneath the surface of the sediments. The gradient that this establishes from depth in the sediments to the surface drives the diffusion. This amount of salt that could come from diffusion is far less than the load in the lake, and much too low to have caused the chloride spike in the mid 1960s.

The second groundwater source is advection, which is simply the movement of salt along with the flow of the groundwater. Groundwater flow into the lake from the sediments beneath the lake would carry groundwater at the concentration observed in the sediments. This flow is also known as Darcian flow and is driven by a pressure, or head,[2] gradient across the sediments. This salt flow is in addition to the flow caused by diffusion. *Both Halfman et al. (2006) and*

[1] At the deepest point of the valley, the thickness may be several hundred meters (Wing et al. 1995), so 50 meters is a conservative value to use in this estimate. It is conservative because a thicker sediment thickness could provide for more salt availability.

[2] Head is pressure expressed as the height of a water column, commonly expressed as feet or meters of head.

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Wing et al. (1995) concluded that advection is the most likely source of additional salt to match concentrations observed in the 1990s.

Evidence of advective flow into the lake includes mudboils at the north end of the lake which discharge 0.003 m^3/s at 50,000 mg/l, a flux of 500,000 kg/y (Halfman 2014; Goodman et al. 2011; Halfman et al. 2006). These are small enough to be missed by routine sampling and seismic surveys and the flow is too small to be noticeable in the lake water balance. Also, nearby deep wells drilled during the 1800s have found brine with TDS exceeding 100,000 mg/l at depths which would be along the pathway for advective flow to the lake (Goodman et al. 2011).

Advective flow carrying salt into the lake must have an upward gradient to drive the flow. Goodman et al. (2011) identified a potential source of that gradient, as discussed in Appendix E. The advective flux necessary to deliver to the lake 10,000,000 kg/y Cl at 16,000 mg/l is 1712 m^3/d (0.7 cfs), a rate that would scarcely be noticed in the water balance of the lake. If half of the lake bottom intersects the salt beds (Appendix E, Figure E2), it can be assumed that the salt inflow occurs over half of the lake bottom, or half of 175 km^2. This would require a Darcy velocity of 1.96×10^{-5} m/d. Darcy velocity is gradient (i) times conductivity (K) for average flow through a cross-section; total flow is Darcy velocity times cross-sectional area. Gradient is change in head divided by flow distance (first occurrence of gradient). Neither i nor K is known for the sediments beneath Seneca Lake. Assuming a range of K, i can be determined as $i = v/K$. Table D1 shows that for a low conductivity, K=0.001 m/d, the necessary i would be less than 0.02 m/m or over 50 m the head drop would be less than a meter. A midrange K would require a head drop over the sediment of less than 0.01 m.

If the entire 150,000,000 kg/y were delivered by advective flow through the sediments and the concentration of Cl in the sediments remains the same, the flow would have to be 25,685 m^3/d (10.5 cfs). Table D1 shows the additional head that would be required to drive the additional flux across the sediments into the lake. For K ranging from 0.1 to 10 m/d, the required change in head is much less than a meter. Darcy flow calculations support the conclusion that advection could easily drive the needed salt into Seneca Lake if the gradient changes to increase the flow.

Table D 1: Comparison of required gradient and head drop over 50 m of lake bed sediments for a range in sediment conductivity (K). At a concentration of 16,000 mg/l, 1723 m^3/d would deliver 10,000,000 kg/y and 25,684 m^3/d would deliver 150,000,000 kg/y to Seneca Lake across 85 km^2 of lake bottom sediments.

	Flux = 1712 m^3/d		Flux = 25,684 m^3/d		
K (m/d)	i	over 50 m	i	over 50 m	added head
0.001	0.019	0.98	0.29	14.7	13.7
0.01	0.0019	0.098	0.029	1.47	1.37
0.1	0.00019	0.0098	0.0029	0.147	0.14
1	1.96E-05	0.000978	0.00029	0.0147	0.014
10	1.96E-06	9.78E-05	2.94E-05	0.00147	0.0014

In summary, this appendix shows that salt can flow with natural groundwater inflow to the lake in amounts sufficient to account for the high Cl concentrations observed in the lake. While groundwater inflow is a very small proportion of the lake water balance, the high concentration of salt makes for a very high load. Small changes in pressure beneath the sediments can account for large changes in flow and salt load to the lake.

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APPENDIX E

DETAILS OF HYDROGEOLOGY OF THE SENECA LAKE AREA

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APPENDIX E: DETAILS OF HYDROGEOLOGY OF THE SENECA LAKE AREA

Figures E1 and E2 present a regional view of stratigraphy in the Seneca Lake region. Figure E1 is a cross-section north by about ten minutes of latitude from the proposed LPG storage project. Figure E2 is a longitudinal north-south profile through Seneca Lake. FLLPG's application also discussed stratigraphy in a few locations. Section A-A' (Figure E3) shows the details near the project site.[1] The salt formations are hundreds of feet below the lake bottom at the application site, but rise in profile to the north (Figure E2). Ten minutes is about 11 miles or 58,000 feet at latitude 42°, and a 500-foot rise requires a slope of just one percent. Considering that formations observed a couple thousand feet below ground surface at the application site outcrop just north of the lake (Halfman et al. 2006), the one percent slope required for the salt formations to intersect with the lake for most of the profile beginning a few miles north of the project is reasonable. As implied on Figure E1, a substantial portion of the Syracuse Formation has been eroded and replaced by the valley fill—glacial sediment. Tens of miles of the longitudinal profile of the Seneca Lake valley intersect with the Syracuse Formation, including the salt beds (Figure E2).

There are brine springs along the Onondaga escarpment north of the Finger Lakes. These springs discharge from various Silurian formations (Goodman et al. 2011) including the Syracuse, and are very salty. Their presence demonstrates the presence of an upward gradient, or artesian pressure, in the Syracuse formation (Goodman et al. 2011). The current groundwater discharge zone, as represented by the brine springs, would have been a recharge zone during the glacial periods which ended near 10,000 years ago (Ellis et al. 2004). The formations which received the recharge dip downward to the south and pinch out, so there was no place for the groundwater to go. Once the glaciers retreated, the pressure which had built up in the pinched-out aquifers, or pocket aquifers as termed by Goodman et al. (2011), was higher than the ground surface. Springs formed at the location where the glaciers had been recharging the groundwater. The springs are salty because the flow is along the Silurian formations including many layers of salt. The higher pressure in the Silurian group would also manifest in the areas where the group intersects the sediment in the lake bottom and cause an upward pressure into the sediments or any faults intersecting the formations between the salt and the lake sediments (Halfman et al. 2006, Wing et al. 1995).

The combination of stratigraphy with salt formations intersecting the sediments under the lakebed and the presence of an upward gradient due to glacial unloading indicates that groundwater flows into the lake as described by Halfman et al. (2006) and Wing et al. (1995).

[1] August 2014 Gallery Map and Section (2000-00-01-16-R9 SECTION 8-28-14 INERGY SECT A-A' FINGERLAKES).

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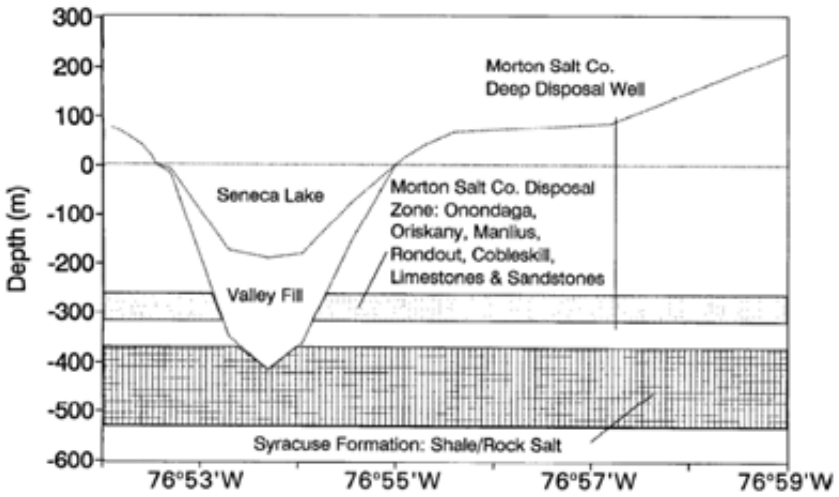

Fig. 5. Schematic latitudinal bedrock profile of Seneca Lake at 42°35'N.

Figure E1: Snapshot of Figure 5 in Wing et al. (1995) showing general stratigraphy from west to east at latitude 42° 35'.

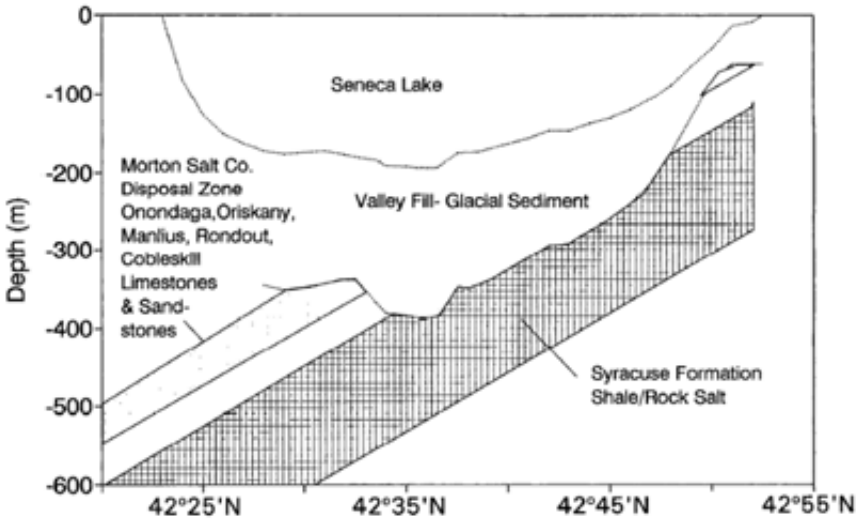

Fig. 6. Schematic longitudinal bedrock profile of Seneca Lake at maximum depth.

Figure E2: Snapshot of Figure 6 in Wing et al. (1995) showing general stratigraphy from south to north. Same as Figure 3 above.

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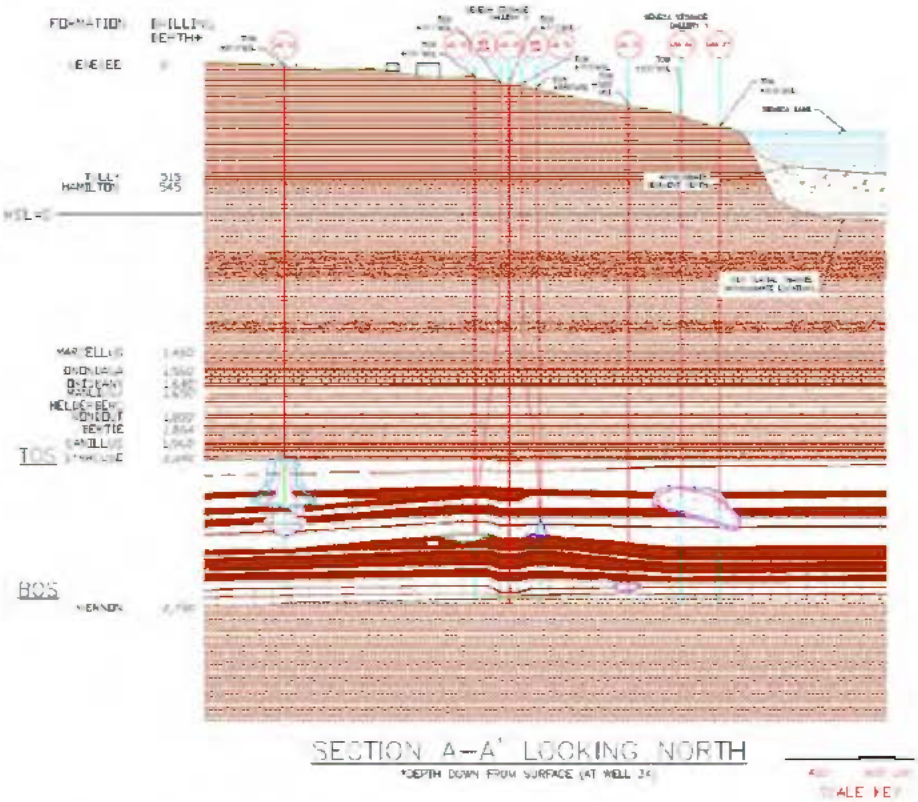

Figure E3: Snapshot of section A-A' from FLLPG's application.[2]

[redacted][4] [5]

In the south near the project site, the salt layers would be connected with the sediments directly overhead through faults/fractures through the overlying shale layers. Early industry studies also provide evidence of faults through these formations (Jacoby 1970, 1966; Jacoby and Dellwig 1973). More recent mapping found faults throughout the area (Jacobi 2002).

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[2] August 2014 Gallery Map and Section (2000-00-01-16-R9 SECTION 8-28-14 INERGY SECT A-A' FINGERLAKES).

[3] [redacted]

[4] This report does not attempt to address the structural stability, or instability, of the proposed salt caverns.

[5] See [redacted]

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Jacoby (1966) noted that faulting in the salt and/or flow along interbedded shale caused significant problems with estimating where injected fluid for hydraulic fracturing operation would go. He wrote that the company found injected fluid discharging from wells roughly perpendicular to the intended well, a finding that indicated substantial heterogeneity, or high variability, in parameters that describe the properties of the fracture system around their wells. Also, during fracturing to connect wells, Jacoby (1970) found that pressure must be maintained in a fracture that has connected two wells or the fracture will heal (Jacoby 1970). This "creep" is an example of the viscoelastic flow that may be established due to highly differential pressures caused intermittently storing brine and LPG gas in caverns.[6] Faults provide pathways connecting the salt beds with the fill underlying Seneca Lake.

[redacted] Vertical cores are very unlikely to actually intersect vertical fractures at a rate even similar to the actual proportion of the rock containing such fractures (Schulze-Mackuck et al. 1999). [redacted]

Further north along the lake profile, the salt layers proposed to be used for this LPG project directly contact the sediments (Figure E2), so there is a direct pathway from the salt into the sediments which would probably be saturated (Bredehoeft 1988). There is already an upward gradient of unknown magnitude that drives advective flow into the lake; changing the pressure in the salt beds would increase that gradient and therefore the advective flow. This is likely the area with the largest proportion of salt flow into the lake.

The formations near the project are faulted. Faults may not always extend through the salt as much as through the overlying shale because salt tends to heal itself over time (Davidson 2009). Faults do form through salt, and under certain conditions fluid can flow along them (Davidson

[6] Note that Dionisio and Istvan (2012), for the company, reports the faults do not cause problems for the galleries. He also suggested that he found no evidence of faults extending through the salt bed, in response to a request from NY DEC to examine the papers of Jacoby. His opinion was not supported by any data or references. See 2014-01-03 & 06, BSK, Istvan & Dionisio to DEC – Valley Stress Conditions Response. [redacted]

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2009), but even with healing in the salt they are unlikely to prevent strain or pressure from being transmitted. Faults thus do not constrain the strain and some near the project site could transmit brine to shallow groundwater due to changing pressures caused by the proposed project. In sum, faults around the caverns can transmit pressure even if the salt has healed on one end of the fault. And faults can directly release Cl or LPG to shallow groundwater, surface waters, and Seneca Lake. Finally, the more that a cavern is intact or free from faults, the more that cavern can increase in pressure and transmit pressure through the salt beds to release salt/Cl into Seneca Lake.

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APPENDIX F

DETAILS OF VISCOELASTIC FLOW OF SALT NEAR SALT CAVERNS

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APPENDIX F: DETAILS OF VISCOELASTIC FLOW OF SALT NEAR SALT CAVERNS

The galleries would have been alternately filled with brine and with LPG gas in the 1960s, just as the proposed project would do, albeit at different galleries within the same formation. Each change would have sent a pressure surge horizontally along the various salt and stringer layers that intersect the galley, based on principles of viscoelastic flow discussed in Ingebritsen et al. (2006). The gallery, if it does not leak, would transmit pressure to the surrounding media similar to that of a balloon perfectly fitting into the gallery pushing on the formations. Increasing pressure would push, or add a compressive stress, to the various layers which would begin to compress, or strain. This volumetric strain is also called dilation (Ingebritsen et al. 2006). Pressure changes and fluid movement could occur along these layers, even without leakage from the gallery. Where plastic deformation compacts the sediments, there can be "important effects on fluid pressure" (Id. p 69). Depending on the magnitude of the stress and the time over which it is applied, the strain is consecutively elastic and then inelastic.

The complex behavior of the flow of salt was best summarized by Berest et al. (2001) (emphasis added):

(a) Salt behavior is elastic-ductile, when short-term compression tests are considered, and elastic-fragile when tensile tests are considered; but in the long term, salt behaves as a fluid in the sense that it **flows even under very small deviatoric stresses**.[1]

(b) Creep rate is a **highly non-linear function of applied deviatoric stress** and test temperature.

Furthermore, experts generally distinguish between . . .

(i) Steady-state (or secondary) creep, which is reached after some time (**several weeks**) when a constant mechanical loading is applied to a rock sample; steady state is characterized by a constant creep rate, which is a function of the (constant) temperature and stress applied during a test; and

(ii) Transient (or primary) creep, which is triggered when the stress applied to a sample is suddenly changed. Transient creep is characterized by high initial rates (following a load increase) that slowly reduce to reach steady-state creep or by slow, sometimes reverse, initial rates (following a load decrease) that slow increase to reach steady-state creep.

The flow is usually considered to be salt creep and contributes to the claim that salt formations are somewhat impermeable (Berest et al. 2001). Over geologic time periods, the movement of

[1] A deviatoric stress is the difference between actual stress and hydrostatic pressure, or that which causes a deviation in the strain.

salt leads to various formations such as salt diapirs (vertical stringers of salt) (Poliakov et al. 1996; Schultz-Ela et al. 1993). Over the short term, salt creep can cause seals around the wells entering salt mines (Berest et al. 2001). All of these processes reflect the short-term transfer of pressure, at time frames as emphasized above, which can lead to significant groundwater flows, such as into Seneca Lake due to salt beds transferring pressure so that the driving force for flow into Seneca Lake changes (Appendix D).

The complete set of poroelastic equations that describe the interactions of pressure, strain, and stress in three dimensions along a formation is highly complex and derived in detail in Ingebritson et al. (2006). In standard groundwater analysis, pressures and flows are a function of standard hydraulic and conservation of mass equations. When stress/strain becomes important, as with the viscous properties of salt, the derivation of the equations couples the standard groundwater equations with stress/strain relations. It assumes the system is at rest, meaning the sum of forces equals zero, and the sum of stresses in all directions equals zero. The equation converts strain, or the compression or pulling of a volume, to stress. Summed, stress equals the total pressure at a location. The set of equations follows:

$$\nabla^2\hat{\sigma}_{xx} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial x^2} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{1-\vartheta}{1+\vartheta}\frac{\partial^2\hat{P}}{\partial x^2} + \nabla^2\hat{P}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial x^2} + \frac{1+\vartheta}{1-\vartheta}\nabla^2\hat{T}$$

$$\nabla^2\hat{\sigma}_{yy} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial y^2} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{1-\vartheta}{1+\vartheta}\frac{\partial^2\hat{P}}{\partial y^2} + \nabla^2\hat{P}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial y^2} + \frac{1+\vartheta}{1-\vartheta}\nabla^2\hat{T}$$

$$\nabla^2\hat{\sigma}_{zz} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial z^2} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{1-\vartheta}{1+\vartheta}\frac{\partial^2\hat{P}}{\partial z^2} + \nabla^2\hat{P}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial z^2} + \frac{1+\vartheta}{1-\vartheta}\nabla^2\hat{T}$$

$$\nabla^2\hat{\sigma}_{xy} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial x\partial y} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{\partial^2\hat{P}}{\partial x\partial y}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial x\partial y}]$$

$$\nabla^2\hat{\sigma}_{yz} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial y\partial z} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{\partial^2\hat{P}}{\partial y\partial z}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial y\partial z}]$$

$$\nabla^2\hat{\sigma}_{xz} + \frac{1}{1+\vartheta}\frac{\partial^2\hat{\sigma}_{kk}}{\partial x\partial z} = \frac{1-2\vartheta}{1-\vartheta}\,\alpha\left[\frac{\partial^2\hat{P}}{\partial x\partial z}\right] + 2G\sigma_T[\frac{\partial^2\hat{T}}{\partial x\partial z}]$$

These equations are written along the x, y, z axis although i, j, and k are the principal axes. This means that a property such as stress may not be maximum or minimum along the chosen reference coordinate system, the arbitrary x, y, and z system, but rather along a i, j, and k

system. The x, y, z system may be manipulated to coincide with the i, j, and k system but the equations do not assume that to be the case. In the salt formations underlying Seneca Lake it may be that reference coordinates in the horizontal and vertical planes do not align with principal coordinates as defined by the direction of maximum stress or a formation property such as conductivity, K. The gradient operator is defined as follows:

$$\nabla = {}^{i\partial}/_{\partial x} + {}^{j\partial}/_{\partial y} + {}^{k\partial}/_{\partial z}$$

This essentially means that the gradient of a property, such as σ for stress in the equation above, multiplied by the unit vector gives a vector value of the stress in its primary direction. It essentially defines the property along its direction of highest or principal value. The equations translate stress from its primary magnitude and direction to the chosen x, y, z directions. The left side of all six equations essentially defines the stress in six directions along the reference and principal access, including its value at a point and the rate that it changes in all six directions.

Values of density and viscosity vary in space and time as a function of temperature, pressure, and solute concentration. Temperature has a significant effect on the density of brine and can cause pressures in brine-filled caverns to be high enough to fracture the cavern walls (Berest et al. 2001). Density and viscosity combine with the basic properties of the medium such as permeability to determine the conductivity of a formation. Permeability is a property of the medium defined by porosity and connectivity of pores, but the medium is also changing and shifting due to both elastic and inelastic strain caused by geologic processes and also due to changes in pressure caused by the storage of LPG gas; pressure will cause the formations to strain, thereby changing their intrinsic properties. Thus, both the properties of the fluid and porous medium, the formation, are changing both spatially and temporally.

G is the shear modulus, in force per area or the same as pressure, and is a function of Young's modulus and Poisson's ratio (E and υ). E is a measure of stiffness and literally is the ratio of stress to strain for a substance and υ is a ratio of the strain normal to the applied stress to the strain parallel to the applied stress. In other words, υ defines how a material deforms due to an applied stress (Ingebritson et al. 2006, p 44).

Together the equations convert strain to stress and pressure, and allow it to be affected by temperature effects. Pressure affects the flow of fluids through the system. Although the properties depend on pressure and actual strain, it may be appropriate to assume that temperature is constant which will make part of the right side of the equation simpler. The partial differential equations are written in gradients along axes, or with distance, not with time, which indicates the changes propagate essentially immediately rather than over time.

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A strain applied at a point, such as the gas reservoirs, would be felt instantaneously throughout the domain. Pressure changes caused by LPG gas and brine cycling through the caverns would be felt under the sediments under Seneca Lake instantaneously. Because the strain propagates laterally, the pressure change miles away will be a smaller proportion of that felt at the cavern; however, because the propagation of strain changes the size and shape of the pores within the medium which causes an instantaneous change in the fluid pressure, the pressure change will still be noticeable. The salt beds are probably saturated with brine having a salt concentration equal to saturation (otherwise the fluid would dissolve the salt) (Bredehoeft 1988). Goodman et al. (2011) discuss that early wells drilled to and through the salt beds encountered significant brine which indicates the salt was not dry. A change in stress on one end of the salt bed, at the cavern, could increase pressure and squeeze brine from the salt as it undergoes compressive strain. This increased stress would cause the head increase that increases the gradient driving flow through the sediments to the lake. As discussed in Appendix D, effective pressure head changes of much less than a meter are sufficient to cause significant changes in the gradient across the sediments under the lake and change the groundwater flow through the sediments by an order of magnitude or more.

The changing properties of the system however make it almost impossible to model the precise pressure shifts without making assumptions, such as isothermal conditions or no change with pressure, that could render the modeling inaccurate. *The parameter selection and modeling assumptions are too complex for the applicant to be able to conduct modeling to show that storage of LPG gas is safe.*

[redacted]

The equations presented above describe a stress/strain relationship as long as it remains elastic, which means that the strain has not gone so far as to not be irreversible—the nonlinearity mentioned in the quote above by Berest et al. (2001). Irreversible strain occurs

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when slip or failure occurs along a plane of weakness. It could be as major as an earthquake or as minor as slow motion diapir formation; a diapir is an intrusion in which a mobile or ductily deformable material is forced into more brittle, or stiffer, overlying bedrock. Salt is one of the most deformable geologic materials in the natural world. Salt flows like a very viscous liquid when pressure is applied to it. This viscoelastic flow is described by the equations above. Salt diapirs are vertical stringers of salt that form in overlying bedrock formations (Poliakov et al. 1996; Schultz-Ela et al. 1993).

In geologic time scales, a salt bed may come under increasing stress due to the accumulation of sediments above it. This increasing stress squeezes the salt until it flows viscoelastically. If constrained in one direction, the flow will find a path of less resistance, such as through vertical fractures, and cause vertical stringers of salt (Poliakov et al. 1996). Existing diapirs could be a source of salt to the sediments under Seneca Lake south of the point where the valley intersects the Syracuse formation (Appendix D). Strains caused by LPG storage, as described above, will cause pressures in any existing diapirs and cause salt to discharge into the lake or sediments above. This process is not expected to be as significant a process as the large-scale advection across the sediments (Appendix C), but it could still cause salt to reach the lake at a time simultaneous to the additional salt advection from the groundwater.

Viscoelastic relations between groundwater and the media it flows through also help to explain many observations of groundwater flow and pressure observed on a much shorter term. The time frame and spatial scale of these observations supports the conclusion that viscoelastic relations between the salt caverns and sediments beneath Seneca Lake can cause significant fluxes of groundwater and salt to reach the lake.

Examples of short-term natural viscoelastic flow are earth tides, seismic activity, or earthquakes at a distance causing pressure fluctuations, strain exerted by pumping confined aquifers on the confining layers, and barometric pressure changes. Earth tides are strains induced on the earth's crust that cause significant changes in pore pressures, and well water levels, by gravitational pull of the moon and sun (Hsieh et al. 1988, Bredehoeft 1967). Earth tides also affect the discharge from springs. At a hot spring in Japan, Kitagawa and Koizumi (2000) found that discharge varied cyclically by about seven percent once they controlled for atmospheric pressure and seismic changes.

Pumping wells cause strain that can have unusual effects on water levels in piezometers of the confining layers. As the hydrostatic pressure in a confined aquifer decreased due to pumping, water levels in the clay confining layers increased, contrary to expectation of standard well hydraulics (Wolff 1970a and b). Pumping the aquifer essentially pulled the clay toward the well, thereby squeezing it which increased the pore pressure and causing the pressure in the clay to

increase (Wolff 1970a). Within six and ninety seconds of the commencement of pumping, water levels half a meter within the clay had increased by 10 and 25 centimeters, respectively (Wolff 1970a). After 18 days, the changes began to approximate that expected from standard groundwater relations (Wolff 1970b). Gambolati et al. (2000) also found that pumping from a confined aquifer pulled the confining layers causing strain and temporarily increasing pressures, contrary to that expect from standard well hydraulics.

Jha and Juane (2014) manipulated the equations of poroelastic flow to simulate pressures in a simplified horizontal formation similar to what exists beneath Seneca Lake. They derived a numerical and analytical solution to the equations. Their simulation shows that initially pressure transmits along the entire length. During the short-term, the pressure at the bottom of the section exceeds that applied at the boundary while the applied pressure dissipates at an upper steady boundary condition; at Seneca Lake, pressure would be applied at the boundary that intersects the cavern and the upper boundary would be the base of the sediments where the pressure is hydrostatic based on the lake level above it. Initially, the upper gradient is higher and with time it dissipates. Jha and Juane (2014) did not simulate flow, but the pressure simulations are similar to those expected at Seneca Lake to potentially drive upward flow across the sediments. They also ran simulations of the effects that groundwater pumping have on faults, showing that pumping can change pressures and strain which could activate historic faults (Jha and Juane 2014); if the pressure changes caused by storing LPG gas encounter faults, which are prevalent in the area (Jacobi 2002), the faults could be activated which could cause earthquakes or allow fluid transport.

Beavan et al. (1991) used barometric and tidal fluctuations in well water levels to estimate aquifer parameters, assuming there is no flow occurring in the formation of interest. Evans et al. (1991) used water level data driven by earth tides and barometric pressure to estimate regional-scale permeability and elasticity parameters; the scale of their work was similar to the scale at Seneca Lake, indicating that the forcing at the proposed salt cavern storage will propagate pressure changes into Seneca Lake. Also, this suggests it is possible to use field data to estimate parameters at Seneca Lake, if one assumes no flow enters the salt at the caverns, or to ignore it if there is leakage (Beavan et al. 1991). However, there are no wells measuring water levels in the salt formations at Seneca Lake, so the data is not readily available.

Lin et al (2004) found that viscoelastic equations best explained the dissipation of the fluctuation in water levels in an alluvial fan resulting from earthquakes. The initial water level changes were as high as 10 meters while the observed strains were less than 0.5 meters due to the earthquake. The modeling simulated pulses among the bedrock, sand and gravel formations, including the transmission of pressure across a bedrock/sediments boundary, as at

Seneca Lake. The simulation was possible because the alluvial aquifer had an extensive alluvial monitoring system which does not exist at Seneca Lake or anywhere else in salt bed formations.

Conversely, Gambolati et al. (2000) found that, except for initially in the confining layers, simulating the strain/pressure effects of pumping in alluvial partially confined aquifers was just as accurate with uncoupled equations; uncoupled means that standard hydraulic calculations were used to simulate pressures and changing aquifer shapes were simulated based on those pressures rather than including each in the same set of equations as is done by the viscoelastic approach. The primary reason is that the aquifer is highly heterogeneous which leads to significant dampening of pressure waves among the different lithologies (among gravel, sand, silt and clay). The salt formations beneath Seneca Lake are relatively homogeneous, at least from a lithologic perspective, so the coupling of processes as represented by the viscoelastic equations is necessary to estimate the change in pressures beneath the sediments under Seneca Lake.

In summary, this appendix describes some of the mathematics that would be necessary to model the potential for pressure-related strain to cause pressure changes under Seneca Lake. The transfer of pressure from the proposed LPG storage to sediments beneath Seneca Lake has the potential to cause massive inflows of salt to the lake, as it did during the late 1960s. The mechanics of this are extremely complex, and the data needed to analyze the expected quantities of salt that can be discharged by these changes in pressure is not available. Even if additional data is collected it would likely be at a small scale and only valid at a single time and a single location for a given pressure and temperature. The assumptions necessary to model the salt discharge potential would render the results highly inaccurate at predicting salt discharges at other locations, pressures and temperatures. Data collection and modeling cannot be used to obtain assurances that such discharges are not possible.

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APPENDIX G

DESCRIPTION OF FINGER LAKES' PROPOSED PROJECT AND APPLICATION

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APPENDIX G: DESCRIPTION OF FINGER LAKES' PROPOSED PROJECT AND APPLICATION

FLLPG proposes to convert Gallery 1 and Gallery 2 to LPG storage, similar to what was done in the 1960s. A cross-section of Gallery 2 is shown in Figure E3 in Appendix E (along with a number of caverns not proposed for LPG storage).[1] LPG will be added to the top of the galleries while brine is removed from the bottom. Because of the density differences, there will be a line of separation (interface) between the brine and LPG in the galleries that moves up and down. There is uncertainty in the rate that the interface moves up and down depending on the exact cross-section of the gallery (it varies with time) and the amount of rubble on the gallery floor. The TDS concentration in the brine ranges from 31,100 to 417,000 mg/l (NYSDEC 2011).[2] Brine that is pumped to the surface will be stored in two large brine ponds. LPG is recovered by pumping brine to the bottom of the cavern while LPG is withdrawn from the top.

The draft permit states that Galleries 1 and 2 will store a maximum of 1,500,000 and 600,000 barrels.[7]

[1] August 2014 Gallery Map and Section (2000-00-01-16-R9 SECTION 8-28-14 INERGY SECT A-A' FINGERLAKES).
[2] SEQR Documents (Final DSEIS Text).

[7] Draft permit conditions at Attachment 1 ¶ 1.d.

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For consideration of pressure transfer along the formations, is accurate as a description of the pressure change that occurs at the point the formations intersect with the caverns.

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APPENDIX H

REFERENCES

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APPENDIX H: References

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APPENDIX I

CURRICULUM VITAE OF TOM MYERS

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Tom Myers, Ph.D.
Consultant, Hydrology and Water Resources
6320 Walnut Creek Road
Reno, NV 89523
(775) 530-1483
Tom_myers@charter.net

Curriculum Vitae

Objective: To provide diverse research and consulting services to nonprofit, government, legal and industry clients focusing on hydrogeology specializing in mine dewatering, contaminant transport, natural gas development, groundwater modeling, NEPA analysis, federal and state regulatory review, and fluvial morphology.

Education

Years	Degree	University
1992-96	Ph.D. Hydrology/Hydrogeology	University of Nevada, Reno Dissertation: Stochastic Structure of Rangeland Streams
1990-92		University of Arizona, Tucson AZ Classes in pursuit of Ph.D. in Hydrology.
1988-90	M.S. Hydrology/Hydrogeology	University of Nevada, Reno Thesis: Stream Morphology, Stability and Habitat in Northern Nevada
1981-83		University of Colorado, Denver, CO Graduate level water resources engineering classes.
1977-81	B.S., Civil Engineering	University of Colorado, Boulder, CO

Professional Experience

Years	Position	Duties
1993-Pr.	Hydrologic Consultant	Completion of hydrogeology studies and testimony focusing on mine dewatering, groundwater modeling, natural gas development, contaminant transport, NEPA review, and water rights for nonprofit groups and government agencies.
1999-2004	Great Basin Mine Watch, Exec Director	Responsible for reviewing and commenting on mining projects with a focus on groundwater and surface water resources, preparing appeals and litigation, organizational development and personnel management.
1992-1997	Univ of NV, Reno, Res. Assoc.	Research on riparian area and watershed management including stream morphology, aquatic habitat, cattle grazing and low-flow and flood hydrology.
1990-1992	U of AZ, Res. and Teach. Assistant	Research on rainfall/runoff processes and climate models. Taught lab sections for sophomore level "Principles of Hydrology". Received 1992 Outstanding Graduate Teaching Assistant Award in the College of Engineering
1988-1990	U of NV, Reno Res. Asst	Research on aquatic habitat, stream morphology and livestock management.
1983-1988	US Bureau of Reclamation Hydraulic Eng.	Performed hydrology planning studies on topics including floodplains, water supply, flood control, salt balance, irrigation efficiencies, sediment transport, rainfall-runoff modeling and groundwater balances.

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Myers, T., 2014. Technical Memorandum: Twin Metals and the Boundary Waters Canoe Area Wilderness, Risk Assessment for Underground Metals Mining. Prepared for Northeastern Minnesotans for Wilderness. August 8, 2014.

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Myers, T., 2013. Technical Memorandum: Review of Montanore Mine Dewatering Instream Flow Methodology. Prepared for Save our Cabinets, Earthworks. March 26, 2013.

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Myers, T., 2010. Technical Memorandum, Updated Groundwater Modeling Report, Proposed Rosemont Open Pit Mining Project. Prepared for Pima County and Pima County Regional Flood Control District.

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Myers, T., 2006. Hydrogeology of Spring Valley and Effects of Groundwater Development Proposed by the Southern Nevada Water Authority, White Pine and Lincoln County, Nevada. Prepared for Western Environmental Law Center for Water Rights Protest Hearing.

Myers, T., 2006. Potential Effects of Coal Bed Methane Development on Water Levels, Wells and Springs of the Pinnacle Gas Resource, Dietz Project In the Powder River Basin of Southeast Montana. Affidavit prepared for Northern Plains Resource Council, April 4, 2006.

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Myers, T., 1997. Groundwater management implications of open-pit mine dewatering in northern Nevada. In Kendall, D.R. (ed.), Conjunctive Use of Water Resources: Aquifer Storage and Recovery. AWRA Symposium, Long Beach California. October 19-23, 1997.

Myers, T., 1997. Groundwater management implications of open-pit mine dewatering in northern Nevada. In Life in a Closed Basin, Nevada Water Resources Association, October 8-10, 1997, Elko, NV.

Myers, T., 1997. Uncertainties in the hydrologic modeling of pit lake refill. American Chemical Society Annual Meeting, Las Vegas, NV, Sept. 8-12, 1997.

Myers, T., 1997. Use of groundwater modeling and geographic information systems in water marketing. In Warwick, J.J. (ed.), Water Resources Education, Training, and Practice: Opportunities for the Next Century. AWRA Symposium, Keystone, Colo. June 29-July 3, 1997.

Myers, T., 1995. Decreased surface water flows due to alluvial pumping in the Walker River valley. Annual Meeting of the Nevada Water Resources Association, Reno, NV, March 14-15, 1995.

Special Coursework

Years	Course	Sponsor
2011	Hydraulic Fracturing of the Marcellus Shale	National Groundwater Association
2008	Fractured Rock Analysis	MidWest Geoscience
2005	Groundwater Sampling Field Course	Nielson Environmental Field School
2004	Environmental Forensics	National Groundwater Association
2004 and -5	Groundwater and Environmental Law	National Groundwater Association

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Exhibit 4

Noise Report
Sandstone Environmental Associates, Inc.

A. Brook Crossan, Ph.D., P.E.
Nancy C. Neuman, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

Sandstone Environmental Associates, Inc.

Noise Review
Proposed Liquid Petroleum Gas Storage Facility
Finger Lakes LPG Storage, LLC

January 14, 2015

A. Brook Crossan, Ph.D., P.E.
Nancy C. Neuman, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

Noise Review
Proposed Liquid Petroleum Gas Storage Facility
Finger Lakes LPG Storage, LLC

1.0 Background

1.1 Introduction

Sandstone Environmental Associates Inc. (SEA) was retained by Earthjustice in December 2014 to assess noise associated with the proposed construction and operation of an underground liquid petroleum gas (LPG) storage facility (Project) in the Town of Reading, New York, and to determine whether the Project may have significant unmitigated noise impacts.[1] To answer that question, I reviewed the Draft Supplemental Environmental Impact Statement (DSEIS) prepared in support of the application of Finger Lakes LPG Storage, LLC (the Applicant) for an underground storage permit for the Project as well as a Sound Study prepared by Hunt Engineers, Architects & Land Surveyors (Hunt), and I evaluated those documents in light of the New York State Department of Environmental Conservation (NYSDEC or the Department) Program Policy and guidance entitled *Assessing and Mitigating Noise Impacts* (NYSDEC, 2001). I also performed a review of the scientific literature on long-distance sound transmission over water bodies; conducted noise monitoring in the Town of Reading and the Town of Hector (east side of Seneca Lake); and calculated future noise levels at receptors in Hector.

As detailed in the Community Character Analysis by Harvey K. Flad, Ph.D., the study area is a significant recreational destination with wineries, historic sites and districts, scenic roads, numerous bed-and-breakfasts, and the Watkins Glen State Park. As the Department has recognized:

> The sound generated by proposed or existing facilities may become noise due to land use surrounding the facility. When lands adjoining an existing or proposed facility contain residential, commercial, institutional or recreational uses that are proximal to the facility, noise is likely to be a matter of concern to residents or users of adjacent lands.

(NYSDEC, 2001: 2) Residents seeking to preserve the character of the Seneca Lake community have expressed concern about the Project's potentially significant noise impacts.

I believe that those concerns are well founded. In my opinion as an environmental engineer with more than 40 years' experience in conducting noise studies, environmental impact statements, and environmental assessments in over 30 states (see Appendix 7.3.1), residents of the Seneca

[1] Two SEA experts collaborated on this report. A. Brook Crossan, a principal environmental engineer, conducted SEA's noise monitoring and drafted this report. Nancy C. Neuman, a principal environmental analysis, reviewed the report for purposes of quality assurance and approved its contents. Curriculum vitae for both Crossan and Neuman are attached to this report as Appendices 7.3.1 and 7.3.2.

Lake community and tourists visiting the area are likely to suffer significant and unmitigated noise impacts from the Project, notwithstanding the mitigation measures proposed by the Applicant and conditions that NYSDEC proposes to attach to the Applicant's permit, if the permit is granted. As I explain below, more study is needed to characterize those noise impacts, particularly on residential and recreational receptors on the eastern shore of Seneca Lake. Until that study and characterization have been completed, the Applicant cannot identify all potentially significant impacts and cannot propose measures to mitigate some or all of them; nor can the Department ascertain the full extent of unmitigated significant noise impacts.

1.2 Noise Characteristics and Parameters

The Department defines noise as "any loud, discordant or disagreeable sound or sounds. More commonly, in an environmental context, noise is defined simply as an unwanted sound." (NYSDEC, 2001: 2)

Sound pressure level (SPL), or perceived loudness of noise, is expressed in decibels (dB) or measured on the A-weighted decibel (dBA) scale. The A-weighted scale is used for evaluating the effects of noise in the environment because it is "weighted towards those portions of the frequency spectrum . . . to which the human ear is most sensitive" (NYSDEC, 2001: 7) and therefore most closely approximates the response of the human ear. On this scale, the threshold of discomfort is 120 dBA, and the threshold of pain is about 140 dBA. Because the scale is logarithmic, an increase of 10 decibels represents a SPL that is 10 times higher. However, humans do not perceive a 10 dBA increase as 10 times louder; they perceive it as twice as loud. The following is typical of human response to relative changes in noise level:

Perception of Changes in Noise Levels

Change (dBA)	Average Ability to Perceive Changes in Noise Levels (Human Perception of Change)
2-3	Barely Perceptible
5	Readily Noticeable
10	A doubling or halving of the loudness of sound
20	A dramatic change
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt Baranek and Neuman, Inc. *Fundamentals and Abatement of Highway Traffic Noise, Report No. PB-222-703*. Prepared for Federal Highway Administration, June 1973.

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The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate environmental noise levels over time. Some typical descriptors are defined below:

- L_{eq} is the continuous equivalent sound level. The sound energy from the fluctuating SPLs is averaged over time to create a single number describing the mean energy or intensity level. High noise levels during a monitoring period will have greater effect on the L_{eq} than low noise levels. The L_{eq} has an advantage over other descriptors because L_{eq} values from different noise sources can be added and subtracted to determine cumulative noise levels.
- L_{max} is the highest SPL measured during a given period of time. It is useful in evaluating L_{eq}s for time periods that have an especially wide range of noise levels.
- L_{10} is the SPL exceeded 10 percent of the time. Similar descriptors are the L_{01}, L_{50}, and L_{90}.

"Frequency (perceived as pitch) is the rate at which a sound source vibrates or makes the air vibrate." (NYSDEC, 2001: 7) Most sounds are composed of more than one frequency. Long-distance atmospheric transmission of noise affects its various constitutive frequencies differently than short-distance transmission. The higher frequencies attenuate faster in the atmosphere than do the mid- and lower frequencies.

To accommodate this phenomenon in a noise analysis, the whole frequency range is divided into bands, each of which covers a specific range of frequencies. A band is said to be an octave in width when the upper band frequency, expressed in Hertz (Hz), is twice the lower band frequency. Because the differential attenuation rates are not significant over short distances, an octave band analysis is typically not necessary for evaluation of noise at receptors within 1,000 feet of sources. Over long distances, an octave band analysis should be conducted for both the source and the receptor, to provide an accurate quantitative analysis of noise transmission and to allow an adequate assessment of the intrusiveness of that noise into the background.

1.3 Traffic Noise

Since traffic noise is the most important component of the baseline existing noise levels in the Project area, it is important to understand the disproportionate contribution of trucks to ambient noise. It is common industry practice to convert vehicular traffic volumes into Passenger Car Equivalent (PCE) values. This system is summarized in the *2014 CEQR Technical Manual* (NYC, 2014), as follows:

- autos and light trucks = 1 passenger car,
- medium trucks (9,900-26,400 pounds) = 13 passenger cars,
- heavy trucks (more than 26,400 pounds) = 47 passenger cars, and
- buses (capacity of at least 10 persons) = 18 passenger cars.

Thus, PCEs are the numbers of autos that would generate the same noise level as the observed vehicular mix of autos, medium trucks, and heavy trucks. PCEs are useful for comparing the effects of traffic noise on different roadways or for different future scenarios. These

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relationships highlight the need for traffic classification counts to understand existing traffic noise levels and to calculate future traffic noise.

1.4 Organization of this Noise Report

This report starts with a description of the independent work that I conducted, summarizes the significant deficiencies that I identified in the Applicant's sound studies (Hunt, 2011, 2013 & 2014)[2], and ends with recommendations for additional analysis and mitigation.

Section 2.0 summarizes the work that I performed.

Section 3.0 describes the following significant deficiencies in the Applicant's sound studies:

1. The region of influence has not been correctly delineated.
2. Noise sources and receptors have not been adequately mapped.
3. Background noise levels have not been properly monitored and reported.
4. Construction noise has not been analyzed and cannot be analyzed with currently available information.
5. Project-related rail and truck noise has not been properly analyzed.
6. Effective mitigation measures have not been identified.

Section 4.0 summarizes our recommendations for (1) additional analysis required before NYSDEC determines whether to grant the permit and (2) additional required permit conditions, should the permit be approved.

Section 5.0 provides a glossary of terms.

Section 6.0 is a bibliography of documents reviewed.

Section 7.0 includes three Appendices:

7.1: Georgia State University, *Refraction of Sound*
7.2: Three maps of the SEA study area and noise receptors
7.3: Curriculum vitae of A. Brook Crossan, Ph.D., P.E. and Nancy C. Neuman, Ph.D.

2.0 Work Performed by SEA

2.1 Review of Current Literature Regarding Noise Transmission over Water

Review of the literature shows several important quantitative studies relating to wind turbine noise traveling over large bodies of water to the shoreline. The studies (Bolin, Boue, & Karasalo, 2009: Harrison, 2012; and Institute of Acoustics, 2013) have shown that the traditional spherical noise transmission from a point source, which results in a six dB drop per doubling of distance, is not present over the water body. Rather, a cylindrical transmission occurs, with a 3 dB drop per doubling of distance at distances greater than 600' from the source. This reduction

[2] 2012-01-20, BSK to DEC Supplemental Information, Attachment 7; 2014-03-07, Hunt Revised Sound Study, with report revised July, 2013.

of attenuation has significant implications for noise transmission to the east side of Seneca Lake, as will be discussed further in Section 2.3.

These studies of sound transmission over water involve bays and oceans, which have far more wave action than does Seneca Lake. Also, the turbines do not generate noise under calm wind conditions, so noise from turbines are highest in windy conditions during which there is significant wave action. At Seneca Lake, the most sensitive conditions are during calm periods, when the water is flat with no waves, and the surface is even more reflective. Under those circumstances, there will be even less than a 3 dBA drop per doubling of distance from the noise source. (For more information on this effect, see Appendix 7.1.)

The Department has acknowledged this phenomenon:

> Temperature inversions may cause temporary problems when cooler air is next to the earth allowing for more distant propagation of sound**.** *Similarly, sound waves will bend towards water when it is cooler than the air and bounce along the highly reflective surface. Consequently, large water bodies between the sound source and the receptor may affect noise attenuation over distance.*

(NYSDEC, 2001: 10) (emphasis added) The scientific research thus adds credence to reports I have received that, under certain meteorological conditions, conversations on the west side of Lake Seneca are plainly audible (almost to the point of being able to understand the words) on the east side of the lake, a distance of 8,000 feet. The monitoring discussed in Section 2.3 below confirms that noise is transmitted across the lake.

2.2 Review of DSEIS and NYSDEC Guidance

Review of the DSEIS (Finger Lakes, 2011)[3] revealed that it falls far short of what is recommended in the Department's guidance (NYSDEC, 2001) and standard industry practice for SEQRA documents, as does the Sound Study (Hunt 2011, 2013, 2014)[4]. These shortcomings are discussed in detail in Section 3.0 Deficiencies.

2.3 SEA Noise Monitoring

Procedures

Appendices 7.2.1 through 7.2.3 are maps showing four locations or receptors (A, B, C, and D) where I performed noise monitoring or for which I made noise calculations. On Monday, 15 December 2014, SEA measured noise at A, B, and C locations, and on Tuesday, 16 December 2014, I measured noise at locations A and B.

- Location A is the deck at 4207 Phelps Road in Hector, NY, on the east side of Seneca Lake.

[3] Final DSEIS Text.
[4] 2012-01-20, BSK to DEC Supplemental Information, Attachment 7; 2014-03-07, Hunt Revised Sound Study, with report revised July, 2013.

- Location B is the top of the stairs to the dock to the south of Receptor A. These locations were selected to be representative of the western (lake-facing) frontage of the lakefront houses and recreational areas in Hector.
- Location C is 25' from the edge of Route 14, at the parking lot of the Glen Motor Inn at 3380 Route 14, south of the Project in Reading. It was selected to investigate why truck noise generated on the western side of Seneca Lake and monitored at Receptor A (on the eastern side) was louder when the trucks were *not* directly across the lake.
- Location D is in Reading directly across the lake from Receptor A in Hector.

The instruments used were a Larson Davis Model 831 Sound Level Meter, an ANSI Type I-certified instrument. The device was either mounted on a tripod at a height of five feet above the ground and positioned at least six feet away from all surfaces capable of reflecting sound, or held in front of the body facing the noise source. I calibrated the noise monitor before and after use. I used a wind screen during all sound measurements, except for calibration. All measurement procedures conformed to the requirements of ANSI Standard S1.13-1971 (R1976). During the monitoring periods, the weather was clear to slightly overcast, with temperatures in the 20s° and 30s° Farenheit, and with calm to light winds from the southeast. The instruments were within their annual factory calibration times and all monitoring was above the instrument limit of 14° Farenheit.

Noise Monitoring Results – East Side of Seneca Lake in Hector

Naturally occurring background noise sources in Hector that were noted and monitored during the two days on-site varied depending on the meteorological conditions.[5] When winds were calm, the loudest source was nearby bird chirping. The next loudest, and relatively constant, source was a small intermittent stream that was flowing into the lake, because of recent rain events. Other intermittent events included the gentle rustle of leaves caused by squirrels moving through the understory. During such calm conditions in the summer months, cicada noise is likely to be a major component of the background during the evening and night-time.

When the wind blew, there were waves on the lake that broke against the shoreline and docks, raising the sound levels. The wind also caused the sound of rustling leaves. During a portion of the time of our observations, there was a SE wind that generated small waves in the lake.[6] While we were there, the waves lapping against the shore were the loudest natural sound source.

So in summary, the noise from natural (without human sources) background sources, as monitored by SEA, was:

- Calm Conditions

[5] These sounds do not appear to fit the NYSDEC definition of "noise," as they often are welcome, rather than "loud, discordant, or disagreeable." Natural sounds may not be perceived as intrusive even if they are as loud as industrial noise.

[6] Studies have shown that noise transmission downwind is not increased (NYSDEC, 2001). But noise is transmitted less well upwind, as the wind does disperse the sound waves. So noises on the west side will be more apparent and intrusive with a SW, W, or NW wind than with a SE, E, or NE wind.

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  - Normal background – mid to high 20s dBA
  - Background with intermittent stream flowing after a rain – 29 to 31 dBA
  - Distant bird chirping – 32 to 35 dBA (peaks)
  - Nearby bird chirping – 40 to 44 dBA (peaks)
- Windy Conditions
  - Water lapping on shore – 44 to 52 dBA

In the summer months, I would expect cicada noise in the 50s or 60s dBA, based on monitoring I have done at similar locations. It is standard practice to acknowledge their presence but to exclude them from analysis, because they are intermittent in nature.

Anthropogenic (human-made) sources from Reading, produced the following noise, as monitored from the west-facing receptors in Hector:

- Trucks on Route 14 on the west side of the lake – 33 to 39 dBA (the 38 and 39 dBA values were from northbound trucks leaving Watkins Glen and climbing the hill toward the Project site)
- Trains on the spur near the lake west shore – 42 to 53 dBA
- Trains on the main line near the ridge line – 42 to 53 dBA
- "Industrial" activity (various audible thumps that were monitored) – 38 to 42 dBA
- General aviation aircraft – 33 to 36 dBA

These results demonstrate that existing transportation and industrial noise originating in Reading is up to 30 dBA higher than the natural background in Hector and thus can and does have significant noise impacts on occupants of west-facing homes. Notwithstanding the existing noise from Reading, the Project may have significant noise impacts on west-facing receptors in Hector, if Project noise occurs more frequently, for more extended periods of time, or at different times than current anthropogenic noise sources. For example, the Applicant currently estimates that more than 100 additional rail cars will travel to the Project site and unload propane during the summer months, creating the noisiest activity precisely when west-facing windows in Hector are likely to be open and temperature inversions will propagate sound farther over the lake. The Applicant's Sound Study analyzed receptors only in Reading, however, and thus failed to provide an adequate analysis of potentially significant noise impacts from the Project. That study should be supplemented with new measurements, taken at the appropriate time of year, under a variety of meteorological conditions, from receptors on the east side of Seneca Lake, and a new noise analysis should be performed.

Noise Monitoring Results – West Side of Seneca Lake in Reading

During the limited SEA noise monitoring on the west side of the lake, we were able to monitor noise levels of trucks traveling on Route 14 and a train on the lower (slower) track near the lakeside. Although closer to the receptors than the main line trains, the trains on the spur traveled slower and therefore were quieter at 50' than the faster trains.

For northbound trucks traveling up the hill after leaving Watkins Glen, the L_{max} was 87 dBA at 25', or 81 dBA at 50'. Monitoring was conducted at the hill because noise monitoring on the

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east side of the lake demonstrated that truck noise on that hill was greater than on the level stretch of highway directly west of the east-side receptors.

The train traveling at just a few miles an hour along the lakefront had a L_{eq} of 75 to 76 dBA at 50' for just the track noise. The L_{max} of the train whistle was 112 dBA.

This data reinforces the fact that off-site truck and train activity generates higher noise levels in Hector than the on-site activities, and therefore cannot be excluded from an adequate noise analysis.

- The trucks approaching the site from the south are 6 to 7 dBA louder at the lakeside receptors in Hector than the trucks on-site.
- The train whistles at the off-site road crossings are 23 dBA louder than the loudest on-site noise generator and exist for a longer period of time.

2.4 Calculation of Project-Induced Noise Levels in Hector

As has been discussed above, a variety of factors affect noise transmission over the lake. The best way to demonstrate these factors is to examine truck noise from two different locations. At Location C (in Reading) SEA-monitored truck noise had an L_{max} of 81 dBA at 50' for trucks climbing the hill. We then used the non-climbing L_{max} of 78 dBA at 50' at location D, which is in Reading directly across the lake from Receptor A in Hector. The distances from source to receptor are summarized below, and depicted In Appendix 7.2.3.

Source Location	Distance from Source to Receptor A, feet		
	Over Land	Over Water	Total
C	1,300	14,000	15,300
D	3,400	6,000	9,400

If the 6 dBA decrease per doubling of distance pertained to both land and water, the 81 dBA L_{max} at Location C would measure 31 dBA at Receptor A. However, SEA monitored an L_{max} of 39 dBA at Receptor A. If, following the scientific literature on cylindrical transmission over water discussed above, we assume a 6 dBA drop over land and the first 600 feet of water, and a 3 dBA drop for the remainder of the distance over the water, the predicted result for Receptor A is 40 dBA. We also did a calculation assuming a 7 dBA drop over land, to account for intervening vegetation, and a 3 dBA drop over the water, which resulted in a predicted L_{max} of 35 dBA at Receptor A. See the summary chart below.

Truck at Location C, L_{max} at 50', dBA	Decrease per doubling over land/water, dBA	Calculated L_{max}, dBA	Monitored L_{max}, dBA
81	6/6	31	39
	6/3	40	

	7/3	35	

These calculations demonstrate that the differential noise attenuation over distance for transmission of sound across a large water body as opposed to over land applies to transmission over Seneca Lake. Since SEA's monitoring was done on a cold day and does not account for the enhanced transmission when refraction occurs, we would expect even less attenuation when the air over the lake is warmer than the lake water, with noise levels higher than the 39 dBA monitored in December.

We did similar calculations for the truck at Location D, and the results are summarized in the chart below.

Truck at Location D, L_{max} at 50', dBA	Decrease per doubling over land/water, dBA	Calculated L_{max}, dBA	Monitored L_{max}, dBA
79	6/6	34	33
	6/3	38	
	7/3	32	

With regard to noises directly across the lake from Receptor A, and about 3,000' upslope from the lake, we anticipate that there will be about a 45 dBA reduction from the values at 50' that residents on the east side of the lake will experience. Thus, the L_{max} train noise of 89 dBA would be 44 dBA on the east side of the lake. This is more than 15 dBA higher than the normal background under calm conditions (of mid- to high-20s dBA) and would be very intrusive. The L_{eq} of 78 dBA would be 33 dBA, which also is above calm background conditions. These calculations do not include the train whistle that is 23 dBA louder.

For sources operating near the lake shore such as the fire pumps (Hunt 2013)[7], the decrease would only be 30 dBA. If not mitigated, this would result in noise at a level of about 54 dBA in Hector, which is 25 dBA above the existing calm background.

3.0 Deficiencies in the Sound Study

3.1 The Region of Influence (ROI) Has Not Been Correctly Delineated.

The ROI is the physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis. It can vary by resource area—for example, the ROI for visual impact analysis may be smaller than the ROI for socio-economic impact analysis. Sometimes multiple resource areas have the same ROI—for example, the traffic, noise, and micro-scale air quality analysis for a destination commercial development would be defined by the geography of intersections potentially affected by project-induced traffic. If the ROI is improperly defined, potentially significant impacts of the project may not be identified.

[7] 2014-03-07, Hunt Revised Sound Study, with report revised July, 2013.

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Some EISs explicitly define the ROI for each resource area; in others, the ROI is implicit in the scope of analysis. Neither the DSEIS nor the Sound Study for the Project expressly defines the ROI for noise, but that ROI is implicit in their analysis, which includes only on-site noise sources and receptors only in Reading, in the immediate vicinity of the proposed storage facility.

The Project will increase off-site rail and truck traffic over baseline conditions, but only on-site transportation noise has been evaluated so far. Off-site train noise cannot be ignored, because whistle noise is the peak noise, and it occurs off-site; moreover, the rumbling trains can be heard miles and miles away. Off-site truck traffic cannot be ignored, because trucks in Reading sound the loudest in Hector, when they are traveling northbound from Watkins Glen on Route 14 and are climbing the hill toward the Project site. If the off-site transportation noise is included, as it must be, noise will have to be evaluated at receptors in a geographic study area that could extend from Watkins Glen at the south to Geneva at the north.

It is standard industry practice in analyzing impacts under SEQRA to assess noise caused by project-related traffic not only when it is on the project site, but also as it approaches and leaves the site. The entire area affected by project-induced traffic is the relevant ROI for noise during both construction and operations. The Applicant ignored off-site rail and truck noise that will be caused by the Project, some of which is louder than on-site noise, and thus incorrectly delineated the ROI.

In addition, the Applicant failed to acknowledge the influence of temperature and wind on noise transmission over Seneca Lake. As the foregoing discussion of SEA noise monitoring demonstrates, both on- and off-site rail and truck noise sources are likely to have significant adverse impacts on receptors across the lake in Hector. The failure to identify receptors outside of Reading compounds the failure to analyze off-site noise sources, and the result is an indefensibly narrow ROI for noise.

With an incorrectly delineated ROI, the Applicant cannot adequately evaluate the potentially significant noise impacts of the Project (on receptors on both sides of Seneca Lake) and cannot identify appropriate mitigation measures to be included as conditions on its permit, should one be granted. Until those problems are cured, the analysis cannot demonstrate that significant noise impacts have been mitigated to the extent practicable. DEC therefore should deny the underground storage permit.

3.2 Noise Sources and Receptors Have Not Been Adequately Mapped.

A noise analysis that meets industry standards will provide maps that clearly identify all noise sources and receptors, at the variety of scales needed to illustrate the relationships among them and their relationship to the wider community. The understanding of noise in the wider context is important because the community's attitude to and tolerance for noise are part of what defines its character. The character of a community that has worked together to create a peaceful and bucolic retreat will be adversely affected by increasing industrial noise, even if some residents are out of earshot.

For the Project, there should be one overview map that covers Seneca Lake and shoreline communities (including Watkins Glen and Geneva); maps at smaller scales to portray specific

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sources and potentially impacted receptors; and the closest views would be reserved for the noise monitoring sites, to show exactly where noise monitoring data had been collected and where receptor calculations were being made. The Applicant's maps do not meet this standard, and the deficient mapping in the Sound Study made evaluation of the report very difficult. For example, without conducting independent research on Google, it was not clear that Figure 1 and Figure 2 were views of areas immediately adjacent to one another. When the ROI is properly redefined, and new noise sources and receptors are properly identified, the Applicant also should correct and supplement its maps.

3.3 Baseline Noise Levels Have Not Been Properly Monitored and Reported.

Accurate assessments of noise impacts involve both quantitative and qualitative analysis, and they depend on accurate accounts of "not only ambient noise levels, but also the existing land use." (NYSDEC, 2001: 20) If baseline noise levels are overstated, noise increases will appear lower than they actually are, and the significance of impacts will be understated. Similarly, the description of the human context must make it possible correctly to determine "whether an increased noise level or the introduction of a discernable sound . . . is out of character with existing sounds, [and thus] will be considered annoying or obtrusive." *Id.*

The reported values for the receptors in Reading were of limited utility for a variety of reasons:

- There was no sketch, with clearly delineated dimensions, showing the exact location of the monitoring with respect to the major existing noise source (adjacent roadway), the sensitive receptor (house), and the Project element of interest. These relationships are very important, as can be seen from the following examples:
    - If the monitoring is 10' from the edge of the road, and the house is set back 40' from the road, the real background could be 6 to 8 dBA lower than reported, and the potential for impacts would be greater.
    - For some receptors, road noise may impact the front of the house, while the train or pump noise impacts the side or rear of the house, where the background noise level is likely to be substantially lower. Adding Project noise to existing levels at the front of the house understates the impact.
- There was no description of what caused the L_{max} at each location. Was it a car, a truck, a train whistle, a dog barking, or an airplane overhead? Without that knowledge it is not possible to completely assess the impact of additional trucks and trains, either quantitatively or qualitatively. Nor is it possible to use that value for comparison to projected L_{max}s.
- No concurrent traffic counts were reported. When taking noise measurements along a roadway, it is standard industry practice to perform traffic classification counts (e.g. counts of the number of autos, medium trucks {2-axle, 6-wheel}, and heavy trucks {3 or more axles}) for that time period. Because, on average, one heavy truck is as noisy as 47 cars, an understanding of truck volumes is crucial.
- With the noise levels being influenced so much by individual heavy truck passbys, other noise parameters, such as L_{50} or L_{90}, would give a much better idea of the typical background levels to which new sources would be added. The baseline is likely to be lower with use of these measures.

- The reported night-time noise levels were monitored in July between 8:30 and 10:30 P.M. and therefore were contaminated with cicada noise. In cooler weather, the ambient noise levels will be substantially lower, and the potential for Project impacts will be substantially higher.

The Sound Study Supplement (Hunt, 2014)[8] attempted to address the problem of noise levels monitored at the front of a motel as the base for Project noise coming from the rear. The revised analysis identified L_{eq}s of 42.4 dBA and 45.0 dBA, respectively, for daytime and night-time noise at the rear face of the motel, as compared with L_{eq}s of 61.7 dBA and 55.7 dBA, respectively, at the front face of the motel (used as the baseline in the original sound study). (Hunt, 2014: Appendix B, Table 2)[9] The 19.3 dBA difference in daytime values was caused by the building, which shields the rear from highway noise. Other receptors also should be checked for similar biases.

The new analysis, based on noise levels at the rear of the motel, does not wholly cure the bulleted problems with the Sound Study. The fact that the evening value at the rear was nearly 3 dBA *higher* than the daytime value demonstrates that summertime cicada noise was likely a dominant component at night. With traffic volumes lower in the evening, a more accurate night-time level would be 19.3 dBA less than the 55.7 dBA value at the front, or 36.3 dBA (rather than 45.0 dBA). Moreover, since truck volumes continue to decrease later in the night, it is quite likely that true baseline night-time levels (from about 2 to 4 A.M.), without cicadas, would be closer to 30 dBA. At either time, the projected noise levels from the Project would be 10 dBA above the baseline—a significant impact requiring mitigation. The current noise analysis thus fails to identify all significant impacts not only in Hector but also in Reading.

3.4 Construction Noise Has Not Been Analyzed and Cannot Be Analyzed with Currently Available Information.

Standard industry practice has evolved to perform a quantitative construction noise impact assessment, upon which mitigation measures can be evaluated. The Department plainly assumes that such an analysis will be done and recommends measures to mitigate significant construction noise impacts. For example, the guidance states:

> Alternative *construction* or operational methods, equipment maintenance, selection of alternative equipment, physical barriers, siting of activities, set backs, and established hours of *construction* or operation, are among the techniques that can successfully avoid or reduce adverse noise effects.

(NYSDEC, 2001: 3) (emphasis added) Specifically:

> Limiting hours of *construction* or operation can be an effective tool in reducing potential adverse impacts of noise. The impacts of noise on receptors can be significantly reduced by effectively managing the hours at which the loudest of the operations can take place.

[8] 2014-03-07, Hunt Revised Sound Study, with report revised July, 2013.
[9] *Id.* at app. B, tbl. 2.

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(NYSDEC, 2001: 23–24) (emphasis added) There is no analysis of Project construction noise in the Sound Study (Hunt, 2011, 2013, & 2014).[10] Moreover, there is no description of proposed construction activities—their duration, the types of equipment needed to conduct the operations, and the number of such pieces of equipment—on which such an analysis could be based.

Standard industry practice for a project with so much grading and construction, in part on steep slopes and over such a large area, is to provide a quantitative assessment of noise sources during construction. This analysis is especially important for construction activities that may occur on weekends or at night, when noise levels are typically lower. Construction noise that might not be noticed when people are at work also may be out of character and more intrusive on weekends, when residents and tourists are engaged in outdoor recreational activities. The risk of significant adverse Project construction noise impacts on receptors in both Reading and Hector is increased because the Applicant has made no commitments to limit the time of day, or day of week, within which construction activities can occur.

3.5 Project-Related Rail and Truck Noise Has Not Been Properly Analyzed.

Neither the DSEIS nor the Sound Study clearly quantifies either existing or Project-related transportation in the relevant ROI for noise. Baseline conditions with respect to train activity through the Project area (frequency, number of cars, and time of day) and vehicular trips on Route 14 (both northbound and southbound) have not been documented. The number and frequency of potential train trips and vehicle trips to and from the Project, during construction and operation, have not been definitively identified. Without accurate information about baseline and Project-generated train and truck traffic, an assessment of potential transportation noise impacts, during both construction and operation, is impossible.

What information there is about on-site Project-generated train and truck noise raises significant questions. Noise levels (L_{max} and L_{eq}) for the following train noises were based on monitoring at a similar site at 50' from the source:

Activity	L_{eq}, dBA	L_{max}, dBA
Train Entrance	72.4	81.2
Train Uncoupling	78.8	87.9
Full Train Car Removal	73.8	88.9
Empty Train Car Placement	77.2	87.3
Train Car Coupling Air Release	77.2	87.0
Total Train Time	76.1	88.9

[10] 2012-01-20, BSK to DEC Supplemental Information, Attachment 7; 2014-03-07, Hunt Revised Sound Study, with report revised July, 2013.

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A few items are worthy of note with respect to train activity:

- Monitoring periods for the various train activities ranged from 10 minutes to 35 minutes, depending upon the duration of the activity.
- The values reported for the total train time (1 hour & 55 minutes) included 15 minutes that was reported as background. The L_{eq} for the 1 hour & 40 minutes of actual total activity is higher than reported and is approximately 78 dBA.
- The Sound Study reports that, at a distance of 800', the train had a L_{eq} of 67.3 and a L_{max} of 76.6 dBA. If that measurement is correct, a 6 dBA change per halving of distance would translate to an increase of 24 dBA at 50', or an L_{eq} of 91.3 and an L_{max} of 100.6 dBA, which is 19 dBA higher than what was monitored at 50' from the train entrance. The discrepancy is very significant and is unexplained. It suggests that the monitoring at 50' did not capture peak noise levels and therefore should be redone.

Truck activities were also monitored at 50' as summarized below.

Activity	L_{eq}, dBA	L_{max}, dBA
Trucks	71.3	79.2
Unloading Trucks	73.6	77.8

It is unclear as to whether large differences (up to 15 dBA) between the reported L_{eq}s and L_{max}s for the train and truck activities are based on true variations of noise from the source or reflect that the noise source was moving and was not always 50' away from the monitor. Given the variable nature of the truck and especially rail noise, a one-hour L_{eq} is not an appropriate measure from which to assess impacts. The L_{max} should be used to assess rail and truck noise. Out-of-character fluctuating industrial noise sources in a residential and recreational area cannot be assessed adequately using one-hour L_{eq}s, which averages out the peaks and valleys.

In addition, there ostensibly has been a major revision of proposed Project operations since completion of the noise analysis. As recently as December 2014, the Applicant filed a "transportation allocation" that purports to utilize pipelines for 95 percent of propane transportation to the Project and for 100 percent of propane transportation from the Project. The Applicant suggests that all propane would be piped directly to Selkirk (south of Albany), but no commitment has been made not to pipe propane to the TEPPCO site for truck distribution over Route 14 and throughout the Finger Lakes or not to use trucks or rail for propane transportation in the future. Moreover, a complete noise analysis has not been performed for the various transportation options.

In my expert opinion, noise evaluation should be based upon worst-case conditions, if they cannot be ruled out for a particular project. In the case of noise generated by the Project, that approach requires an analysis of the original transportation allocation, because the Applicant has made no binding commitment to adhere to the new one for the life of the Project. It would defeat the intent of SEQRA to allow the Applicant to obtain a permit by analyzing almost exclusive use of pipelines for propane transportation, if future lack of pipeline capacity would allow the use of trucks or trains. Analysis of the worst-case scenario should be required unless the Applicant makes a legally binding written commitment to permanent use of the December 2014 transportation allocation.

3.6 Effective Mitigation Measures Have Not Been Identified.

Because potentially significant noise impacts have not been adequately analyzed, the Applicant must identify or demonstrate the efficacy of proposed mitigation measures. Without an adequate analysis of effective mitigation for significant adverse environmental impacts, NYSDEC cannot design permit conditions that would enable it to make the requisite findings under SEQRA and may not approve the permit.

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4.0 Recommendations Additional Study and Permit Conditions

4.1 Recommendations for Further Analysis

To address the deficiencies describe above, the Applicant must expand and revise the Sound Study in the following ways:

4.1.1. Establish a proper ROI for both construction and operation noise (including from pumps and transportation).

Include at least the corridor from Watkins Glen to Geneva and the entire eastern shore of Seneca Lake.

4.1.2. Conduct a special study of noise transmission over Lake Seneca during different meteorological conditions.

Since noise transmission over water is dramatically influenced by meteorological conditions, sufficient monitoring needs to be performed to document the full range of conditions, especially those days with calm conditions and warm air. More work needs to be done with concurrent monitoring on both sides of the lake under various meteorological conditions to determine what are reasonable parameters to use for calculations of noise transmission across Seneca Lake. Without such work, SEA has no confidence in any projections that would be made for the east side of the lake.

4.1.3. Obtain octave band information for all sources to use in modeling of noise transmission across the lake.

Perform an octave band analysis of all construction and operation sources in order to properly calculate projected noise levels on the east side of the lake. The octave band sources should either be based on manufacturer's data or monitored data from similar equipment. The calculations at the eastern receptors should reflect the fact that higher frequency noise levels do not travel as well across long distances as do the mid- and low-range frequencies.

4.1.4. Add, and monitor noise at, new receptors for the appropriate conditions, time, and days of week.

Establish appropriate receptors on the east side of Lake Seneca. Multiple receptors are necessary to cover the full length of the construction activities and off-site transportation. Additional receptors also will have to be added on the west to evaluate the transportation noise impacts along the full Seneca Lake corridor.

4.1.5. Monitor at old receptors for appropriate conditions, time and days of week.

Monitoring at the existing receptors needs to be done to:

- Capture the full range of night-time background, including late-night hours (2 to 4 AM), without cicada noise;
- Take proper notes for the source of L_{max} values in all time periods;

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- Where front yard monitoring is appropriate, take concurrent traffic classification counts;
- Change monitoring locations to side and rear yards as appropriate.

4.1.6. Document the construction materials, equipment, and schedule.

To perform the required construction noise analysis, the Project must be defined in far greater detail. The following items require clarification, but this list should not be considered exhaustive:

- For brine ponds, specify:
  - Number of pieces of earthmoving equipment
  - Duration of clearing & grubbing and grading
  - Cut and fill calculations to demonstrate the volume of fill needed to be imported (if any)
  - Number of trucks and/or trains required for that fill
- For the train yard, specify:
  - Volume of sub-ballast needed
  - Volume of ballast needed
  - Length of track
  - Number of ties needed
  - Number of trucks and/or trains required
  - Number and type of equipment needed for the construction
  - Duration of the construction
- For the 2-mile pipeline, specify:
  - Duration of the construction
  - Width of construction zone
  - Equipment to be used
  - Whether there are any locations where it will be "jacked" under roads or streams.
- Overall construction schedule

4.1.7. Document commitments on hours of construction and operation.

Either exclude nighttime and weekend/holiday operation by binding commitment or evaluate baseline noise levels by monitoring throughout the entire 24 hours including weekdays, weekends, and holidays. It should be noted that background values are lower at all receptors during the night and on holidays and weekends. Thus, potential noise impacts are greater during those time periods.

4.1.8. Document the existing conditions for rail, traffic, and pipeline.

There needs to be better documentation of the existing conditions for rail, traffic, and the pipeline, so that, if it is determined that there are 100 truck trips/day during certain construction activities, or 32 rail cars per day during certain period of operation, we can ascertain whether those numbers will represent a 5, 50, or 200 percent increase in truck or rail traffic. There also needs to be information on the availability of pipeline capacity, if loss of capacity would allow the Applicant to convert pipeline transmission of propane back to rail or truck.

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4.1.9. Clearly describe all operational details, especially all of the transportation options.

Provide an up-to-date description of the operational noise sources (including all rail and trucking operations under currently proposed, previously proposed, and potential future scenarios), including anticipated number of trucks, trains, and rail cars per train; location of operation; duration of operation; and time of operation by hours of the day and days of the week. The rail and truck noise should include travel of new or lengthened trains as they travel to and from the site. The pipeline scenarios should address the percentage of available and projected capacity that they will use.

4.1.10. Model construction and operation noise at all receptors for all times and scenarios.

Once all of the monitoring and special studies are completed, quantitative modeling of construction and operation noise should be performed. The draft permit conditions recommend use of an L_{eq}, but they do not specify a length of time for monitoring. The Department staff also discusses using the L_{max} as a comparison. In order to do that, the source of the baseline L_{max} needs to be described. For example, it should not be unusual events such as an aircraft flying overhead or a barking dog. Since compliance monitoring would exclude an event like that, as the Applicant would not take responsibility for someone else's noise, the baseline L_{max} should represent common noise events such as truck traffic on adjacent roads.

SEA believes that, while the L_{eq} is appropriate for sources that are relatively constant, such as the pumps in this case, for sources such as rail and truck that are highly variable, the L_{eq} is not an appropriate measure. A measure, such as the $L_{90,}$ should be used to allow the analyst to determine whether there is intrusion of peak noises into the quiet background or other high intensity noise that presents disturbances to residents.

4.1.11. Develop appropriate impact criteria.

Appropriate impact criteria need to be developed. Quantitative thresholds are not sufficient. The land use and community character context needs to be taken into account in developing impact criteria.

4.1.12. Compare results to impact criteria to assess the need for mitigation.

The modeling results the need to be compared to the impact criteria to assess the need for mitigation.

4.1.13. Propose and evaluate alternate mitigation measures.

The Department guidance clearly specifies various types of appropriate mitigation. (NYSDEC, 2001) Limiting the times of day when certain activities can take place is an acknowledged mitigation strategy and, in this situation, could be one of the most effective means to mitigate adverse noise impacts, should the permit be approved. Additional sound barriers also may be required around noise generating equipment.

4.1.14. Propose construction noise compliance monitoring plan.

There should be a construction noise compliance monitoring plan that sets limits for equipment noise and establishes a monitoring protocol to ensure that excess noise is not generated.

4.1.15. Propose operational noise compliance monitoring plan.

There should be an operational noise compliance monitoring plan similar to what is in NYSDEC's draft permit conditions. It should, however, be more detailed. For example, the duration of any L_{eq} monitoring and reporting should be specified.

4.1.16. Prepare and submit revised sound study.

A revised Sound Study needs to be prepared that addresses all of the deficiencies discussed above. The report should include a consolidated map that shows all noise sources including the 2-mile pipeline, laydown areas, the rail yards, and the various pumps in relation to all receptor locations on the east and west side of the lake.

4.2 Permit Conditions Required

Until the additional study recommended above is complete, and the numerous major deficiencies that I have identified in the Sound Study have been cured, it will be impossible for NYSDEC to make the findings required under SEQRA, and the permit therefore should not be issued. If the additional study is completed, effective mitigation is identified for significant noise impacts, and the permit it granted, those measures should be incorporated as additional conditions in the permit.

5.0 Glossary

A-Weighted Sound Level - A measurement of the sound pressure level, weighted to most closely approximate the range of frequencies detectable by the human ear. The sound level measurement is weighted by filtering out sounds in the lower and upper frequencies that the human ear is less capable of detecting. Expressed as dBA.

Decibel - A logarithmic scale used to quantify sound measurement. Use of a decibel scale reduces a dynamic range of sound pressures of a million to one to a more manageable range of sound pressure levels of only 1 to 120, zero indicating the reference minimum threshold and 120 the approximate threshold of pain.

Decibel Sound Level ($L_{\%}$) - the sound level which is equaled or exceeded for a specified percentage of the time period of interest; L_1, L_5, L_{10}, L_{50}, etc., are the sound levels exceeded for 1%, 5%, 10%, 50%, etc., of the time period, respectively.

Equivalent Sound Level (L_{eq}) - The long-term A-weighted sound level which is equal to the level of a steady-state continuous noise having the same energy as the time-varying noise, for a given situation and time period. Therefore, it is a time-integrated average sound level.

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Maximum Sound Level (L_{max}) – The maximum sound level measured during the period of measurement.

Octave Band Frequencies - Noise can be broken down into different frequencies to better define the spectral characteristic of the noise source. An octave is any two frequencies whose ratio is exactly two to one; therefore, a standard center frequency has been established to identify the frequency range in which the octave changes. This information is important in order to evaluate a noise source in relation to the frequencies that the human ear is capable of detecting. Since the human ear is most sensitive to the mid-range frequencies (1000-4000 Hz), high sound levels in the lower and upper frequencies are not as easily detectable or annoying (see A-weighted definition above).

6.0 Bibliography

Bond et al.	2014a	Letter to Mr. David L. Bimber, Regional Permit Administrator NY State Department of Environmental Conservation, Region 7 dated March 7, 2014; From Kevin M. Bernstein. (2014-03-07, Hunt Revised Sound Study, with report revised July, 2013, BSK to DEC Cover Letter)
Bond et al.	2014b	Letter to Lisa Schwartz, Esq., Assistant Regional Attorney, NYS DEC, dated December 2, 2014 Re: Product Transportation Allocation, From Kevin M. Bernstein. (2014-12-02, Product Transportation Allocation – Revised December 2014, letter and attachment)
Bolin et al.	2009	Long Range Sound Propagation Over a Sea Surface; Bolin, K., Boue', I. Karasalo, J. Acoust. Soc. Am. 126 (5), November 2009, pp. 2191–2197.
Finger Lakes	2011	Draft Supplemental Environmental Impact Statement (DSEIS), Finger Lakes LPG Storage, LLC, LPG Storage Facility, Finger Lakes LPG Storage, LLC, August 2011. (Final SSEIS Text)
Harrison	2012	Sound Propagation From Off-Shore Wind Turbine Arrays, John Harrison, January 2012.
Hunt	2011	Sound Study Prepared for Finger Lakes LPG Storage, LLC, Proposed Watkins Terminal, NY State Route 14, Watkins Glen, NY, Hunt, January 2011, Revised January 2012. (2012-01-20, BSK to DEC Supplemental Information, Attachment 7)

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Hunt	2013	Sound Study Prepared for Finger Lakes LPG Storage, LLC, Proposed Watkins Terminal, NY State Route 14, Watkins Glen, NY, Hunt, January 2011, Revised July 2013. (2014-03-07, Hunt Revised Sound Study, with report revised July, 2013)
Hunt	2014	Memorandum to Kevin Bernstein, Bond, Schoeneck & King, March 7, 2014, From Paul Congdon, Re: Sound Study Supplement. (2014-03-07, Hunt Revised Sound Study, with report revised July, 2013)
Institute of Acoustics	2013	Supplementary Guidance Note 6: Noise Propagation Over Water for On-Shore Wind Turbines, Institute of Acoustics, December 2013.
NYC	2014	City Environmental Quality Review (CEQR) Technical Manual, Mayor/s Office of Environmental Coordination, March 2014.
NYSDEC	2001	Assessing and Mitigating Noise Impacts, NY State Department of Environmental Conservation, Division of Environmental Permits, Issuance Date: October 6, 2000, Revised: February 2, 2001.
NYSDEC	2011	Draft Supplemental Environmental Impact Statement (DSEIS) Final Scoping Outline, Finger Lakes LPG Storage LLC, Watkins Glen LPG Storage Facility. DEC 8-4432-00085/00001, 15 February 2011 by cover letter from David L. Bimber. (2011-02-15, DEC to BSK – Final Scope)
NYSDEC	2014	Letter to James T. McClymonds, Chief Administrative Law Judge, NYS Dept. of Environmental Conservation, Office of Hearings and Mediation Services, Attachment: Draft permit conditions, which Department staff propose in the event that a determination is made, after the hearing process, to issue a permit, November 10, 2014, From Lisa Schwartz, Assistant Regional Attorney. (2014-11-10, DEC Staff Draft Permit Conditions)
Reading	1995	Town of Reading, Local Law No. 1 of the year 1995, Land Use Law for the Town of Reading, New York.

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7.0 Appendices

7.1 Georgia State University, Refraction of Sound, http://hyperphysics.phy-astr.gsu.edu/hbase/sound/refrac.html (last visited Jan. 6, 2015)

7.2 Maps

7.2.1. SEA Noise Monitoring Sites in Hector

7.2.2. SEA Noise Monitoring Site in Reading

7.3.3. Truck Noise Calculation Locations

7.3 Curriculum Vitae

7.3.1 A. Brook Crossan, Ph.D., P.E.

7.3.2 Nancy C. Neuman, Ph.D.

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Appendix 7.1

Georgia State University, *Refraction of Sound*

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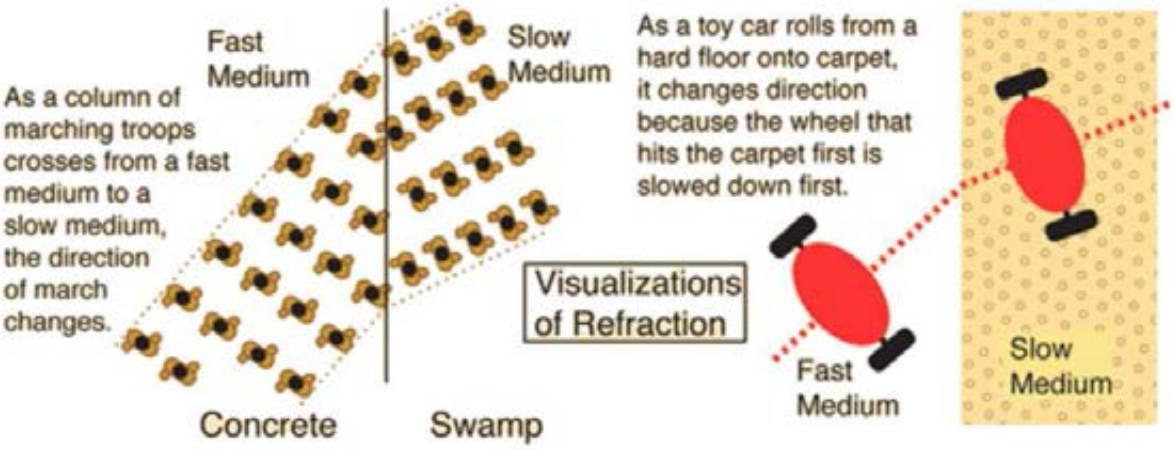
Refraction of Sound

Refraction is the bending of waves when they enter a medium where their speed is different. Refraction is not so important a phenomenon with sound as it is with light where it is responsible for image formation by lenses, the eye, cameras, etc. But bending of sound waves does occur and is an interesting phenomena in sound



These visualizations may help in understanding the nature of refraction. A column of troops approaching a medium where their speed is slower as shown will turn toward the right because the right side of the column hits the slow medium first and is therefore slowed down. The marchers on the left, perhaps oblivious to the plight of their companions, continue to march ahead full speed until they hit the slow medium.

Not only does the direction of march change, the separation of the marchers is decreased. When applied to waves, this implies that the direction of propagation of the wave is deflected toward the right and that the wavelength of the wave is decreased. From the basic wave relationship, $v=f\lambda$, it is clear that a slower speed must shorten the wavelength since the frequency of the wave is determined by its source and does not change.

Another visualization of refraction can come from the steering of various types of tractors, construction equipment, tanks and other tracked vehicle. If you apply the right brake, the vehicle turns right because you have slowed down one side of the vehicle without slowing down the other.

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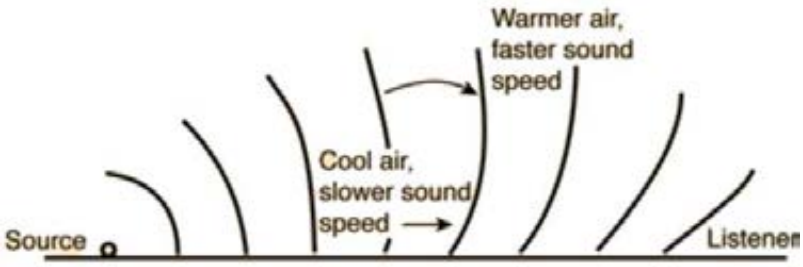
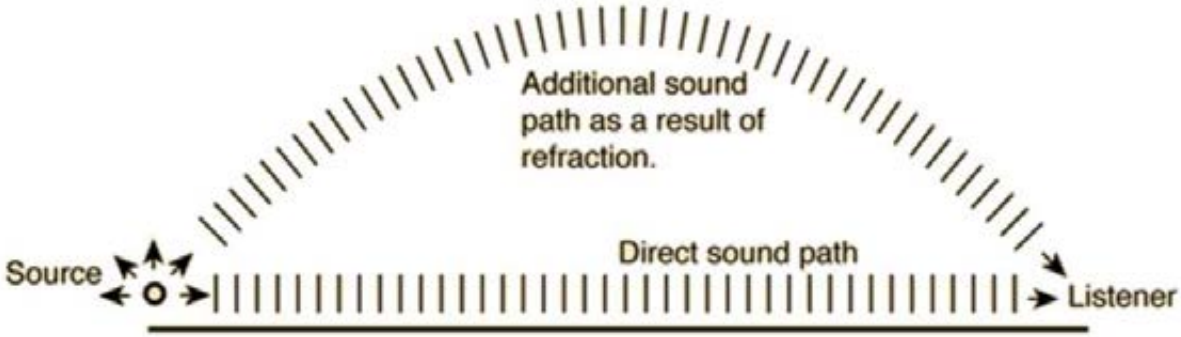
Refraction of Sound

If the air above the earth is warmer than that at the surface, sound will be bent back downward toward the surface by refraction.



Sound propagates in all directions from a point source. Normally, only that which is initially directed toward the listener can be heard, but refraction can bend sound downward. Normally, only the direct sound is received. But refraction can add some additional sound, effectively amplifying the sound. Natural amplifiers can occur over cool lakes.



Further discussion

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Traveling wave concepts

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Refraction of Sound

Early morning fishermen may be the persons most familiar with the refraction of sound. Consider that you have gone out to a lake before dawn. Just as the sun rises over a cool lake, you may hear someone speak to you, saying "Good morning!". You look around and can't see anyone. You are just about at the point of questioning your sanity anyway, being out at this time of the morning, so you decide to ignore it. But the voice comes again,

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"Good morning". Finally you locate the other nut who has gotten up at this hour, far across the lake -- much further than you could normally hear a voice. That fisherman is aware of the early morning lake's effect on sound transmission. The cool water keeps the air near the water cool, but the early sun has begun to heat the air higher up, creating a "thermal inversion". The fact that the speed of sound is faster in warmer air bends some sound back downward toward you - sound that would not reach your ear under normal circumstances. This natural amplification over cool bodies of water is one of the few natural examples of sound refraction. Illustration	concepts
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Appendix 7.2.1

SEA Noise Monitoring Sites in Hector

Figure 1. Monitoring Locations A&B

Hector, NY

Source: Google Maps

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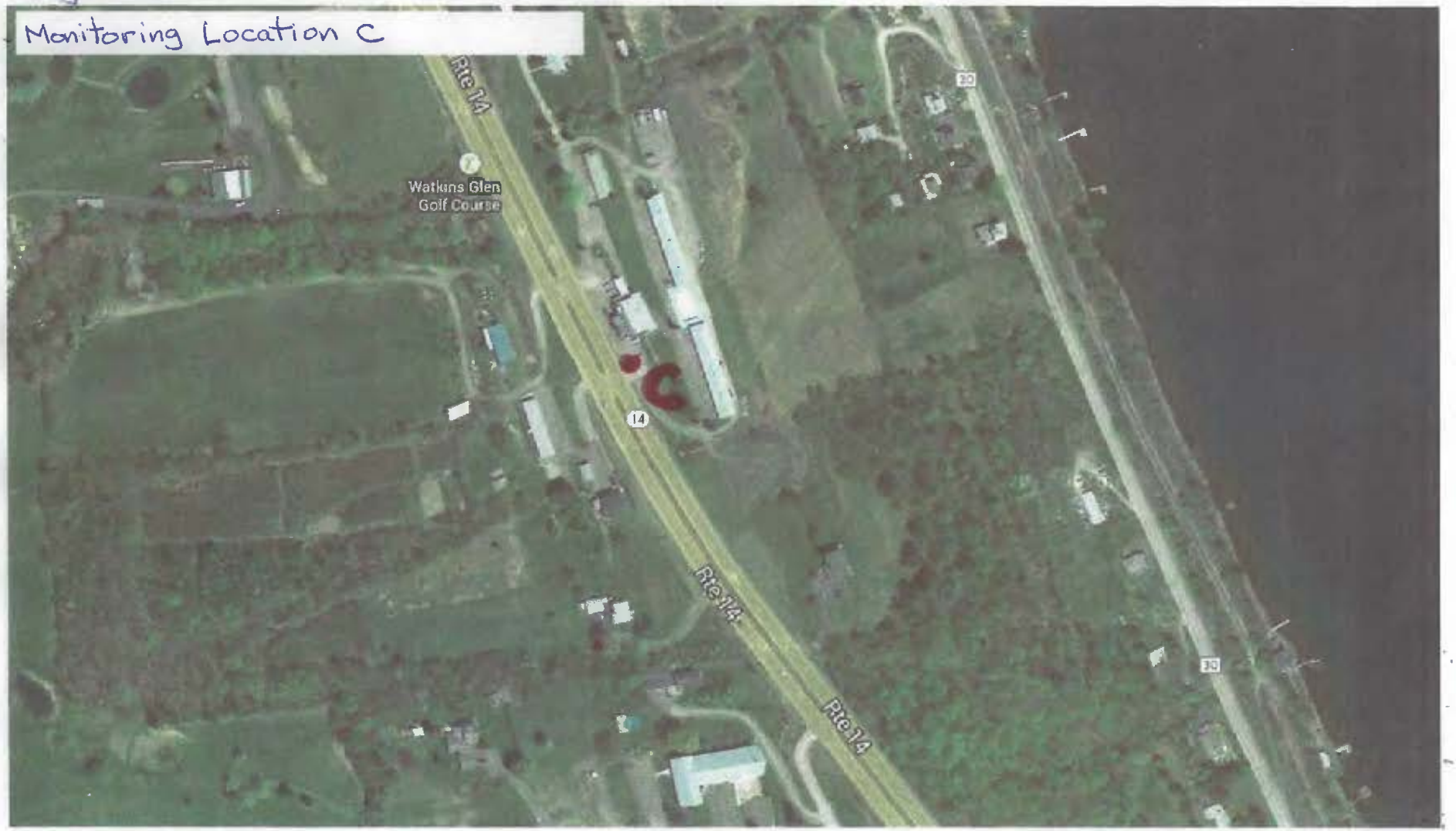
Appendix 7.2.2

SEA Noise Monitoring Sites in Reading

Figure 2

Monitoring Location C



Reading, NY

Source: Google Maps

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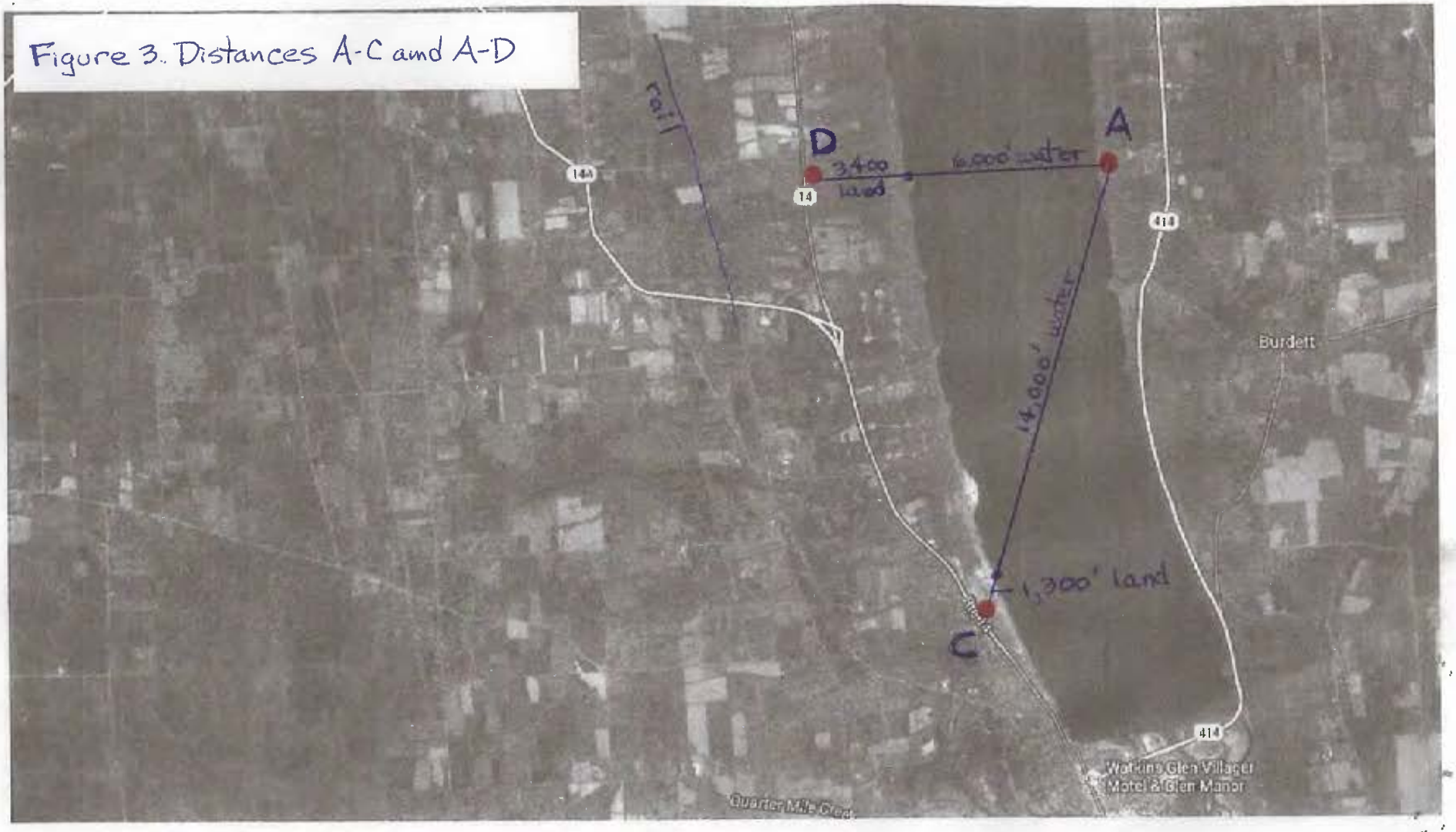
Appendix 7.2.3

Truck Noise Calculation Locations

Figure 3. Distances A-C and A-D



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Appendix 7.3.1

Curriculum Vita
A. Brook Crossan, Ph.D., P.E.

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A. Brook Crossan, Principal Environmental Engineer

Years of Experience	Education
40	Ph.D., Geophysical Fluid Dynamics, Rutgers University, 1974 M.S., Mechanical Engineering, Rutgers University, 1971 B.S., Mechanical Engineering, University of Pennsylvania, 1969

Employment

Sandstone Environmental Associates, Inc., 2009-Present
MACK Associates, LLC 2009-2013 part-time
Potomac Hudson Engineering, Inc., 1988-2008
Maser Sosinski & Associates, 1989-1991
The Hudson Partnership, Inc. 1984-1988
Louis Berger & Associates, Inc. 1975-1984
Ecolsciences, Inc., 1973-1974

Professional Registrations/Certifications

Professional Engineer - New Jersey, Pennsylvania, New York
Professional Planner - New Jersey
Community Noise Enforcement – Rutgers Noise Technical Assistance Center, 2000, 2002, 2004, 2006, 2008, 2010 & 2012
Certificate, Basic, Advanced and Expert Seminar in CadnaA, Datakustics, 2014
Certificate, Air Quality Dispersion Modeling with AERMOD, Lakes Environmental, 2014

Professional Summary

Dr. Crossan has more than 40 years' experience in conducting noise studies, environmental impact statements, and environmental assessments in over 30 states. His environmental experience includes: noise monitoring (in rural, suburban, and urban sites), modeling (CadnaA, STAMINA and TNM), and mitigation design (barriers, berms, site plan changes, and equipment changes for example); air monitoring, modeling (most recently AERMOD and CAL3QHC), permitting and impact assessment; as well as management of comprehensive Environmental Impact Statements. Noise assessments have included equipment noise, transportation noise and has included both construction and operation impacts and mitigation. He has also prepared greenhouse gas inventories for several projects.

The transportation impact assessment has included: truck loading docks, interstate and state highways (for Georgia, Maryland, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Maine, and Idaho), both construction and highway noise; county and local roads; electric, diesel, and natural gas buses and bus maintenance facilities; subways, passenger and freight rail; and waterborne including tugs, barges, ferries and berthing facilities; and expansion at general aviation and international airports.

Dr. Crossan also has wide experience in the monitoring, modeling and mitigation design of construction and industrial noise. He has both prepared (more than 400) and critically reviewed (more than 70) many noise studies and EISs. These noise reviews have been performed for: municipal planning boards; citizen groups; environmental groups; and federal agencies.

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Relevant Experience

Sterling Forest Resort, Tuxedo, NY,
Review of Air Quality and Noise Analyses for EIS
Client: Town of Tuxedo, NY
Period: May 2014 – Ongoing

Reviewed materials prepared by developer's consultants for proposed resort/casino on the NY Renaissance Faire property as well as new Interchange 15B on I-87. Reviewed proposed EIS scope of work and recommended modifications for traffic, air quality, and noise tasks. Reviewed DEIS analyses and advised Town Board on completeness with respect to scope of work. Contact: Bonnie Franson, H2M architects + engineers, New City, NY. 845-499-2264

Casino Impact Study Review
Air/Noise Impact Review, Orange County, NY
Client: Town of Tuxedo
Period: 2014 to present

Dr. Crossan has attended meetings in Tuxedo and reviewed and commented extensively on the Scoping Document with emphasis on alternatives, cumulative impacts, construction impacts, and air/noise impacts. He will be reviewing these sections in the DEIS and FEIS when they are submitted.

Indian Casino Impact Study
Air/Noise Analyses, Sullivan County, NY
Client: Parish & Weiner
Period: 2002 - 2009

Prepared an air and noise quality impact assessment for a NEPA EA and another impact assessment for a SEQRA EIS for a proposed Indian Casino at Monticello Raceway in Sullivan County NY. These included noise monitoring (with concurrent traffic counts), assessment of construction impacts, and modeling of future air quality and noise levels.

Review of Construction Noise Impact Study
CadnaA Noise Analysis, Wappinger, NY
Client: Town of Wappinger Planning Board.
Period: January 2012 – May 2012

Project manager at MACK Associates for noise consultant services to the Town of Wappinger Planning Board. Reviewed the construction noise impacts for the DEIS for a new eastern portal in Wappinger for a new aqueduct crossing under the Hudson River for the water supply of the City of New York (*DEIS for the Water for the Future Program: Delaware Aqueduct Rondout-West Branch Tunnel Repair*). Reviewed and commented on the CadnaA modeling carried out for the DEIS and determined that there would be significant adverse noise impacts for the 7- to 8-year construction project that were not identified in the DEIS and that must be further mitigated. Testified at Planning Board meetings.

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Tappan Zee Replacement Bridge DEIS & FEIS, and Construction Review of Noise Analyses and Mitigation, Tarrytown, NY

Clients: Village of Tarrytown, The Quay, Salisbury Point Cooperative, and the Village of South Nyack

Period: October 2011– 2014

Project manager at MACK Associates to provide noise consulting services to the Village of Tarrytown in Westchester County, The Quay Condominiums in Tarrytown, and the Salisbury Point Cooperative in Rockland County for the review of the noise analyses contained in the DEIS and FEIS and their appendices. Generated over 100 pages of detailed comments relating to deficiencies in methodologies, noise monitoring, noise modeling, and proposed mitigation measures. Participated in meetings with NYSDOT and the NYS Thruway Authority. He is currently assisting Salisbury Point and The Quay Condominiums with respect to replacement windows and other measures to mitigate construction and operation noise. At Sandstone he is assisting The Quay with replacement window specifications, and the Village of South Nyack with respect to excessive pile driving noise and additional measures to mitigate it.

Taylorville Energy EIS Noise Analysis, Taylorville, IL

Client: Potomac Hudson Engineering, Tinton Falls, NJ

Period: September 2009 – April 2010

Task manager for several components of EIS for proposed energy center. Responsibilities for noise analysis included supervision of noise monitoring field work throughout rural municipalities through which coal trucks would travel. Noise monitoring occurred in October 2009 for peak AM, Midday, PM, evening, and nighttime periods. Prepared noise sections for Existing Conditions, No Build Conditions, and Build Conditions for DEIS.

Shopping Center DEIS Review of Air/Noise Analyses, New Haven, CT

Client: Cowdery, Ecker & Murphy, LLC

Period: January 2004 – August 2004

Reviewed the air quality analysis and noise analysis of potential impacts of the Galleria at Long Wharf Project in New Haven, CT as documented in the FONSI and appendices. Dr. Crossan testified on these matters in State superior court and the project was ultimately withdrawn.

Western Greenbrier Co-Gen Facility EIS Traffic /Noise and CadnaA Noise Analyses, Rainelle, WV

Client: Potomac Hudson Engineering, Inc.

Period: April 2004 – May 2006

Technical lead (wetlands, surface water quality and fisheries, hydrology, floodplains and transportation resources) for the preparation of an EIS for the construction and demonstration of a 90-MW Co-Production Facility in rural Rainelle, West Virginia. Also assisted with monitoring of traffic noise. Coordinated with client in obtaining site plans and equipment information for use in CADNA modeling of noise from proposed power plant equipment. Assisted in developing noise impact criteria.

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Additional Experience

Expert Testimony

- Provided expert environmental/noise testimony to planning boards, zoning boards of adjustment, and/or governing bodies in more than 120 different municipalities in NJ and NY (including Rockland, Orange, Westchester, Putnam and Dutchess Counties).
- Provided expert noise testimony to State Superior Court in NJ (Bergen and Ocean Counties) and CT, Administrative Law Judges in NY and NJ, and Condemnation Commissioners in NJ.

Additional Industrial & Commercial Noise

Performed monitoring of noise levels and assessment of night-time compliance with noise regulations for:

- salvage yards (Wappinger, NY);
- asphalt batching plant (Edison, NJ);
- emergency generators (multiple sites in NJ and NY, several using CadnaA in the design);
- plastics extrusion plants (Piscataway, NJ and Brewster, NY);
- concrete batching plants (North Castle, NY and Edison, NJ);
- home improvement center loading docks (Old Bridge, NJ);
- gasoline service stations (Cranford and Aberdeen, NJ);
- 8-plex movie theater (East Brunswick, NJ);
- bar/restaurants (North Plainfield, Morristown and Cranford, NJ and Yonkers, NY);
- truck terminals(East Brunswick, Washington and Hamilton Townships, NJ);
- truck loading docks (Cranbury, East Brunswick, Hightstown, Monroe, Union and Washington Township, NJ);
- transfer station (Closter, NJ);
- recycling facilities (North Bergen & Jersey City, NJ);
- coal fired power plants (Rainelle, WV, Meredosia, IL and Taylorville, IL);
- gasoline & diesel service stations (Aberdeen and Mahwah, NJ);
- hospital – rooftop HVAC equipment (Bronxville, NY); and
- mixed use city center – rooftop HVAC (White Plains, NY).

Performed monitoring and assessment of construction and/or operation noise at more than 300 sites in total, including:

- single family residential
- apartments
- solid waste transfer station
- courthouses
- shopping centers
- parking decks
- asphalt batching plants
- plastic extrusion factories
- automobile junkyards
- townhouses
- dormitories
- new roadways
- offices
- industrial
- hotels
- prisons
- quarries

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Proposed and designed/specified mitigation measures as necessary and appropriate including: increased setbacks, berms, operational changes, acoustic barriers, acoustic louvers on equipment.

Rail Noise

Performed monitoring of noise levels and assessment of impacts to residential developments adjacent to numerous CONRAIL, AMTRAK and New Jersey Transit lines in New Jersey (5 sites), and METRONORTH, AMTRAK, and elevated subway lines in New York (10 sites), as well as rail lines in IL and Edmonton, Canada.

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Appendix 7.3.2

Curriculum Vita
Nancy C. Neuman, Ph.D.

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Nancy C. Neuman, Principal Environmental Analyst

Years of Experience	Education
35	Ph.D., Geography, Rutgers University, 1986 M.C.R.P. (Master of City and Regional Planning) Rutgers University, 1976 B.S., Urban Affairs, Boston University, 1973

Employment

Sandstone Environmental Associates, Inc., 1993-Present
Metcalf & Eddy of New York, Inc., 1990-1993
Urbitran Associates, Inc., 1987-1990
Louis Berger & Associates, Inc. 1981-1987
Rutgers University Center for Urban Policy Research, 1976-1981

Professional Registrations/Certifications

Certificate: Environmental Due Diligence: Principles and Practice, Commonground University, 2009
Certificate, Building Acoustics, Bruel & Kjaer, 2009
Certificate, Advanced Seminar in CADNA, Datakustics, 2008
Certificate, Community Noise Enforcement, Rutgers University Noise Technical Center, 2000, 2002, 2004, and 2006
Certificate, TNM Traffic Noise Model, Bowlby & Associates, Inc., 2000
Certificate, Improving Indoor Air Quality in Non-Industrial Buildings, Environmental Occupational & Health Safety Institute, 1995
Qualified Environmental Professional, 1993
Certificate, Air Quality Dispersion Modeling, Trinity Consultants, 1986
Certificate, Traffic Noise Analysis, Vanderbilt University, School of Engineering, 1985

Professional Summary

Dr. Neuman is president of Sandstone Environmental Associates, Inc. She has over 30 years of experience in environmental studies in New York City and New York State, as well as other parts of the U.S. This includes studies of air quality and noise impacts from proposed fire stations, diesel-powered equipment for construction and other off-road activities, and numerous other residential or transportation-oriented projects. She has also served as an expert witness for both air quality and noise analyses, and she has been a guest lecturer on community noise assessment at New York University for the Summer Institute in Environmental Impact Assessment and the Science and Environmental Reporting Program. She has also conducted over 100 Phase I ESAs. The following selected projects are representative of her experience with on-call projects, large complex projects, projects using off-road diesel equipment, and projects for NYC agencies.

Relevant Experience

NYC Fire Station On-Call
Air/Noise Analyses
Client: New York City Fire Department
Period: 2001 - 2006

Project Manager for air quality and noise components of Environment Assessments for proposed projects by the NYC Fire Department. A representative example was the proposed rehabilitation and expansion of an existing fire facility for Engine 201/ Ladder114/ Battalion 40, in Sunset Park, Brooklyn. Tasks included monitoring background noise at nearby sensitive receptors; calculating noise level impacts from sirens during typical daytime and nighttime periods; and preparing a written report to be submitted with the EAS. Reference: Philip Habib, Philip Habib & Associates, New York, NY 212-929-5656

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Astoria Cove EIS, Air Quality and Noise Analyses, Queens, NY
Client: Astoria Developers, LLC
Period: September 2013 - 2014

Directed operational air quality and construction air quality and noise analyses for EIS. Tasks included modeling and analysis with MOVES2010b, CAL3QHCR, AERMOD, RCNM, and CADNA for motor vehicles, parking facilities, stationary source stacks, and construction equipment. Prepared EIS materials. Used MOVES2010b and CAL3QHCR in a Tier II analysis of $PM_{2.5}$ over a 1 km area. Prepared detailed construction analysis and modeling for air quality. Reference: Philip Habib, Philip Habib & Associates, New York, NY 212-929-5656

NYC School Construction Authority On-Call, Air Quality and Noise Analyses, Manhattan, NY
Client: New York City School Construction Authority.
Period: 2012 - 2014

Project manager for air quality and noise analyses for on-call studies for NYCSCA. Directed or carried out air quality traffic screening and stationary boiler analyses, as well as traffic and recreation noise analyses for proposed school construction projects. Carried out CO intersection modeling with MOBILE6.2 and CAL3QHC when warranted. Monitored noise levels, calculated PCEs from traffic and buses, and determined noise level impacts from playground activities. Modeled traffic noise and barrier mitigation measures with the FHWA's TNM model. Studies were prepared according to methods in NYC *CEQR Technical Manual.* Reference: Philip Habib, Philip Habib & Associates, New York, NY 212-929-5656

Courtlandt Community Supportive Housing Development EAS, Noise Analysis, Bronx, NY
Client: Phipps Houses
Period: July 2009 – October 2010

Directed noise monitoring of peak AM, Midday, and PM periods for proposed residential building adjacent to Melrose Station on Metro North rail line. Identified required window attenuation as well as manufacturers that could provide suitable windows. Calculated Day-Night Average Sound Level (Ldn). Presented results in terms of US HUD and NYCDEP criteria for residential uses. Recommended site plan changes to comply with HUD noise requirements for passive recreation spaces. Coordinated with NYC Department of Housing Preservation and Development. Reference: Karen Hu, Phipps Houses, New York, NY 212-243-9090

Chappaqua Crossing EIS, Air/Noise Analyses, Rye Brook, NY
Client: Summit Development Corp., Inc..
Period: July 2008 – May 2011, et al

Task manager for air quality and noise studies for EIS to redevelop Readers Digest Headquarters into a residential village. Calculated greenhouse gas (GHG) contributions in the form of equivalent CO_2. Directed noise monitoring at multiple locations in study area, including evening noise levels associated with rail passbys. Directed projections of future traffic noise based on passenger car equivalents (PCEs). Determined impact criteria based upon NYSDEC guidelines. Modeled construction noise for worst-case days during each quarter during multi-year construction period using FHWA's RCNM construction noise model for diesel-powered construction equipment. Prepared technical appendices and EIS text for nearly a dozen alternatives to the proposed action. Responded to comments from review agencies. Reference: Lisa Baker, Diviney Tung Schwalbe, White Plains, NY 914-428-0010

47 NYCHA Properties, Phase I Environmental Assessments, Brooklyn and Queens, NY
Client: NYC Department of Housing
Period: 2008 – 2010

Project manager responsible for preparing Phase I ESAs for 47 NYCHA properties in Queens and Brooklyn according to ASTM E1527-05.and and 40 CFR, Part 312. Carried out site visits. Reviewed historical materials, regulatory database, and government correspondence. Wrote reports. Reference: Katherine Gray, NYCHA, New York, NY 718-9923-8656

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Exhibit 5

Community Character Report
Harvey K. Flad, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

COMMUNITY CHARACTER ANALYSIS

Finger Lakes LPG Storage, LLC
Town of Reading, Schuyler County, N.Y.

Prepared by:
Harvey K. Flad, Ph.D.
115 Academy Street
Poughkeepsie, NY 12601

January 15, 2015

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COMMUNITY CHARACTER ANALYSIS

1. Introduction

This report considers whether the proposal of Finger Lakes LPG Storage, LLC (FLLPG) to develop a liquid petroleum gas (LPG) facility in the Town of Reading, New York (Project), is consistent with the community character of the Finger Lakes region, generally, and the Seneca Lake area, in particular. FLLPG proposes to store 88 million gallons of LPG underground and to install a rail depot, tanks for temporary storage of 150,000 gallons of propane and butane, pipelines, compressors, brine ponds, a flare, and other industrial facilities on the western shore of Seneca Lake. To assess the Project's potential community character impacts, I have used the theoretical and methodological approach of "cultural landscape studies."

"The cultural landscape of an area is formed by the interaction of people and places and is imbued with the historic and cultural influences that make it special on a personal, regional, or national level."[1] Studying an area's cultural landscape illuminates the social, economic, historic, environmental, and cultural contexts of a geographically defined space, which over time shape a sense of place and identity—community character. Although a variety of subjects familiar to environmental impact analysts influence a region's cultural landscape—including aesthetics, noise, historic resources, and socio-economics—the relationship of these diverse elements to the people identified with a particular place is evolving and iterative. Community character thus is not merely the sum of those elements but rather emerges as their collective and dynamic manifestation.

To conduct my cultural landscape study, I reviewed and analyzed a wide array of relevant documents and websites—including, academic books and articles, marketing materials, municipal government publications and resolutions, and press reports—all of which illuminate the history and self-image of the Finger Lakes and Seneca Lake communities and their core character. I also conducted a number of personal interviews with leading community members. That research showed that the character of the Seneca Lake community and the wider regional community is based in deeply felt connections to the region's natural beauty and the pace of small-town rural life. After 50 years studying and teaching geography, including 40 as a professor at Vassar College, it is my opinion that the industrialization of Seneca Lake represented by the Project will have significant adverse impacts on community character for which no effective mitigation is possible.[2]

1.1. Community Character: an Environmental Concern

"Environment," according to the State Environmental Quality Review Act and its regulations, is defined as "the physical conditions which will be affected by a proposed

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[1] Katherine Ghilain, "Improving Community Character Analysis in the SEQRA Environmental Impact Review Process: A Cultural Landscape Approach to Defining the Elusive 'Community Character'," *NYU Environmental Law Journal*, vol. 17, no. 2 (2009), pp. 1194-1242, at 1194.

[2] A copy of my curriculum vitae is annexed as hereto as Exhibit A.

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action," and an action's environmental impacts include effects on the natural landscape or physical environment such as impacts on the land, including geology, topography and soil; atmosphere; water, both surface and subsurface; ecology, including flora and fauna; and human environmental or cultural landscape features including demographic and spatial patterns of population concentration, distribution, and growth; quality-of-life issues, including noise; visible objects of historic and aesthetic significance; and existing community or neighborhood character. Significant adverse impacts on community character can be ascertained through examination of potential impacts on the natural environment, aesthetic and historic resources, and socio-economic resources, even though the static picture revealed by that process will not fully capture the dynamic quality of the cultural landscape.

Landscapes evolve over time. The history of change in the Finger Lakes region can be seen in the early land use of the Iroquois, followed by the actions of the Sullivan-Clinton campaign during the Revolutionary War; the movement of early settlers into and through the region and their agricultural practices including growing grapes and attempts at wine making; developing an economic and transportation infrastructure; and evolution into a post-industrial economy dependent on recreational activities, heritage and agri-tourism, especially an internationally important wine industry. In this report, I discuss potential impacts of the proposed LPG storage facility on the community character of the Finger Lakes region and its cultural landscape, Seneca Lake and its immediately surrounding aesthetic landscape, and the evolving economy of the designated American Viticultural Areas (AVAs) against that historical background. For the purposes of this document, the geographic and spatial scale of analysis includes cultural landscapes at both regional and local levels.

1.2. Community Character: a Cultural Landscape Approach

Community character is the sense of place formed through a people's relationship to its environment. It is a community's formulation of an identity through history and can be found in the landscape as a combination of visual elements, such as natural landforms, buildings, or other cultural artifacts, as well as in more subjective and value-laden expressions of identification with place. Community character can be discerned through studying the cultural landscape as a people's "unwitting autobiography," that helps "to establish their identity, articulate their social relations, and derive cultural meaning."[3]

The scale of a community, or neighborhood of interest, relates to the history of land use and economic and social relationships among the people who inhabit the cultural landscape. New York State has recognized that the scope of the term "community"

[3] Paul Groth, "Frameworks for Cultural Landscape Study," in *Understanding Ordinary Landscapes*, ed. Paul Groth and Todd W. Bressi (1997); Peirce Lewis, "Axioms for Reading the Landscape," in *The Interpretation of Ordinary Landscapes: Geographical Essays*, ed. D.W. Meinig (NY: Oxford University Press, 1979), pp. 11-32; *see also* Dolores Hayden, "Forward: In Search of the American Landscape," in *Preserving Cultural Landscapes in America*, eds. Arnold R. Alanen and Robert Z. Melnicj (1997); D.W. Meinig, "The Beholding Eye: Ten Views of the Same Scene," in *The Interpretation of Ordinary Landscapes*, pp. 33-50.

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changes with the circumstances. For example, for the proposal by the St. Lawrence Cement Company, LLC to construct a cement plant in the Town of Greenport, New York, the assessment of community character included a multi-municipal group of two counties, two towns, and one city.[4] In this analysis of community character, the scale expands from the community surrounding Seneca Lake (from Watkins Glen to Geneva and Seneca Falls), to the wider Finger Lakes region, which is a clearly identifiable region with similar historic, economic, and scenic values and assets.

1.3. Community Character: Impact Analysis of the Project

In a substantive review of the elements that dynamically interact to form the region's community character, the role of natural beauty and an agricultural landscape, including a viticultural landscape, are central to the Finger Lakes region's sense of place over time and to the branding of the emerging tourism economy. The community is consciously pursuing economic development strategies—especially recreation and agri-tourism—that will enable it to preserve these aesthetic and environmental values and to continue enjoying the high quality of life central to its self-image. In the following analysis, I first explain the historic context and then examine nine facets of existing community character that could be adversely affected by the Project: (1) scenic views, including of vineyards and the rural landscape; (2) historic sites and districts; (3) scenic roads and transportation corridors, especially the state-designated Seneca Lake Scenic Byway and the Seneca Lake Wine Trail; (4) parks, open space, and land trusts,; (5) American Viticultural Areas; (6) wine tourism; (7) agricultural tourism; (8) recreational tourism, particularly fishing; and (9) comprehensive planning. This cultural landscape analysis of potential community character impacts associated with the Project clearly indicates that the construction and operation of such a facility will cause significant and unmitigated adverse impacts on the character of the Finger Lakes region generally and the area around Seneca Lake in particular.

Historical Influences on Community Character

2. Landscape History

Residents of the Finger Lakes region constitute a community of interest; their identity and sense of place incorporates a natural and cultural landscape that includes the area from Keuka Lake eastward to Seneca Lake and Cayuga Lake. It is a landscape rich in history, with a visual texture blending rural economic activity harmoniously with

[4] Harvey K. Flad, "Community Character," in *Visual Impact Assessment of St. Lawrence Cement Proposal, Hudson, NY* (Albany, NY: Department of State, 2005); Harvey K. Flad, "The Influence of the Hudson River School of Art in the Preservation of the River, its Natural and Cultural Landscape, and the Evolution of Environmental Law," in *Environmental History of the Hudson River*, ed. Robert E. Henshaw (Albany: State University of New York Press, 2011), pp. 293-313; Miriam D. Silverman, *Stopping the Plant: The St. Lawrence Cement Controversy and the Battle for Quality of Life in the Hudson Valley* (Albany: State University of New York Press, 2006). Ms. Silverman provides the full text of New York State Secretary of State Randy Davis's "Objection to Consistency Certification," which denied a permit to construct the St. Lawrence Cement plant due to its incompatibility with the area's economic future in heritage tourism, in her book's Appendix, pp. 119-155.

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natural forms. Scenic views of working vineyards cascading down steep slopes towards glistening pure lakes meld with rural farmsteads, orchards and small villages and towns. It is a relatively open countryside interspersed with rather small, nucleated settlements. The rolling topography offers scenic views both dramatic and pastoral, a humanized landscape where community character has been shaped by a deep history and current substantial progress in heritage- and agri-tourism.

View from Route 414 in Hector looking west over Seneca Lake (2006)

2.1. Natural History

During North America's last great Ice Age, approximately 15,000 years ago, areas of what is now New York State were covered with up to a mile in ice. The Finger Lakes region emerged about 10-12,000 years ago with deep lakes, rivers and streams and rolling topography oriented in a northerly direction. During glacial retreat the lakes were formed by glacial scouring while the hills and vales resulted from glacial outwash deposits and the remnants of massive prehistoric Lake Albany which left rock layers of sandstone, shale and limestone interspersed with pockets of minerals, such as salt at the southern end of Seneca Lake. This geological history offered a rich mixture of natural resources for human use over the next thousands of years. Although winter air temperatures are very cold, the narrow deep lakes, such as Seneca Lake, do not freeze and the waters also moderate the local temperature. The soils, many of which are finely textured and

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granular, offer good drainage especially on the steep slopes adjacent to the lakes. For example, flora and fauna around Seneca Lake are especially diverse. Its bioregion includes the steep slopes, deep lakes and climatic challenges that would become over the years the productive fields of Native Americans, settlers and immigrant viticulturists, that would transform the economy from one based on extractive resources, such as the lumbering of hard wood forests or mining salt, to one of sustainability, including thousands of acres of fruit orchards and vineyards and incorporating low-impact tourism.

The Finger Lakes ecosystem is both geologically and biologically diverse. The 2001 inventory of "Unique Natural Assets of Schuyler County, New York" declares:

> Schuyler County is home to a very large diversity of plants and animals. Over 250 species of birds either nest here or utilize our natural assets during their migrations. The New York Breeding Bird Atlas has identified over 140 avian species breeding in the county. The New York Reptile and Amphibian Atlas has identified 32 species in the county. Plants exist here that have been extirpated elsewhere. The Botanical Atlas project of the New York State Museum lists 11 species of rare native plants in Schuyler, although more are being discovered. Thirty-nine species of mammals, including us, inhabit our county. Fifty of the 64 tree species found here are native to Schuyler County and our Butternut trees (*Juglans cinera*) are listed as a regional sensitive species. Fifty-seven butterfly species have been found and a few are quite uncommon. A new study is underway to identify Dragonflies and of the more than fifty thus far confirmed, one very large and unusual species is dependent on the specific environment found in our gorges. Underpinning all of this life is the unique geology that contributes the habitat upon which all life depends.[5]

The authors of the inventory further note: "Some species exist here which have been extirpated in all other areas of the Finger Lakes and the Northeast."[6]

2.2. <u>Cultural History</u>

The Finger Lakes region in upstate New York from Lake Canandaigua and the land east to the junction of the Mohawk and Hudson rivers was inhabited by the Haudenosaunee, or Iroquois Indian Nation, when the earliest Europeans arrived in the 17th century.[7] The original Five Nations consisted of the Seneca, "Keepers of the Western Door"; Cayuga, "people of the marsh" and "Keepers of the Great Pipe"; Onondaga, "name bearers" and "Keepers of the Central Fire" who held the wampum that contained

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[5] John and Sue Gregoire, *Unique Natural Assets of Schuyler County, New York: An Annotated Inventory* (Burdett, NY: Kestral Haven Avian Migration Observatory, 2001), p.4.
[6] *Id.*, p.2.
[7] For a list of scholarly publications on this subject, see the bibliography in Harvey K. Flad, *The City and the Longhouse: A Social Geography of American Indians in Syracuse, New York*, (Ph.D. Dissertation, Syracuse University Department of Geography, 1973).

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the history of the Iroquois; Oneida, "stone people" symbolized by the Great Tree; and Mohawk, "Keepers of the Eastern Door;" they were joined by the Tuscarora as the Six Nations to form the Iroquois Confederacy. For hundreds of years they hunted, trapped, fished and grew diverse crops in villages that produced a settled agricultural landscape interspersed with vast tracts of wilderness forest. The Iroquois were highly sophisticated and productive farmers, with farmed crops representing 50 percent of their food.[8] Early relations with French, Dutch and English explorers, missionaries and traders were mainly in economic and social spheres, although such negotiations were disrupted by the French and Indian wars of the early 18th century and subsequent expansionist settlement by English colonists.

The aftermath of the American Revolution saw rapid changes to the landscape. In 1779 General George Washington ordered the destruction of all Native American settlements. In the Sullivan and Clinton campaigns waged during that year, between 40 and 50 towns, nearly 1,200 dwellings, surrounding fields of vegetables and fruit trees, and perhaps 1,000,000 bushels of corn were burned and laid waste. As Seneca Chief Cornplanter declared in 1790, Washington and all subsequent United States presidents would be given the appellation of "Town Destroyer." Washington's reasons have been described by historians as: giving protection to defenseless frontier settlements; cutting off the food supplies of corn and dried vegetable and fruits from the Indians to Loyalists and the British forces, necessary in order to capture the strong forts at Oswego and Niagara; and finally to create an "inland empire" for the emerging new nation. Vast numbers of Indians fled north to British Canada, including many Seneca and Cayuga, leaving their former lands forever. Many died as refugees in the brutal winter of 1778-79. The net effect of the Sullivan-Clinton campaign's "scorched earth" policy was to reduce the Iroquois population approximately by half and reduce the original land holdings of the Iroquois of approximately 25,000,000 acres to less than 87,000 acres by the late 20th C. After the Treaty Fort Stanwix in 1784, Euro-American settlement of the lands began; the westward expansion of the nation would not stop until it reached the Pacific Ocean.

The settlers found a landscape that had been productively cultivated for hundreds of years. The National Park Service brochure for the Fort Stanwix national monument notes that the soldiers on the Sullivan-Clinton campaign were surprised to find that the Indian's homeland did not consist of

> the crude bark huts or longhouses of 'Savages' but instead orderly rows of houses built of hewn timbers and frame houses with windows. Well-cultivated vegetable fields extended out from the villages, along with extensive apple, peach, and cherry orchards. Many of these Indian villages

[8] Laura Winter Falk, *Culinary History of the Finger Lakes: From the Three Sisters to Riesling* (Charleston, SC: American Palate, 2014), p. 24.

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> rivaled or surpassed the towns that the soldiers had come from.[9]

As one soldier wrote in his journal, the cultivated fields produced "the best corn I Ever saw."

Settlement was not uniform, as topographic features, soil conditions, and transportation routes differed throughout the vast interior, but within just a few years after the Treaty of Paris in 1785 a "land rush" spread settlers "into nearly every nook and corner suitable for habitation."[10] By 1800, the census indicated that there were more than 100,000 inhabitants west of the old colonial settlements in the Mohawk, Wyoming, and Cherry valleys. Central to the opening up of the western lands were acts by the state that created Military Tract lands as payment to soldiers in lieu of non-existent funds. Also, the state sold off huge tracts of land to speculators and land companies who in turn sold properties to individuals. Settlers came from many source areas, particularly New England where population pressure, associated with poor and thin soils, and fostered by local promoters, fostered whole communities to migrate. Other source regions were Pennsylvania and New Jersey from where colonists traveled up the Delaware and Susquehanna into the Finger Lakes along with New Englanders from Connecticut and Long Island. Villages at the ends of the lakes grew quickly, such as Skaneateles, Auburn and Ithaca, or near particular natural resources such as Syracuse near the salt springs of Onondaga Lake, or along the main transportation routes and turnpikes such as Utica and Rochester along the Genesee Road, later chartered as the Seneca Turnpike.

Towns sprang up as thousands moved west, each with hopes of becoming the major center of economic and social activity. The cultural landscape of post-Revolution America is visible in the use of classical names for new settlements, the Classical Revival style in the architecture of private and public buildings, and the rapid expansion of the use of the rectangular grid in town planning and transportation networks. Plotting and interpreting the spatial and temporal patterning of "the peculiarly American practice of memorializing the ancient world of Greece and Rome in the place-names of the United States" offers, according to one geographer, "persuasive evidence pleading the American's image of himself as the reincarnated Athenian or Roman."[11] The spatial extent and pattern of classical toponyms indicates the time frame of settlement from the 1790s to the 1820s westward along the Seneca Turnpike, through the Finger Lakes region towards the Ohio Valley. For example in the area surrounding Seneca Lake are towns and villages named Romulus and Ulysses; both of these municipalities have passed resolutions opposing the plans of FLLPG to establish a gas storage facility on the shores of Seneca Lake. Mingled with Indian place-names, such as of the lakes themselves, the

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[9] "The Clinton-Sullivan Campaign of 1779," http://www.nps.gov/fost/historyculture/the-western-expedition-against-the-six-nations-1779.htm.

[10] D.W. Meinig, "Three and a Half Centuries of Change: Geography of Expansion, 1785-1855," in *Geography of New York State*, ed. John H. Thompson (Syracuse, NY: Syracuse University Press, 1966, 1977), p. 140.

[11] Wilbur Zelinsky, "Classical Town Names in the United States," in Wilbur Zelinsky, *Exploring the Beloved Country* (Iowa City: University of Iowa Press, 1994), p. 296.

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cultural landscape is a remarkably American creation and forms a framework for regional community character.

2.3. Economic History

2.3.1. Transportation

The organization of a transportation network was crucial to the development of the local and regional economies. Routes to, through and within the region began along well-worn Indian paths, then turnpikes and wagon roads. In 1825 the Erie Canal opened along the route of the Mohawk River and the Seneca Turnpike from Albany to Buffalo and the Great Lakes to bring in the era of greatest growth. As presented by the U. S. National Park Service at the visitor center for the Erie Canalway National Heritage Corridor, the Erie Canal "made New York the Empire State and confirmed New York City's status as the young nation's most prosperous and vibrant seaport."[12]

Feeder canals extended the spatial reach of the Erie Canal; for example, the Cayuga & Seneca Canal was chartered in 1815 and completed in 1828 shortly after the Erie Canal opened. As a link to both lakes the Cayuga & Seneca Canal promoted the export of agricultural products and timber from the farms around both lakes. Steamboats plied lakes Seneca and Cayuga throughout the ante-bellum period. The Seneca Lake Steamboat Company was chartered in 1825 and established a route from Geneva to Watkins Glen after 1828. Views of the picturesque and beautiful scenery of Lake Seneca became important assets to the emerging tourism economy. As a guidebook for tourists traveling to the natural wonder of the Glen outside the village of Watkins in 1879 enthused, travel to the village "is also reached by a line of steamers, running from Geneva to Watkins, touching all the parts along the lake. This is a delightful way of reaching the Glen from the north, as the scenery of this beautiful lake is equal to anything on the Continent."[13] Lake steamboats traveling north from Watkins carried freight, including coal, and passengers to link with the canals, and eventually the east-west rail lines.

Railroads followed in the mid-nineteenth century and by the end of the century New York had captured the economy of the mid-west through its links to Chicago. The New York Central followed the canal route and served the towns at the north ends of the lakes while the New York & Erie opened up the Southern Tier with service to the towns at the south end of Seneca and Cayuga lakes. Other trunk lines connected the two major east-west lines, such as the Fall Brook System which consolidated a number of small railways to bring coal from western Pennsylvania coal fields north through Corning and Watkins Glen to Geneva and Lyons. At the end of the century the Fall Brook Railway Company was renamed the Geneva, Corning and Southern Railroad, which consolidated into the reorganized New York Central system in 1914.[14] Currently known as the

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[12] "Erie Canalway National Heritage Corridor," brochure (Washington, DC: National Park Service, n.d.), http://www.nps.gov/erie/planyourvisit/upload/ERCA_unigrid.pdf.
[13] A. J. Michener, *Descriptive Guidebook of the Watkins Glen and its Romantic Surroundings, 1879*, (Philadelphia: Culbertson & Bache, 1879) p. 10.
[14] "Introduction," http://fallbrookrailway.com/.

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Norfolk and Southern Railroad, its tracks run along the western shore of Seneca Lake and are proposed for transportation of butane to Reading for storage and from there to refineries on the urban East Coast. Salt mining had begun around Lake Seneca in the 1860s.[15] Relicts of this industry still operate on the southern and southwestern shore, but they are inconsistent with the efforts of the Seneca Lake to develop its recreational and tourist economy, and the expanded industrial use of the area will damage the new economic and cultural landscape.

Railroads and steamboats not only carried freight but also passengers, particularly tourists to visit the lakes, waterfalls, glens and gorges in the area surrounding Seneca and Cayuga lakes. Early settlement at the south end of Lake Seneca began in 1788, only nine years after the Sullivan expedition, with the foundation of the village attributed to Dr. Samuel Watkins in 1828. His name of Salubria for its moderate climate was later changed to Jefferson upon its incorporation in 1842 and subsequently renamed Watkins a year after his death in 1851.[16]

2.3.2. Tourism

Over the next few decades the Village of Watkins prospered and by 1863 became a noted summer resort with the opening of Glen Mountain House. According to an 1879 guidebook, during that first year "from 8,000 to 10,000 persons visited the Glen during the balance of the season; and their number has continued to increase."[17]

Tourism continued in the decades after the Civil War as guidebooks dramatized the attractions of the gorge with classic romantic prose: "There is not to be found a more strikingly wonderful and beautiful freak of nature than Watkins Glen. Differing in all its characteristics, from any other remarkable locality of natural interest, it has as distinct an individuality as Mount Blanc, the Falls of Niagara, or the Mammoth Cave."[18] By 1916 the glen was incorporated into a state park adding an important boost to 20th century recreational tourism in the local and regional economy.

In the 20th century, tourists sought not only the romantic pleasures of the picturesque, including the sublime views associated with grand vistas or the intimate and mysterious passageways of dark wilderness footpaths or tumbling streams in gorges and glens. Rather, recreational activity focused on outdoor activities such as boating, fishing, and swimming in the cold clear lakes as well as camping and traveling through the more pastoral and bucolic landscape in the countryside. Special events drew visitors as well, such as county and state agricultural fairs, automobile races at Watkins Glen raceway, and wine tasting at the lakes many wineries. The culture of tourism was changing and the economic landscape adapted; small family-owned businesses emerged in the form of

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[15] John Corbett, *The Lake Country: An Annal of Olden Days in Central New York* (Rochester, NY: Democrat and Chronicle Print, 1898), p. 105.
[16] Brian Altonen, "1778 to 1795 – The 'First Settlers' of Salubria," http://brianaltonenmph.com/6-history-of-medicine-and-pharmacy/hudson-valley-medical-history/1795-1815-biographies/john-w-watkins-natural-products-land-use-and-health/1778-to-1795-the-first-settlers/.
[17] Michener, *Descriptive Guidebook*, pp. 5-6.
[18] Michener, *Descriptive Guidebook*, p. 9.

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B&Bs and direct-sales wineries associated with independently-owned vineyards, as boat tours on Seneca lake offered scenic views of the lake and cultivated landscape on its shores. The economic landscape of the 21st century was of a rural, agricultural, terraced vineyard and small town cultural landscape. Remaining resource extraction or other industrial activities were vestiges of the past, rejected in favor of a more sustainable future.

2.3.3. Vineyards and Wineries

The history of grape and wine production goes back to the earliest French Jesuit Catholic missionaries in the 17th century. According to a letter dated 1668 from Father Jacques Bruyas of Mission St. Francis Xavier, "There are also vines, which bear tolerably good grapes, from which our fathers formerly made wine for the mass. I believe that, if they were pruned two years in succession, the grapes would be as good as those of France."[19] A century and a half later sacramental wine would also be made from local grapes. As settlement progressed after the Revolutionary War, churches sprung up next to taverns and general stores in villages and towns among the lakes. The Rev. William Bostwick arrived in Hammondsport at the head of Keuka Lake in 1829 as rector of the village's first church. He was an amateur horticulturist "with a secular appreciation for wine and a visionary interest in hybridization" who planted *Vitis labrusca* (Catawba and Isabella) in his rectory garden.[20] He distributed cuttings to parishioners and soon offshoots from his vineyards spread throughout the region. Others soon followed, including German immigrants who attempted to grow European varieties with varying degrees of success. By the 1850s, terracing of the steep slopes overlooking lakes Keuka and Canandaigua began to change the look of the land. It would become the characteristic cultural landscape of the Finger Lakes wine district.

Vineyards were typically small, no more than a few acres in size. This pattern, too, would continue, as both consolidations and various corporate entities purchased their grapes from small individual vineyards. Commercial viticulture officially began in 1862, when the Hammondsport and Pleasant Valley Wine Companies were founded. The Pleasant Valley Wine Company was the collective venture of 13 grape-growing stockholders, the largest of whom began with 30,000 vine cuttings while the smallest grower had but one acre of vines. His "little vineyard climbed the slope behind property he deeded to the company for construction of a wine cellar."[21] Two more companies were formed three years later. The region became famous for its sparkling wines, with the Pleasant Valley Wine Company winning European awards in 1867 and 1873. These successes spurred growth in commercial plantings in the area, and by the end of the century there was 25,000 acres (10,117 ha) planted throughout the region.[22]

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[19] Richard Figiel, *Circle of Vines: The Story of New York Wine* (Albany: State University of New York Press, 2014), p. 30.
[20] Figiel, *Circle of Vines*, pp. 32-3.
[21] Figiel, *Circle of Vines*, p. 39.
[22] Wikipedia, "Finger Lakes AVA," http://en.wikipedia.org/wiki/Finger_Lakes_AVA.

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In 1866, the western shores of Seneca Lake became home to its first winery, the Seneca Lake Grape Wine Company. The winery planted 100 acres (0.4 sq. km.) of grapes. At the time, it was the largest vineyard in the state. By 1869 they were producing 14,000 US gallons of Seneca Lake's first commercial wine. Then, in 1882, New York State opened its Agricultural Experiment Station in Geneva, New York, located at the north end of Seneca Lake. Its grape breeding and research programs helped to establish Seneca Lake as a prominent player in the grape growing industry. By 1900 there were over 20,000 acres (80 sq. km.) of vineyards throughout the Finger Lakes and more than 50 wineries.[23]

A few large producers, such as Taylor and Wiemers, established headquarters in the area, although their bottled wines often contained primarily California wine rather than locally produced vintages. Most grapes harvested in the Finger Lakes region went to the fresh fruit market as Temperance advocates pressured the state to direct crop research at the experiment station in Geneva towards fruit production. The passage of the 18th Amendment to the US Constitution in 1919 began the Prohibition era that ended only in 1932 with its repeal by the 21st Amendment. Only the largest wineries were able to survive by making grape juice and sacramental wines. Also, jellies and other products were made by the Welch brothers who first bottled grape juice at a plant in Watkins Glen from vineyards around Seneca Lake. However, the Welch Company soon moved west to Chautauqua County. Sweet Kosher wines were also produced during Prohibition in the north and west on the Lake Ontario plain. When Prohibition was repealed, the wine and grape growing industry remained a shadow of its former self. The Seneca Lake Grape Wine Company had folded, and area farmers struggled to survive in a much reduced New York State market.

Most wines made from American grape varieties were sweet. It was not until the post-WWII period that individual winemakers began to grow French hybrids and varietals successful and profitably.

A major change in Finger Lakes viticulture occurred when two young European viticultural pioneers named Charles Fournier and Dr. Konstantin Frank began to research and experiment with vinifera grapes in the Finger Lakes region. Frank, a Ukrainian immigrant with a PhD in Plant Science, came to work for Cornell University Geneva Experiment station in 1951. Commercial growers and researchers at the Geneva Experiment Station were convinced that European *Vitas vinifera* varietals could not grow in the cold Finger Lakes climate.[24] After years of planting *Vitas vinifera* in the colder climate of the Ukraine, Dr. Frank was sure that it could be grown in the Finger Lakes if grafted onto the proper, cold-hardy native rootstock. He proved this in 1962 when he started Vinifera Wine Cellars, in Hammondsport. Dr. Frank successfully grew and produced wine from *Vitas vinifera* grapes such as Riesling, Chardonnay, Pinot noir, Gewurtztraminer, and Cabernet Sauvignon, grafted onto native rootstock.

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[23] Wikipedia, "Seneca Lake AVA," http://en.wikipedia.org/wiki/Seneca_Lake_AVA.
[24] *Id.* (citing James L. Newman, "Vines, Wines, and Regional Identity in the Finger Lakes Region," *Geographical Review*, vol. 76, no. 3 (1986), pp. 301-316).

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During the same period, Walter S. Taylor, grandson of the founder of the Taylor Wine Company (now a division of Coca-Cola, a publicly held corporation) bought back the Taylor family homestead on Bully Hill outside of Hammondsport to start his own independent winery. He planted various French hybrids and varietals, and bottled and sold his wine with distinctive labels promoting their New York State origin. Both Taylor and Frank campaigned against "wine factories" such as the Taylor Corporation that combined cheap California wines with sweet New York grape juice. They became the most prominent faces of the New York State wine industry as it changed from commercial production of sweet wines to varietals that became favorites of the emerging wine lovers of the late 20th century and 21st century.

At Seneca Lake, Fournier and Frank's initial research had found the most favorable microclimates conducive for growing vinifera grapes. In the early 1970s, Fournier planted 20 acres (81,000 sq. m.) of vinifera on the east side of Seneca Lake. At the same time, a German native named Hermann Wiemer bought and planted 140 acres (0.6 sq. km.) of vinifera on the west side of Seneca Lake. The success of these two vineyards along with the establishment of a wine research program at the New York State Agricultural Experiment Station in Geneva helped to start the revitalization of Seneca Lake in the grape growing and wine producing industry.[25]

Wiemer promoted growing Riesling as the answer to the viticulture problems with the region's cool climate. As the author of a history of winemaking in the Finger Lakes commented to the food editor of the New York Times, "[a]t the time, [Wiemer's] dogmatic view that Riesling was the answer looked foolhardy… People were slow to follow, but 15 to 20 years later they realized he was right."[26] The 21st century Riesling wines have become the premier quality white wine of the region.

Plantings of *Vitas vinifera* varieties spread throughout the region along with grafting of French hybrids, reinvigorating the Finger Lakes wine region's growth and popularity. Passage of the New York State Small Farm Winery Act in 1976 aided the spread of both French-American hybrids and *vinifera*. Lessening the restrictive licensing on wine-making during the Prohibition era, the "Farm Wineries and Cider Mills Low-Cost License Law," lowered taxes and licensing fees and encouraged a new scale of operations in the wine industry, "an eastern parallel to the so-called boutique wineries in California. In 1976, there were 19 wineries when the Farm Winery law was passed.[27] By 1985, 26 wineries of this sort, each featuring hybrids or *vinifera*, had opened in the region."[28]

As of 2008, there were nearly one hundred wineries in operation in the Finger Lakes AVA, most of which are in the counties of Seneca (33), Yates (36), Cayuga (10) and Schuyler (25). In 1985, along Seneca Lake they included: Four Chimneys; Hermann J. Wiemer; Glenora; and Giasi on the west bank, and Wagner; Poplar Ridge; Hazlitt

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[25] Wikipedia, "Seneca Lake AVA," http://en.wikipedia.org/wiki/Seneca_Lake_AVA.
[26] Eric Asimov, "Deep Lakes, Icy Climate, Great Wine," *The New York Times* (October 11, 2011).
[27] Figiel, *Circle of Vines*, p. 159.
[28] Newman, "Vines, Wines, and Regional Identity," p. 313.

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"1852"; Wickham; and Rolling on the east. By 2014 these nine had grown to over thirty named vineyards or wineries, and the regional wines had received its own Seneca Lake Appellation.

Quality of the region's wines is rapidly gaining. In 2013 *Wine Spectator*, one of the world's leading and most quoted publications on the subject, conducted its first official tasting and analysis of Finger Lakes wines.[29] Of 325 Finger Lakes wines reviewed, two-thirds received 85 points or higher on the magazine's 100-point scale; 28 received a rating of 90 or better.

The region is also drawing nationally and internationally recognized winemakers. Vineyards that formerly grew Concord grapes for grape juice now grow vinifera stock and produce medal-winning wines by winemakers such as Johannes Reinhardt, originally from Germany, and Peter Bell, originally from New Zealand.[30] However, the possibility that the FLLPG project may be built has concerned some significant winemakers from further investments. In a recent letter to Governor Cuomo, Paul Hobbs, of the Sonoma Valley in California, and Johannes Selbach, of Germany's Mosel Valley, asked the governor to reject the gas-storage plan and to "let the wine industry reach its full potential in Watkins Glen and the Finger Lakes." They also said "they were considering holding off further investment in their vineyard – and a handsome visitors center – 'until the question of gas storage expansion is resolved.'"[31]

Tourism to the Finger Lakes region and to Seneca Lake in particular grew progressively in the latter half of the 20th century. The Seneca Lake Wine Trail was founded in 1986 in response to the increase in visitation to the Seneca Lake region and as a coordinated approach to support the economic importance of the wine industry. In 2014, the wine trail links over thirty vineyards and wineries that bottle and sell wines directly to customers that "principally [use] grapes harvested with the federally recognized Seneca Lake Appellation."[32]

Constructing Community Character

3. Elements of Community Character

Communities can express aspects of their historical and cultural identity with observable features in the landscape. A combination of such elements can provide a

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[29] Don Cazentre, "Finger Lakes wines win long-awaited recognition, praise from Wine Spectator," *Syracuse Post-Standard* (February 4, 2013) http://blog.syracuse.com/cny/2013/02/finger_lakes_wines_win_long-awaited_recognition_praise_from_wine_spectator.html; listing in *Wine Spectator* (January 31-February 28, 2013 issue) http://www.winespectator.com/magazine/show?id=47893.

[30] "Reinhardt and Bell on Top Winemaker List at *Vineyard & Winery Management* magazine," *Finger Lakes Wine Gazette* (Winter 2015), p. 8.

[31] Jesse McKinley, "What Pairs Well With a Finger Lakes White? Not Propane, Vintners Say," *The New York Times* (December 26, 2014), p. A25.

[32] "Seneca Wine Trail Guide 2014" http://www.senecalakewine.com/images/stories/brochures/SWLT_2014-LowResForWeb.pdf.

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framework useful in assessing community character, especially if these assets have been recognized and officially designated for their value to the community. For the Seneca Lake community, the following have been officially recognized:

3.1 Scenic Views and Aesthetic Resources

3.2 Historic Sites and Districts

3.3 Scenic Roads and Transportation Corridors

3.4 Parks, Open Space, and Land Trusts

3.5 American Viticultural Areas

An analysis of these officially recognized cultural landscape assets indicates that aesthetic values persist through history in the region's creation of its identity. Those values are preserved and fostered in the tourist economy of the 21st C through efforts in:

3.6 Wine Tourism

3.7 Agricultural Tourism

3.8 Recreational Tourism

3.9 Comprehensive Planning

The analysis below discusses the community character of the Finger Lakes region with primary focus on Seneca Lake and its surrounding area with regard to the nine inter-related historic, cultural, and economic components listed above.

3.1. Scenic Views and Aesthetic Resources

The Finger Lakes region as a whole and the landscape in close proximity to and including Seneca Lake have been recognized for over a century for its beauty, natural wonders and cultural historical and aesthetic resources. As described by the Seneca Lake Scenic Byway Project Team and the Hector Community Association citizen's committee in their proposal to establish the Seneca Lake Scenic Byway, and reviewed, accepted and thereby designated by the state, the landscapes of Schuyler and Seneca counties contain views of "unsurpassed natural beauty." There are "incredible views of rolling vineyards, orchards, and breath taking vistas of the Hector and Lodi rural community on Seneca Lake" and the lake itself.[33] The natural landscape of waterfalls, gorges, and lakes, and the cultural landscape of vineyards, orchards, fields, dwellings, farms and associated farm structures, fences, cemeteries, and communities and their small commercial districts offer scenes of rural landscape in harmony with its natural and cultural features.

[33] Seneca Lake Scenic Byway Project Team, *Seneca Lake Scenic Byway Nomination Proposal*, rev., 2010, p. 5.

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3.1.1. Wineries

Views of the wineries and their carefully tended vineyards are quite exotic, reminiscent of the terraced vineyards in France and Italy. Guidebooks from the 19th century to the 21st century comment on this rather romantic association, with hints as to a landscape character of multi-cultural history and economic significance.[34] Many of the wineries advertise the scenic vistas from and towards Seneca Lake to promote tours and tastings at their vineyard. Visitors travel to wineries on roads with expansive views of the lake and the patterned rows of grapes that offer colorful displays from the yellow-green leaves of spring through the dark green of summer to the deep purples of fall harvest, set in a landscape of autumnal reds and rusts. These viewscapes have been captured in art and photographs and on post cards, travel brochures and yearly calendars for over a century.

3.1.2. Rural Recreational Landscape

The community character of this landscape, from Reading on the west bank of Seneca Lake to Hector and Lodi on the east bank and Watkins Glen at the south end of the lake is both enjoyed and advanced by these local communities, county and state through efforts to promote recreational and heritage tourism. For example, the creation of public parks, camping sites, hiking paths, boat launches significantly encourages activities including fishing, boating, touring and picnicking.

3.1.3. Natural Landscape

Natural features such as lakes, gorge, glens, and waterfalls are equally picturesque. Nineteenth-century artists and tourists with "pencil" and camera sought out such natural wonders throughout New York State, including iconic Niagara Falls,

View from Hector Falls below Route 414, looking west (2008)

[34] Michener, *Descriptive Guidebook*.

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Kaaterskill Falls in the Catskill Mountains, and the wilderness in the Adirondacks.[35] Scenes and views of America's natural landscape became the source of the new nation's identity. Seneca Lake and the Glen at Watkins would do the same for Schuyler County and remain as foundational features in the 21st century, combined with photographic views of picturesque waterfalls and vistas of the rural landscape. For example, Hector Falls in the village of Burdett, Town of Hector, is a 165-foot series of vertical plunges and cascades on Route 414, approximately three miles north of Watkins Glen, on the east bank, with excellent views of Lake Seneca 150 feet below and its western shore.

3.2. Historic Sites and Districts

3.2.1 Watkins Glen

Sites of historic significance reflect the community character of local and regional communities. In Schuyler County, the Watkins Glen Commercial Historic District focuses on the establishment of the urban center of Watkins and Watkins Glen during the heyday of tourist explorations of the picturesque landscape promoted by the Hudson River School of artists in the Hudson River Valley. Hotels and Mountain Houses were established that brought visitors to the natural and cultural landscapes that were promoted.[36] The promotion of the glen and gorges outside of the village of Watkins brought hundreds and thousands of tourists to the area, beginning what would become the foundation for heritage tourism in the 21st century.[37]

The village of Watkins Glen contains a number of sites listed on the National Register of Historic Places.[38] The *First Baptist Church in Watkins Glen*, 1888-89, a classic eclectic 19th C building with elements of Romanesque, Gothic Revival and Eastlake architectural elements; the *A. F. Chapman House* (1870-73 Gothic Revival; modified 1888-94 Queen Anne Victorian); *Schuyler County Courthouse Complex* (1855); *United States Post Office* (1934-35, Colonial Revival); *Watkins Glen Commercial Historic District*, a cohesive group of 33 buildings dating from 1844 to 1939 of mostly Italianate and Commercial styles, including Second Empire, Romanesque, Colonial Revival and Classical Revival, including theaters, a hotel and opera house; and *Watkins Glen Grand Prix Course*, 1948-52, with its original 6.6 miles (10. 6 km) course that passed through the village, starting and finishing in front of the historic Schuyler County Courthouse.[39]

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[35] Harvey K. Flad, "Following 'the pleasant paths of Taste": The Traveler's Eye and New World Landscapes," in *Humanizing Landscapes: Geography, Culture and the Magoon Collection*, exhibit catalogue (Poughkeepsie, NY: Vassar College Frances Lehman Loeb Art Center, 2000), pp. 69-102.
[36] Charles R. Mitchell and Kirk W. House, *Around Watkins Glen* (Charleston, SC: Arcadia, 2006), pp. 49-58; for a review of mountain house resorts in the Hudson Valley, see Harvey K. Flad, "The Parlor in the Wilderness: Domesticating America's First Iconic Landscape," *Geographical Review*, vol. 99, no. 3 (2009). Pp. 356-376; and Harvey K. Flad, "Scenes 'most impressive and delightful': Nineteenth-century Artists in the Shawangunks," *The Hudson River Valley Review*, vol. 31, no. 1 (2014), pp. 95-120.
[37] Watkins Glen Area Chamber of Commerce and Schuyler County Historical Society.
[38] *Village of Watkins Glen Comprehensive Plan*, "Watkins Glen Road Map," (Albany, NY: Laberge Group, 2012), pp. 19-21.
[39] Mitchell and House, *Around Watkins Glen*; and *National Register of Historic Places* nomination forms.

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All physical elements of the Watkins Glen streetscape create visual coherence to the cultural-historical landscape.[40] They help to define the village's community character and are place markers of memory for all inhabitants of the region.

3.2.2 Seneca and Schuyler County Historic Markers

The historic landscape becomes visible through signs and maps that locate sites and routes that give substance to community identity. For example, Seneca County has memorialized the route of the Clinton-Sullivan Campaign and the sites of a number of former Seneca Indian villages. Scenic heritage tours have been developed along the Seneca Lake Scenic Byway that take visitors past historic sites of significance that have already received New York State designation with state historic markers in place. The State University of New York College of Environmental Science and Forestry study in 1997 indicated the following New York State Historic Markers: Hector #1 Railroad Tunnel 1892 on Satterly Hill Road; #3 Ciprich House built 1780; #4 Sullivan-Clinton Military Route 1770; #5 Presbyterian Church 1827; #6 Methodist Church 1842; #7 Baptist Church and Grange Hall 1836, Tug Hollow Road; #8 CCC Camp 1930s, west of Gates Farm; and #9 Willow Grove Mills 1820, adjoins the Village Park.

3.2.3 Montour Falls

Historic preservation is an important tool in urban and small town revitalization. Grants from the New York State Main Street Program to the Schuyler County Partnership for Economic Development (SCOPED) were instrumental in the restoration of 1854 Montour House as a mixed use project with commercial shops on the first floor and residential units above. The preservation and reuse of historic assets are place-makers for community character.

3.2.4 Geneva

Geneva's position at the north end of Seneca Lake on the Genesee Road, the major east-west route for travelers in the 18th and 19th centuries, offers visitors insights into the nation's growth and expansion.[41] Excellent examples of Greek and Italianate Revival architecture represent the mid-nineteenth century wealth associated with population movement westward to the Genesee country and the Ohio Valley and the construction of the Cayuga & Seneca Canal in 1818 which connected Seneca Lake and Cayuga Lake to the Erie Canal allowing farmers to ship their agricultural produce to larger markets and resulting in the doubling of the village's population between 1820 and 1840.[42]

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[40] Alita Trouble Howard, *A Landscape Look at Watkins Glen*, n.d. http://www.paduaprep.com/Images/PDFs/LandscapesLook.pdf; see also John R. Stilgoe, *Common Landscape in America, 1580-1845* (New Haven: Yale University Press, 1982).
[41] Meinig, "Three and a Half Centuries of Change," pp. 143-51.
[42] City of Geneva, *City of Geneva Waterfront Infrastructure Feasibility Study* (Parsons Brinckerhoff, Inc., 2012), p. 7.

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3.2.5 Seneca Falls

Landmarks of social history significantly alter and constitute the cultural landscape of a place or region. Similar to historic markers and plaques, memorials and museums identify important events or individuals that have changed the local, regional or national culture. *The Women's Rights National Historic Park* in Seneca Falls on the Cayuga-Seneca Canal identifies a specific place and group of individuals who were vanguards in the Suffragist Movement of the 19th century. The park was established in 1980 and consists of 6.8 acres in Seneca Falls and adjoining village of Waterloo; it contains four major historic properties, including the Elizabeth Cady Stanton House that now serves as a museum that contains artifacts and materials related to the Seneca Fall Convention of 1848.[43] A *Votes for Women History Trail* begins at the park and extends west across Upstate New York linking various sites related to women's efforts to gain the right to vote. The museum and park are tourist magnets that bring thousands of visitors to the Seneca Lake area, many of whom also visit Geneva's historic sites and travel the length of Seneca Lake to Watkins Glen by boat or auto, viewing the scenery along the lake shore and the vineyards and rural landscape of Seneca county adding to the region's tourism economy. Many will travel the scenic roads designated by the state to encourage tourist visitation with the area's aesthetic resources.

3.2.6 Cayuga-Seneca Canal

The *Erie Canalway National Heritage Corridor* was established in 2000. National heritage corridors are special places designated by Congress. As described by the National Park Service:

> Each is distinctive, selected because they illustrate significant chapters in the American experience. Corridor features and stories remind us of the connections between geography and human events that shaped the course of American history.
>
> National heritage corridors promote cooperative preservation and community renewal efforts through joint efforts by governments, organizations, businesses, and individuals…
>
> National heritage corridors are more than monuments to the past, they represent living traditions. Residents are proud of their heritage and many have worked for years to preserve the *distinctive character of their communities*.[44]

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[43] National Park Service, *Women's Rights National Historic Park* brochure, n.d.
[44] National Park Service, *Erie Canalway* brochure, n.d. (emphasis added) http://www.nps.gov/erie/planyourvisit/upload/ERCA_unigrid.pdf.

Over 30 municipalities in the four counties bordering Seneca Lake are incorporated into the Heritage Corridor. They include the 13 municipalities of Reading, Hector and Dix and village of Watkins Falls in Schuyler County; towns of Fayette, Lodi, Ovid, Romulus, Seneca Falls and Waterloo in Seneca County; city and town of Geneva in Ontario County; and town of Starkey in Yates County. The majority of these towns and villages have passed resolutions objecting to locating the FLLPG facility on the western shore of the lake.

In 2014 the entire *New York State Barge Canal Historic District* that incorporates the Corridor was placed on the National Register of Historic Places.[45] The National Historic District includes the four branches of the canal system that was first built in the 1820s: the Erie, Champlain, Oswego, and Cayuga-Seneca canals. It covers 450 miles over 18 counties, including the Finger Lakes counties of Seneca, Schuyler, Ontario, and Yates, and encompasses 23,000 acres.

3.3 Scenic Roads and Transportation Corridors

The New York State Scenic Byways program was created in 1992 by the State Legislature. State Scenic Byways are transportation corridors that "are of particular statewide interest. They are representative of a region's *scenic, recreational, cultural, natural, historic or archaeological significance*."[46]

Overlooking the Project site on the western shore of Lake Seneca, the *Seneca Lake Scenic Byway* "presents," according to the state description of the route:

> a *scenic paradise* capped by the topography including waterfalls, caverns and gorges all left by the Last Ice Age. Seneca Lake presents travelers with recreational opportunities such as boating, canoeing, fishing and swimming…The area presents a history as visitors can visit landmarks that represent the interaction between Native Americans and European settlers. Rich bounties of agricultural products from wine to fruit and vegetables, are produced in the area.[47]

A project team of 13 citizens that included members of local and municipal town and village boards of the Hector and Lodi communities nominated the Byway in the spring of 2005. The state assisted with advice from the Department of Environmental Conservation and officially designated the route as a State Scenic Road. After the proposal was accepted by the state the 501(c)(3) "Seneca Lake Byway, Inc." has

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[45] New York State Barge Canal Historic District website, http://www.eriecanalway.org/get-involved_hist-pres_NRupdate.htm.
[46] New York State Scenic Byways, "NYS Scenic Byways Program," (http://www.dot.my.gov/display/scenic-byways/programs) (emphasis added).
[47] New York State Scenic Byways, "Seneca lake, Hector and Lodi Scenic Byway," (https://www.dot.ny.gov/display/programs/scenic-bywaus/seneca) (emphasis added).

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continued to coordinate plans for the Byway. As described in the Scenic Byway proposal:

> A scenic byway corridor is managed to protect its *outstanding character* and to encourage economic development through tourism and recreation.
>
> Located in the Finger Lakes Region of Central New York State, scenic Seneca Lake and specifically the Towns of Hector and Lodi, have long been sites of interest for visitors and residents. Rich in natural landscapes, recreational opportunities, and diverse history, the proposed NYS Route 414 Seneca Lake Scenic Byway provides visitors and residents 19 miles of unsurpassed natural beauty. This corridor provides incredible views of rolling vineyards, orchards, and breathtaking vistas of the Hector and Lodi rural community on Seneca Lake, while also highlighting our rich history and traditions predating the arrivals of Europeans to our area."[48]

As an economic development project, the local citizen authors of the Seneca Lake Byway Proposal describe many features of their local landscape that constitute their perception of community character. In their own words they identify the cultural landscape elements as opportunities for visitors to appreciate, such as views of the lake and the rural farms and orchards, and the numerous recreational activities available along the corridor.

> The NYS Route 414 Seneca Lake Scenic Byway is the north-south corridor through the Towns of Hector and Lodi, that features overlooks of the shores of Seneca Lake, rural and woodland landscapes and numerous intrinsic recreational, natural, tourist and cultural attractions. This thoroughfare provides visitors an opportunity to observe the glacial formation characteristic of Seneca Lake, visit landmarks of historic significance, explore the Finger Lakes National Forest, experience local wineries, farms and trades people, and enjoy the extensive recreational activities associated with Seneca Lake…
>
> The Byway offers panoramic views of Seneca Lake, the area's agricultural fields, rolling woodlands, vineyards and orchards. In addition to scenes of Seneca Lake, the rural roadside includes views of waterfalls, common and rare

[48] Seneca Lake Scenic Byway Project Team, *Seneca Lake Scenic Byway Nomination Proposal*, rev., 2010, p. 5.

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> indigenous plants, and many sites of cultural and historical significance. …
>
> Visitors and residents appreciate the agricultural beauty of the region. Wineries along Seneca Lake offer wine-tasting tours, and sell bottles of their locally grown vintages…roadside farm stands and Bed and Breakfast's *(sic)* offer visitors seasonal favorites. …
>
> Recreation seekers have long enjoyed the clean air, natural landscape, and wide variety of opportunities in the Seneca Lake region. Boating and swimming are always popular lakefront activities…and world-class fishing for brown, lake and rainbow trout, salmon, pike and numerous other game fish within Seneca Lake. At the south end of the Byway is access to Queen Catherine's Marsh bird sanctuary providing ideal opportunities for bird watchers. Choices of golfing, cross-country skiing, horseback riding, bicycling, and hiking are also available through federal, municipal or private facilities.[49]

The creation of the State-designated Scenic Byway is a result of a local citizens' coalition from Hector and Lodi, towns in Schuyler County, including the West Hector Community Association and the Hector Scenic Byway Project Team and Town of Lodi Board Members as the Seneca Lake Scenic Byway Project Team, with eastern shorelines on Seneca Lake, overlooking the lake and scenic western shore as well as the proposed Project site. The formation of this multi-municipal project team is substantive proof of the organizing principal of community character in local decision-making and cultural understanding of sense of place.

3.4 Parks, Open Space, and Land Trusts

The Finger Lakes Land Trust and other local and regional designations for open space preservation identify the region's community character as rural, scenic and heritage-agri-cultural tourism related. Many municipalities have planned parks and recreational areas, such as the Clute municipal park, Waterfront Park & Marina, and the Watkins Glen State Park in Watkins Glen at the south end of Seneca Lake, the Lodi park in Lodi overlooking the western shore of the lake and the FLPPG project site, and the Finger Lakes National Forest in Hector and Lodi. The designated public lands of FLNF encompasses 16,032 acres and has over 30 miles of interconnecting trails that traverse gorges, ravines, pastures, and woodlands. These lands constitute a significant community land trust in the preservation of scenic and recreational values associated with the cultural landscape immediately surrounding Seneca Lake.

[49] *Id.* at 6.

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There are three state parks and several municipal parks in the area. They include Seneca Lake Park, Sampson State Park, and Watkins Glen Park, as well as Clute municipal park. The 16,036 acre Finger Lakes State Forest is within the Seneca Lake watershed as well.

3.5 American Viticulture Areas

AVAs are federally designated economic zones that have a substantive economic and social context that define them as a region. They are cultural landscapes that have, as their community character, an historical and contemporary economic and social coherence. The scenic landscape of vineyards and wineries of the Finger Lakes AVA and Seneca Lake AVA is a visual and perceptual image of the region's community character.

3.5.1 Finger Lakes AVA

Established in 1982 and amended 1987, the Finger Lakes AVA, according to the Federal designation, is an "American Viticultural Area located in Upstate New York, south of Lake Ontario. The Finger Lakes encompass eleven glacial lakes, but the area around Canandaigua, Keuka, Seneca, and Cayuga Lakes contain the vast majority of vineyard plantings in the AVA. Cayuga and Seneca Lakes each have their own American Viticultural Areas completely contained within the Finger Lakes AVA (Cayuga Lake AVA and Seneca Lake AVA). The Finger Lakes AVA includes 11,000 acres (4,4451 ha) of vineyards and is the *largest wine-producing region in New York State*."[50] In recognition of the significance of the local environmental and cultural conditions, wine produced in the Finger Lakes containing grapes grown in the AVA district were given their own Finger Lakes appellation in 2007.

The environmental conditions and historical development of vineyards in the Finger Lakes region are described on the Finger Lakes AVA website:

> The deep lakes in the region help to moderate the local microclimate. Stored heat is released from the deep lakes during the winter, keeping the local climate mild relative to surrounding areas and preventing early season frost. Most vineyards are planted on steep hillsides overlooking the lakes which helps provide the vines with good drainage, better sun exposure, and a reduced risk of frost….the soil in the region is generally deep, providing good drainage.[51]

3.5.2 Seneca Lake AVA

The federally designated Seneca Lake AVA includes portions of Ontario, Schuyler, Seneca and Yates counties, consisting of approximately 204,600 acres (82,799

[50] Wikipedia, "Finger Lakes AVA," http://en.wikipedia.org/wiki/Seneca_Lake_AVA (emphasis added).
[51] *Id.*

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ha) with a vineyard planted area of 3,700 acres (1,497 ha) and 44 wineries. Focused on the lands surrounding Seneca Lake, a "glacial lake about 35 miles (56km) long and up to 600 feet (180 m) deep. The lake does not freeze in winter, and acts as a giant heat storage unit for the vineyards surround the lake, extending the growing season. The most commercially important variety in the region is Riesling, although a wide variety of *Vitis vinifera* and French hybrid grapes are grown."[52] Wine produced in the Seneca Lake *terroire* can be sold with its officially designated Seneca Lake appellation.

Tourism Economy – 21st Century

In 2011, Governor Andrew Cuomo called upon all regional development councils and corporations to develop proposals to the state for funding specific projects that would be of region wide significance and substantially benefit its economic progress. Noting that "the proposed Seneca Lake industrial gas projects are inconsistent with local wineries," the Finger Lakes Regional Economic Council (REDC) emphasized that tourism contributes significantly to the regional economy. For example, in 2010 tourism generated nearly $60 million in Yates County and $43.3 million in Seneca County, which represented a 34 % increase from 2005. In Schuyler County, tourism accounted for 530 jobs, $1,936,000 in local taxes, and $10,781,000 in labor income.[53]

3.6 Wine Tourism

The Finger Lakes REDC's strategic plan also "recognizes the importance of the area's agricultural and tourism industries. The plan notes that the Finger Lakes hosted more than 90 wineries in 2011, accounting for 85% of the State's wine production."[54] According to the New York Wine and Grape Foundation, there are now 108 wineries in the four counties surrounding Seneca Lake. They contribute substantially to the economic benefits from tourism through sales, tours, tasting, lodging and restaurants.

In 2014 Governor Cuomo recognized the Finger Lakes REDC's focus on the wine industry. He participated in the "Governor's Cup Wine tour" of the four counties surrounding Seneca Lake, where he earlier had called attention to the "great wines and the breathtaking places that produce them." During the tour the governor "pledged to support New York's position as a leader in wine production and boost tourism to grow the economy Upstate."[55] As the winner of the best in show, the 2014 Governors Cup was awarded to Chateau Lafayette Reneau 2013 Semi-Dry Riesling of Hector, Schuyler County, overlooking Lake Seneca.[56]

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[52] *Id.*
[53] Finger Lakes Regional Economic Council, "The Proposed Seneca Lake Industrial Gas Projects Are Inconsistent with Local Wineries and the Governor's Pledge to Support Tourism in the Region," (REDC, 2014).
[54] *Id.*
[55] *Id.* (quoting a press release released on day of 2014 Governor's Cup Wine Tour).
[56] Laura Nichols, "Chateau Lafayette Reneau wins Governors Cup," *Democrat and Chronicle* (August 14, 2014).

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3.6.1 Wine Industry

New York State's wine industry has grown to include 53 of the state's 62 counties, and according to figures from the New York Wine & Grape Foundation in 2013, has an estimated economic impact of $4.8 billion a year.[57] Since the state legislature's approval of the New York Winery Act in 1976, the 14 wineries in just 9 counties that year grew to 54 wineries in 14 counties ten years later, 125 wineries in 24 counties by 2000, and 416 wineries in 53 counties in 2013.[58] The number of vineyards and wineries in the Finger Lakes grew since 1976 to over 100 in 2014; 55 are within the local region, 34 of which are on the Seneca Lake Wine Trail.

The study by the New York Wine & Grape Foundation claimed "that wine is the ultimate value-added product and a major economic engine."[59] The study cited the following data: 25,000 full-time equivalent jobs; $1.4 billion in wages paid; 5.29 million touris visits; $401.5 in wine-related tourism expenditures; and $408 million in New York State and local taxes paid. The data show continued growth in the economic impact of the state's wine industry from $3.14 billion in 2005 and $3.75 billion in 2008 to the 2013 figure of $4.8 billion. Wine tourism has been a major part of the economic engine. According to *Wine Enthusiast* magazine, tourist visits increased over the past three decades from 340,000 to over 5 million in 2014.[60]

For 2015, *Wine Enthusiast* magazine has named the Finger Lakes as one of the world's top ten "wine travel" destinations, along with nine other destinations from Italy, New Zealand, France and Spain.[61] The identity of the Finger Lakes region as a wine tourism destination has clearly emerged.

In 2013, *Wine Spectator* listed more than 300 wines from 50 wineries through a tasting test; two thirds received 85 points or higher.[62] The Seneca Lake Wine Trail lists 34 participating wineries of which 16 submitted wines for tasting, 15 received 85 or higher on one or several of their wines and 5 of these also received ratings of 90 or better on one or more of their wines.

3.6.2 Seneca Lake Wine Trail

The Seneca Lake Wine Trail was established in 1986 and currently lists 34 wineries and vineyards, a distillery, two breweries and a meadery as participating businesses. The businesses collaborate to market their products and

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[57] Don Cazentre, "How the wine industry spread across New York state and grew into a $4.8 billion business," *Syracuse Post-Standard* (March 31, 2014).
[58] *Id.*
[59] *Id.*
[60] *Wine Enthusiast Magazine*, "Wine Enthusiast's 2014 Wine Star Award Winners: Wine Region"
[61] Don Cazentre, "Finger Lakes named one of the world's top 'wine travel' destinations in new report," *Syracuse Post-Standard* (January 1, 2015).
[62] Listing in *Wine Spectator* (January 31-February 28, 2013 issue) http://www.winespectator.com/magazine/show?id=47893.

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> see themselves as a *community of winemakers* who come together at local eateries such as the Stonecat Café to bring the austere beauty of Seneca Lake to the glass. Each vineyard brings its own personality and flavors to the lake's edge, making for a comprehensive tourist destination that features events throughout the year.[63]

A growing interest in the culinary arts is increasing tourism. As a visitor to the area described in a 2014 travel article in *The New York Times*, "We ate (and drank still more cider) on the deck at Stone Cat, surrounded by weeping willows and a lush garden above Seneca Lake."[64] Moreover, "Stonecat Café has a good reason to focus on homegrown wines. It is located on the Seneca Lake Wine Trail, which holds 32 wineries on the deepest of the Finger Lakes, about a four-hour drive from Central Jersey, making it a sound pick for a long weekend getaway, especially in autumn due to the changing foliage. Each winery is located at a three-minute drive or less from the next alongside various roads running next to Seneca Lake."[65]

3.7 Agricultural Tourism

Agriculture has a significant impact on the tourism industry and economy of Schuyler County. Tourists come to visit u-pick farms and wineries, harvest organic foods on community supported agriculture (CSA) farms, and enjoy farm-to-table eating at local restaurants. An analysis reported in the county's comprehensive plan indicates that it

> produces much higher economic multipliers than any other sector of the Schuyler County economy, and as a result comprises a large portion of the County's economy. The three components of agriculture [farms, forestry and vineyards] contribute over $100 million to the local economy. … Agriculture has helped shape Schuyler County into what it has become today and is poised to continue to do so in the future.[66]

3.7.1 Cheese Trail

In addition to tourism associated with vineyards and wineries, visits to the area's farms, orchards and cheese factories help to maintain local farming and dairying. Thirteen family farms that make artisanal cheeses have organized a Finger Lakes Cheese Trail.[67] "Destination farms" are open for visits while the creameries and cheese companies also offer their organic products at the Finger Lakes Cheese Festival.

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[63] Seneca Lake Wine Trail, http://www.senecalakewine.com/seneca-lake/about-us/about-the-seneca-lake-wine-trail.html (emphasis added).
[64] Freda Moon, "Sips From a Cider Spree in New York State," *The New York Times* (September 24, 2014)
[65] Jenna Intersimone, "Travel: A Taste of the Seneca Lake Wine Trail," *MyCentralJersey.com* (October 7, 2014).
[66] *Schuyler County Countywide Comprehensive Plan* (CWCP), (Steinmetz Planning Group, 2014), p. 13
[67] "Finger lakes Cheese Trail" brochure, n.d. (2014) http://www.flcheesetrail.com/.

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Primarily as a result of New York State becoming the number one producer of yogurt in the nation, the state's total dairy production is second in the nation. Cheese is a higher value-added product that helps small farms, as in the Finger Lakes region, and adds additional value as an important feature of the agri-tourism industry.

3.7.2 Organic Farms, CSAs and Farmers Markets

The growth of Farmer's Markets and CSAs throughout the Finger Lakes region has been a significant factor in stabilizing the agricultural industry and preserving farmlands. As existing farmers retire, young men and women interested in educating the public on food issues are taking up organic and sustainable farming methods. CSAs include families as shareholders as they learn about growing and harvesting crops that provide their food supply. Local economies also benefit, as money is not spent on food grown outside the area. For example, a 2013 study in one Finger Lakes county suggested, "about 4,500 shares, equal to approximately $2.25 million…was spent and kept in the local economy through the CSA system."[68]

A number of farms, such as the growing number of organic farms, truck their produce to New York City once or twice a week, while farm stands dot the local roads during the harvest season. Local restaurants advertise their farm-to-table cuisine as "locavore" and "slow food" culinary arts have gained strength in the regional food culture. Distribution of sustainably produced artisanal food products outside the area as a value-added export began in 1989, by the company *Regional Access*, owned by Gary Redmond and his wife. A quarter century later the company works with over 150 regional farms and small-scale producers, and employs over two dozen workers with a self-defined mission to "redefine regional food systems" that create "value-chains in which all participants in a system receive an equitable portion of the profit structure."[69]

3.8 <u>Recreational Tourism</u>

3.8.1 Accommodations: Lodging and Food

Regional growth in tourism has promoted the development of facilities that cater to a more diverse customer base. Dozens of new restaurants have opened that serve farm-to-table meals and other local products.[70] A number of wineries have added restaurants and rooms for overnight visitors to their wine-tasting venues, such as Glenora Wine Cellars with a restaurant featuring regional seasonal cuisine and local wines and a thirty-room inn overlooking their vineyards and Seneca Lake. Many small events, such as those sponsored by the members of the Wine Trail association, encourage visitation throughout the year, including in winter.[71]

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[68] Laura Winter Falk, *Culinary History of the Finger Lakes: From the Three Sisters to Riesling* (Charleston, SC: American Palate, 2014), p. 120.
[69] Interview with Asa and Stephanie Redmond (January 7, 2015); and www.RegionalAccess.net.
[70] Falk, *Culinary History of the Finger Lakes.*
[71] "Seneca Wine Trail Guide 2014." http://www.senecalakewine.com/images/stories/brochures/SWLT_2014-LowResForWeb.pdf.

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Conferences and other large gatherings are accommodated at the upscale Watkins Glen Harbor Hotel with its 300-seat private conference room, and Geneva on the Lake and the Belhurst, an 1880s castle in Geneva. Bed & Breakfasts and Inns are found throughout the region; for example, Schuyler County is home to approximately 15 hotel/motels and 20 B&Bs. Scores of these facilities host weddings and receptions. For example, a half-dozen facilities on Seneca Lake host 40-45 weddings per year and smaller venues from 6-12 weddings per year. Bridal parties come from outside the Finger Lakes AVA and the state, and generate hundreds of thousands of dollars in annual revenue (food, music, etc.) and jobs (caterers, musicians, etc.), in addition to room revenue. Workers in these service industries constitute an important segment of the community. As a result of increased tourism within Schuyler County, "room tax figures have increased steadily [since 2005] and are expected to continue to increase into the future."[72]

3.8.2 Fishing

Seneca Lake is a destination for the fishing community looking for lake trout as well as perch. Every Memorial Day weekend, Seneca Lake is the site of the *National Lake Trout Derby*. In 2014, more than 1,500 entrants vied for the $5,000 grand prize. Many fishermen arrive from outside the region and decide to purchase cottages on the lake's shore as vacation homes. As a reporter for *The New York Times* wrote in 2007, prices for homes on Seneca Lake are relatively cheap compared to other New York State vacation areas. Price is not the only factor for fishermen. According to one respondent, despite being 38 miles long, Seneca Lake has very little boat traffic, a pleasant situation for trolling.[73]

The cultural landscape of the Seneca Lake neighborhood reflects the integrated social and aesthetic values of the residents and vacationers. Vacation and weekend homes line the shores of the six major Finger Lakes, from Skaneateles on the eastern end of the chain to Canandaigua and Keuka on the west, and vineyards march down the hills above the lakeside roads. It is a social landscape that adds to the local region's community character. According to the *New York Times*:

> Not all of the homeowners like to fish. Some concentrate on boating, sailing, water skiing and swimming, or just gazing out at the silver-blue water and sipping the wine. And not all are content with simple cottages. According to several local real estate brokers, prices of property on the Finger Lakes surged after 9/11. … Yet despite the presence of the occasional multimillion-dollar lakeside property…and the renowned local wineries, the Finger lakes remains largely a region of real general stores and

[72] Schuyler County *Countywide Comprehensive Plan* (CWCP), (Steinmetz, 2014), p. 15
[73] David Wallis, "Lake Trout: Big, Deep and Seductive," *The New York Times* (August 17, 2007).

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> front-porch gatherings. Not to mention the gas stations that also sell bait.[74]

The economic multiplier effects from fishing activities reach many kinds of local small businesses, from tackle shops that sell fishing and camping gear to gas stations that sell gas and worms, to grocery stores that sell beer and ice, and restaurants, motels and hotels. The nine towns surrounding Seneca Lake (Burdett, Dundee, Geneva, Hector, Himrod, Lodi, Penn Yan, Rock Stream, and Watkins Glen) are home to a number of historic bed-and-breakfast hotels.

3.8.3 Events

Motor racing events in Watkins Glen bring thousands of visitors to the village and area surrounding Seneca Lake. Originally, races were run on a route through the village. In 1953, the competition moved to a different course outside the village where international races began in 1958. For example, Watkins Glen hosted the *United States Grand Prix* from 1961-80 and other national and international competitions as well as vintage car racing events from 1984 to the present. The thousands of motor-sports fans who attend these events also engage in the other attractions of the area, including the gorges and waterfalls in Watkins State Park, boating on Seneca Lake, enjoying the culinary arts in local restaurants, visiting nearby vineyards, and purchasing locally produced medal-winning wines. Shopping for antiques, locally-produced artisan crafts and sustainably grown farm produce also contribute to the local economy.

Other events also boost the economic significance of tourism. For example, an economic study of the 2012 Musselman Triathlon indicated that the three-day multi-sport weekend (swim-bike-run races) "brought over 3,000 unique visitors to Geneva and was responsible for the infusion of approximately $4 million into the Geneva economy. In addition to these new dollars, the event also confers accessory benefits to the region in the form of return visits, the introduction of a desireable [*sic*] tourist demographic to the region, and positive national press."[75] More than 50 per cent of the participants and their friends and families were from outside the Finger Lakes region. For example, 95 percent of the participants in the half-iron event traveled more than 100 miles or more, including 39 per cent between 200 and 400 miles, with 17 percent traveling to Geneva from over 400 miles away. These participants spent more than one night in the area, spent money for lodging and food, and visited various attractions, most notably wineries.

3.9 <u>Comprehensive Planning</u>

3.9.1 Rural Landscape Preservation

The Finger Lakes landscape combines rural agricultural lands with small towns, villages and cities. Three of the counties surrounding Seneca Lake are among the six least populated counties in New York State: second to last is Schuyler County with

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[74] *Id.* at 2.
[75] "Musselman Triathlon: Economic Impact" (41 pp., December 2012), p. 2.

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18,518; Yates County 25,256; and Seneca County 35,436. Within the Seneca Lake watershed the largest places are Geneva (2010 population 13,261) and Watkins Glen (2010 population 1,859). During the past few decades, counties and local municipalities in the region have developed plans to preserve their historic heritage to encourage the growing rural tourism economy.

In 2014 Schuyler County adopted the *Countywide Comprehensive Plan* (CWCP).[76] The CWCP examines the goals and objectives of all the municipalities in county: "As a community, the decisions we make shape our physical, social, and economic character."[77] In its introduction, Schuyler County is described as being "comprised of a vibrant community of small towns and villages supported by a flourishing agricultural, winery and tourist industry. Schuyler County offers a variety of landscapes, outdoor recreational activities, wildlife habitats, and economic opportunities."[78]

As a rural county, the plan recognizes that tourism and agriculture are two of the largest sectors of the Schuyler County economy. "The challenge [for future social and economic development] is to ensure the continued protection of our resources (i.e. land, air and water), rural character and sense of place."[79]

Federal and state policies have assisted in this effort. According to the Trust for Public Land and the National Trust for Historic Preservation, historic rural landscapes:

> provide a living record of our collective past. The result of the long interaction between humans and nature, rural landscapes have been shaped over time by historical land use and management practices. These landscapes of heritage were formed by the activities and habits of past generations, and to the careful observer they offer a glimpse of long-forgotten lifestyles and traditions…Unfortunately, the historical integrity and visual character of many rural landscapes are threatened by change…a good starting point…for understanding, appreciating, and eventually protecting historic landscapes is from the network of public roads. People largely experience private, working lands from public roads and highways. These public places provide us with visual access to the countryside, where surrounding views reveal themselves as sequences of images which color our perceptions of the environment.[80]

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[76] Schuyler County, *County Comprehensive Plan* (Steinmetz Planning Group, 2014).
[77] *Id.* at 2.
[78] *Id.* at 6.
[79] *Id.* at 23 (emphasis added).
[80] David H. Copps, *Views From the Road: A Community Guide for Assessing Rural Historic Landscapes* (Washington, D.C.: Island Press, 1995), pp. 3-5.

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The Seneca Lake Scenic Byway is an example of local community planning and action, with support from New York State, to experience views of the rural countryside that are visible aspects of regional community character.

Conserving cultural landscapes maintains and reinforces place and community identity, as further observed by the National Trust:

> Our own, expanded concept of conservation…embraces the idea of *community* as a resource, from individual farms or landholdings, to social institutions, to the local economy and sustainability of the community as a whole…Rural conservation, then, includes protecting natural and scenic resources, preserving buildings and places of cultural significance, and enhancing the local economy and social institutions.[81]

Wine-makers and vineyard owners have worked together to create a cultural landscape and viable economy in the Finger Lakes region. The Project could undermine that effort. As an article reporting on the wine community's concern about the project, *The New York Times* reports: "Over the last two decades, vintners in the Finger Lakes region of New York State have slowly, and successfully, pursued a goal that could fairly be described as robust, with a lively finish: to transform their region into a mecca for world-class wines, and invite an influx of thirsty oenotourists."[82]

New York State's agricultural policies that have helped preserve farming and grape growing in the Finger Lakes, such as the Small Farm Winery Act (1976) and the Craft New York Act (2014) are governmental actions that have also conserved the rural working landscape.

3.9.2 Local Government Planning

Public reaction to the proposed Project offers important insight into the factors that interact to form community character. Resolutions by counties, municipalities, and other local governmental bodies document many of the features that residents and communities agree construct their sense of place and identity. Between 2013 and 2015, over a dozen resolutions were passed by local government bodies, expressing concern about potential negative impacts of the proposed Project. These bodies, also shown on the map below, include:

1. Ontario County;
2. Seneca County;

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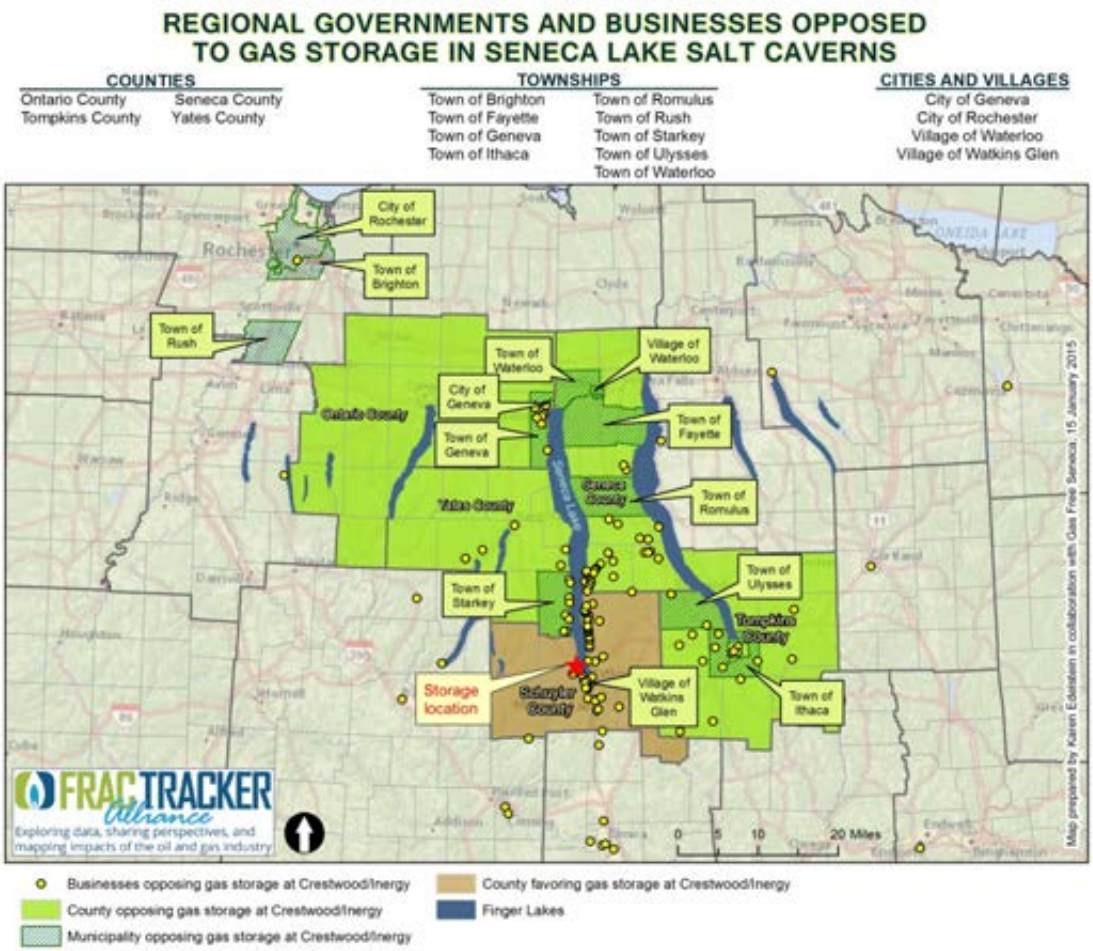
[81] Samuel N. Stokes, A. Elizabeth Watson and Shelley S. Mastran, *Saving America's Countryside: A Guide to Rural Conservation*, second ed. (Baltimore: The Johns Hopkins University Press, 1997), p. 2 (emphasis in the original).

[82] Jesse McKinley, "What Pairs Well With a Finger Lakes White? Not Propane, Vintners Say," *The New York Times* (December 26, 2014), p. A25.

3. Tompkins County;
4. Yates County;
5. Town of Brighton
6. Town of Fayette;
7. Town of Geneva;
8. Town of Ithaca;
9. Town of Romulus;
10. Town of Rush and Rush Conservation Board;
11. Town of Starkey;
12. Town of Ulysses;
13. Town of Waterloo;
14. City of Geneva;
15. Village of Watkins Glen; and
16. Village of Waterloo.[83]



[83] Copies of the resolutions, as well as a letter in opposition to the Project signed by the members of the City Council of the City of Rochester, are available at http://www.gasfreeseneca.com/?page_id=493.

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Geneva and Watkins Glen have developed planning documents that encourage economic development, especially in tourism and revitalization of their waterfronts and commercial districts. The town and city planning process requires public participation, where citizens develop their vision for a future cultural and economic landscape that defines their community character.

From 1958 to 2012, the City of Geneva produced over 15 development plans and waterfront studies focused on lakefront recreational amenities.[84] As in many North American cities after world War II, industries in Geneva moved from their 19th C locations on urban waterfronts, leaving behind a shoreline of abandoned buildings and, often, toxic soils. Federal funding through urban renewal began to clear many of the sites, and cities developed parks, playgrounds, and boat docks to increase public access for recreational use of the lakes and other water bodies. Urban landscapes entered a post-industrial phase of economic development strategies focused on recreation, historic preservation and tourism.

In 1997, Geneva's *City Master Plan & Local Waterfront Revitalization Program* (*LWRP*) addresses this economic and land use transformation as an important change in the city's community character:

> A community's interest in its cultural and historic character says a lot about the way a community views itself and the impression it wants to give to others. Attention to the historic and visual aspects of the City will help restore a positive self image. Activities such as preserving the historic and cultural resources that define the City, improving the primary gateway entrances, and supporting efforts to make Geneva a center for regional tourism will enhance the City's image.[85]

The implementation of Geneva's *Master Plan & LWRP* is ongoing, with current development in phases as outlined in its 2012 *Feasibility Study*.

The Village of Watkins Glen has developed similar plans for its lakefront historic commercial district. Various studies over the past decade include a master plan, waterfront revitalization program titled "Project Seneca," and revitalization of the Village's downtown through New York State's "Main Street" program.[86]

Project Seneca has been designed by Schuyler County's economic development agency, SCOPED, as a waterfront revitalization strategy. It is an estimated $200 million investment in Watkins Glen's waterfront, and is expected to spur $1 billion in private

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[84] City of Geneva, *City of Geneva Waterfront Infrastructure Feasibility Study*, 2012, p. 1.
[85] City of Geneva, *Master Plan & Local Waterfront Revitalization Program* (Saratoga Associates, 1997), pp. II-18 and II-19.
[86] *Village of Watkins Glen Comprehensive Plan*, "Watkins Glen Road Map," (Albany, NY: Laberge Group, 2012).

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investment.[87] As with the City of Geneva's planning, both historic preservation of structures and the provision of recreational amenities are themes that underlie the transformation of the Village's image from an earlier industrial town to a destination location for recreation and tourism.

Impacts on Community Character

4. Visual Impact

The visual impact of a facility is less a matter of seeing something as it is, but more a matter of understanding what is seen. The environmental impact of a proposed industrial facility and its infrastructure can be both measured within a specific viewscape and regarded as a subtle indicator of change to the local or regional economy and sense of place. Images of the Project conflict with the community's perception of its rural character and its plans for a tourism-based economy.

The visual impact of a facility can go well beyond an imposed spatial limit of five or even ten miles, and it is not a function of the size of the facility within the view. Rather small, yet symbolic, indicators of change can alter one's perception of landscape beauty or integrity. The Project's footprint may be somewhat limited, but its visual message is clearly contrary to the character of the locality and region.

4.1 Hector Falls

Specific views of a facility from significant historic, cultural, or natural sites are important, as they supply the context within which the facility is judged as to whether or not it contributes to the community's economic future or emerging character. The direct view from Hector Falls, a natural landmark of extraordinary beauty throughout the seasons and important to local tourism, is not addressed in the recent "Visual Impact Analysis" (VIA). The VIA simply refers to Schuyler County's description of a "grand view" of Seneca Lake and its "western shore." In my opinion, the Project will have a significant adverse visual impact of the view from Hector Falls.

View of Facility Bordering Project Site from Hector Falls along Scenic Byway (2013)

[87] *Schuyler County Countywide Comprehensive Plan* (CWCP), (Steinmetz Planning Group, 2014), p. 16

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4.2 Gas Flare

The impact of the gas flare at the Project site also has not been thoroughly examined. When the gas flare is in operation, it will be seen from the eastern shore and from the lake. The bright light, 60 feet above the Project, will be especially noticeable during the night. For both tourists and residents, it will disturb an otherwise tranquil scene. Such facilities are dramatic visual indicators of the industrializing of the local landscape, which will have a significant negative effect on the Seneca Lake community and its recreational economy.

4.3 Brine Ponds

Views from the road, such as the Scenic Byway, have a direct effect on viewers' appreciation of local landscapes. Structures or signs seen from the road inform the viewers' knowledge of local or regional community character. Historic markers and way-finding signs help establish regional identity, although billboards do not, as New York State has established in legislation banning them along major state highways.[88] The Project's brine ponds remain visible to viewers on Route 14, and, although to some degree mitigated by vegetation, continue to posit a discordant feature.

5. Traffic Impact

5.1 Truck Traffic

Although the revised "Product Transportation Allocation" anticipates that trucks will not be used to transport product in or out of the facility, FLLPG has made no binding commitment to forgo the use of trucks for the life of the Project.[89] Indeed, the document leaves open the possibility that FLLPG will pipe product across the street to TEPPCO's facility, for truck distribution from that site. Unless future use of trucking is taken permanently off the table, the worst-case scenario should be assumed for environmental review purposes. Any increase in truck traffic on Route 14 and other local roads will have an impact on visitor experience. Tourists traveling through vibrant rural agricultural landscapes appreciate them as "working landscapes," with active farms, orchards and vineyards. An increase in heavy truck traffic can cause a change in perception as the landscape becomes less interesting and scenic roads become less "scenic."

5.2 Rail Traffic

According to the revised "Product Transportation Allocation," all butane volumes (in and out) will be transported by rail, and "the average number of rail cards in or out per day is 6.8 cars…[but] some days may come close to the maximum of 32 rail cars."[90] The construction of a new rail depot and the increased use of the former Fall Brook Railway

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[88] Harvey K. Flad, *Blighted Empire: The Visual Environment of New York State* (Albany: New York State Council of Environmental Advisors, 1975).
[89] 2014-12-02, Product Transportation Allocation – Revised December 2014, letter and attachment.
[90] *Id.*

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(New York Central's Norfolk and Southern Railroad) is a visible indicator of "re-industrializing" the Seneca Lake shore.

Tank cars hauling liquids or gases are a potential industrial safety hazard. In 1972, a train derailment "caused 60,000 to 70,000 of oil to spill into Indian Creek which flows into Seneca Lake."[91] In 1980, a train traveling from Watkins Glen derailed in Geneva, causing great concern among the citizens that "it's only a matter of time before a tank car filled with a dangerous chemical derails."[92] During 2013 and 2014, tank cars carrying Bakken oil from Canada across upstate New York to Albany and south along the Hudson River have gone off the tracks, leaked, and caused fires.

Increased train traffic will also have an industrializing effect as a result of noise created by rolling stock; whistling at crossings; and braking, stopping, and starting at the facility when uncoupling cars for unloading and loading of product.

6. Noise Impact

The intensity, variability, and pitch of sound are important elements in the perception of a community's sense of place and quality of life. Recreational spaces such as parks and lakes are important natural landscapes that offer quiet repose away from the noise emanating from industrial and commercial activities, highway or railroad traffic. For boaters on Lake Seneca, or winery or B&B guests overlooking the lake, intrusive sound from the Project, such as truck noise during construction or increased rail activity, would have a significant impact on community character, especially during the summer months, when most residents are outside, windows are open, and campers and tourists are enjoying outdoor recreational activities. The noise study prepared in connection with this proceeding confirms that noise will travel from the Project site across the lake to west-facing receptors in Hector.

7. Economic Impact

A more detailed analysis of the economic elements of the regional cultural landscape is contained in the report 2015 "Sources of Economic Development in the Finger Lakes Region: The Critical Importance of Tourism and Perceptions of Place" by Dr. Susan Christopherson. As the author notes, the emerging regional "brand" that emphasizes scenic beauty and lake-based leisure could be irretrievably damaged by the expansion of an industrial site on Seneca Lake and "have a significant adverse effect on the growth trajectory in the region."[93]

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[91] Greenway Stuart, "Oil spills into Seneca Lake," *The Geneva Times* (July 20, 1972).
[92] Jean Jones, "Chemical, nuke waste transport concern city," and "Another derailment," and "Derailed tank car contained only wine," *Finger Lakes Times* (January 4, 1980).
[93] Susan Christopherson, "Sources of Economic Development in the Finger Lakes Region: The Critical Importance of Tourism and Perceptions of Place," (January 14, 2015), p. 2.

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7.1 **"Industrialization"**

Citizens, public officials, and local businesses have worked hard to change the foundations of their economy and recognize how these changes are observable in the regional and local landscape. The image of the regional environment shared by visitors and residents alike centers on aesthetic values, such as scenic views; prospering wineries and vineyards; culinary arts; heritage sites; and recreational activities, such as fishing and boating. The region is very consciously entering a post-industrial period of growth that could be reversed by the operation of the proposed Project.

An "industrial" landscape image is completely at odds with the current cultural landscape and is contrary to future progress as planned by local, regional and state officials. The Village of Watkins Glen Board emphatically states that "the Crestwood project has polarized the region with valid concerns of *rampant industrialization*, negative environmental impacts, safety risks, negative impacts to infrastructure and, the potential to *negatively affect the economic livelihood of a region dependent on tourism*."[94]

7.2 **Planning**

Proposals for regional development focused on recreational and agri-tourism, especially grape growing and wine-making, are also in the plans of counties and municipalities around Seneca Lake. Both the Village of Watkins Glen and the City of Geneva have adopted comprehensive plans that identify tourism as the most vital economic benefit to the community. Both municipalities are disturbed by the potentially adverse impact of the Project on their water supply, quality of life, and tourist- and recreation-based economy. In a resolution "in opposition of the construction of an underground liquefied petroleum gas storage facility," the Watkins Glen Board identified several State and Federal "financial investments…in recognition of the vital importance that tourism has on the area."[95] They include: "Project Seneca," a multi-million dollar project to help revitalize the shores of Seneca Lake; NY Main Street Program funding to improve the building facades of the Village's commercial district, along with funding from the Rural Area Revitalization Program (RARP) for exterior lighting; and Transportation grants to enhance Village entrance ways for eco-tourism.

7.3. **Scenic and Historic Assets**

In a resolution by the Seneca County Board of Supervisors that "opposes LPG storage adjacent to Seneca Lake," the designation of its Scenic Byway is specifically noted as an asset to the county's promotion of tourism, which serves as an engine of its

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[94] Village of Watkins Glen, "Resolution of the Village of Watkins Glen Board in Opposition of the Construction and Operation of an Underground Liquefied Petroleum Gas Storage Facility," 2014 (emphasis added).
[95] *Id.*

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economy.[96] The legislatures of both Tompkins County and Yates County also mention the Scenic Byway as an important asset to the regional tourism economy.

The regional landscape and its many natural features such as waterfalls and Seneca and Cayuga Lakes are notable for their beauty. As the Village of Watkins Glen Board resolution notes, "the Fingerlakes [*sic*] Region, including Seneca Lake, is an area known for its natural and scenic beauty…and the natural wonder that is the Watkins Glen State Park, home to 19 waterfalls [and] gorges."[97] If the Project is approved, it will have a significant negative effect on the view from the Scenic Byway, which cannot be mitigated.

The cultural landscape of Schuyler and Seneca counties within the Seneca Lake watershed contain numerous historic sites that are listed on the National Register of Historic Places and on New York State and local inventories. Together they constitute a palimpsest that is the foundation of the region's changing community character as a rural, post-industrial economic landscape.

7.4 Recreation

Businesses and municipalities are extremely concerned about the impact that the proposed facility would have on its recreational resources. Seneca Lake has a regional and statewide reputation for swimming, boating, and fishing. Its clear, cold water offers excellent fishing for lake trout; each summer the National Lake Trout Derby attracts thousands of fishermen who camp or lodge and eat in local venues. It is an important annual event in the local economy. Equally, the decade-long success of the Musselman Triathlon is dependent upon maintaining water quality in Seneca Lake. Bicycle touring in the region is an increasingly popular recreational pursuit for an emerging middle-class generation. The Project, a highly visible industrial facility right along the lake, undermines the lake-side community's self-image as a clean and serene destination for water-based recreation.

7.5 Wineries

The growth of the Finger Lakes AVA and Seneca Lake AVA has coincided with the increase of tourism to the area. Within the last few decades, the viticulture industry has seen many new vineyards and wineries developed in the districts. It has successfully grown and bottled prize-winning vintages and organized wine trails around both Seneca and Cayuga Lakes. Visitors come to tour the scenic beauty of the "viticultural landscape," experience wine-tasting at the wineries, and purchase wines directly at the source. The industrial image of the Project and its impact on the aesthetic values inherent in the rural cultural landscape could be devastating, both economically and in terms of identity, or community character.

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[96] Seneca County, "Seneca County Board of Supervisors Opposes LPG Storage Adjacent to Seneca Lake," 2014.

[97] Village of Watkins Glen, "Resolution of the Village of Watkins Glen Board in Opposition of the Construction and Operation of an Underground Liquefied Petroleum Gas Storage Facility," 2014.

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Impact on the wine industry is most often cited by municipal officials, as well as the REDC, as the basis for opposition to the "industrialization" of the Seneca Lake landscape. According to economic geographer Dr. Susan Christopherson, who cites a 2013 study by Tuck and Gartner, New York winery tourists accounted for an estimated 1360 jobs and $35.4 million in labor income.[98] The New York Wine and Grape Foundation, an industry affiliated group, added a figure of $401.5 million in wine-related tourism expenditures. As one of the most significant sectors of the local economy, and the leader in the emerging tourist economy, its economic importance is the reason why local counties and municipalities and 200 regional businesses oppose the LPG storage facility. They are rightly concerned that the Project will have a significant and unmitigated impact on the scenic and bucolic community character that has emerged largely as a result of their efforts.

Conclusion

"Community Character" is a complex composite of social and economic history, cultural and natural landscape features, and aesthetic or visual elements, which collectively and over time, produce a distinctive identity and sense of place. The landscape of the Finger Lakes region, with special focus on the area surrounding Seneca Lake, is recognized for its beauty and amenities as a tourist destination. Cultural and natural landscape features such as vineyards, wineries, parks, historic sites, waterfalls and the deep, cold, glacial Seneca Lake are some of the visible expressions of the community's character that would be adversely impacted by new industrial development.

This analysis of impacts has teased apart nine elements of the Finger Lakes cultural landscape that collectively emerge as community character: (1) scenic views and aesthetic resources; (2) historic sites and districts; (3) scenic roads and transportation corridors; (4) open space; (5) American Viticulture Areas; (6) wine tourism; (7) agricultural tourism; (8) Recreation; and (9) comprehensive planning by local governments. The community character of the Finger Lakes Region and Seneca Lake cannot be reduced to these elements, however, but is in fact greater than their sum—the product of their interaction over time with the people who are tied to the place. Community character joins space and time, weaving together social, cultural, environmental, and economic history, to define what the community means to its members. Even moderate impacts on the elements of the cultural landscape could have a significant impact on community character.

In my opinion, the Project will overlay an indelible industrial image on the cultural landscape of Seneca Lake, and the Finger Lakes more broadly, which will significantly and adversely affect the inhabitants' hard-won and prized community character. The seriously detrimental effects of the Project that I have identified include: (1) disruption of scenic vistas, including views over the lake and its surrounding rural, small town, and viticultural landscape; (2) traffic and noise impacts, potentially of trucks

[98] Susan Christopherson, "Sources of Economic Development in the Finger Lakes Region: The Critical Importance of Tourism and Perceptions of Place," (January 14, 2015), p. 2.

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and certainly of railroad, especially on recreational users of Seneca Lake and lake-side residents seeking peace and quiet; and (3) socio-economic impacts on the region's wineries and tourist-related business, which depend on stable community character as the foundation of their brand. The draft supplemental environmental impact statement has no discussion whatsoever of community character and therefore necessarily fails to take a hard look at these significant adverse impacts on that area of environmental concern. Given the nature of those impacts, moreover, no conditions that may be added to the underground storage permit will be able to mitigate their damage, if it is allowed to occur.

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Exhibit A

Curriculum Vitae of Harvey K. Flad, Ph.D.

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EDUCATION

Ph.D., Syracuse University, Geography, 1973
MA, Syracuse University, Geography, 1972
BA, University of Colorado, 1962

EMPLOYMENT

ACADEMIC APPOINTMENTS (Vassar College)
Assistant Professor Geography1973-79; Associate Professor 1980-89; Professor 1989-2004.
ADMINISTRATIVE APPOINTMENTS (Vassar College)
Chair, Faculty Policy and Conference Committee, 2001-2003; Director**,** American Culture Program, 1998-2001; Director, Exploring Transfer Program, 1999; Chairman, Department of Geology and Geography, 1988-1998;; Director, Office of Affirmative Action, 1991-1993; Director, Urban Studies Program, 1983
OTHER WORK EXPERIENCE
Executive Director, Hudson River Shorelands Task Force, Red Hook, NY, 1980-1981; Assistant Map Curator, American Geographical Society, New York, NY, 1965-1968; Peace Corps, Nigeria, 1962-1964

FELLOWSHIPS, GRANTS, HONORS, AWARDS

Helen Wilkinson Reynolds Award for Scholarship, Dutchess County Historical Association, 2010.
Senior Associate Fellow, Association of American Geographers, 2005.
Russel Wright Award for Environmental Preservation, Manitoga, 2003.
Fulbright Fellow, awarded 1996 for Lectureship in Kyrgyzstan, Central Asia, 1997-1998.
Ford Scholar Program Research grants, 1990, 1994, 2003.
Research Resident Fellow, New York State Library, Albany, N.Y., 1993-1994.
Research Fellow, The Institute on Man and Science, Renssalaerville, NY 1977-78.
County Award, Dutchess County Cooperative Extension Association, 1977.
Ford Fellowship in Ethnic Studies, Ford Foundation, 1971-72.

PUBLICATIONS

BOOKS, MONOGRAPHS

Main Street to Mainframes: Landscape and Social Change in Poughkeepsie. (Co-author Clyde Griffen) Albany: The State University of New York Press, 2009. ISBN: 978-1-4384-2613-6.

Blighted Empire: The Visual Environment of New York State. Albany: New York State Council of Environmental Advisors, 1975. (Cited by the *New York Times* in article and editorial).

ARTICLES, ESSAYS and CHAPTERS IN BOOKS

"Scenes 'most impressive and delightful': Nineteenth-century Artists in the Shawangunks, *The Hudson River Valley Review*, vol. 31, no. 1 (Autumn 2014), pp., 95-120, 134-36.

"Photographs as Place Makers of the Urban Landscape: Poughkeepsie's Downtown," *Thinking Historically: Dutchess County Historical Society 2014 Yearbook*, vol. 93, pp. 25-34.

"IBM's Early Days in the Hudson Valley: Poughkeepsie and Kingston," in *Kingston-The IBM Years*, ed. The Friends of Historic Kingston (Delmar, NY: Black Dome Press, 2014), pp. 9-32.

"The Influence of the Hudson River School of Art in the Preservation of the River, its Natural and Cultural Landscape, and the Evolution of Environmental Law, Chapt. 20 in Robert E. Henshaw, ed., *Environmental History of the Hudson River: Human Uses That Changed Ecology, Ecology That Changed Human Uses* (Albany: State University of New York Press, 2011), pp. 293-313.

"The Hudson River Valley and the Geographical Imagination," *AAG Newsletter*, vol. 46, no. 5 (May 2011), pp. 1, 10-11.

"History of Urban Studies at Vassar College," "Histories" web page, Sesquicentennial web site, (Vassar College, 2010), http://150.vassar.edu/histories/urban-studies/index.html.

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"History of Earth Science and Geography at Vassar College," "Histories" web page, Vassar 150 web site, (Vassar College, 2010), http://150.vassar.edu/histories/earth-science-and-geography/index.html.

"The Natural Resources of Dutchess County in the Past, Present and Future," Natural Resource Inventory web site, (Poughkeepsie, NY: Dutchess County Department of Planning and Development, 2010), http://www.co.dutchess.ny.us/CountyGov/Departments/Planning/19401.htm

"The Parlor in the Wilderness: Domesticating America's First Iconic Landscape," *Geographical Review* vol. 99, no. 3 (July, 2009): 356-376.

"Photography Changes Our Perspective of the American Landscape," (Smithsonian Institution, Click! Photography Changes Everything, 2009), http://click.si.edu/Story.aspx?story=271.

"A Tree and Its Neighbors: Creating Community Open Space," co-authored with Craig M. Dalton, *Hudson River Valley Review*, vol. 21, no. 2 (Spring, 2005), pp. 56-67.

"Audubon Terrace, The American Geographical Society, and the Sense of Place," *Geographical Review*, vol. 94, no. 4 (October, 2004), pp. 519-529.

"Introduction to Ed Zahniser, and 'Wilderness and Our Community of Life'," *The Forest Preserve*, vol. 18, no. 1 (October, 2004), pp. 50-1.

"The Hudson River Valley and the Geographical Imagination," *Watershed Journal*, ed. Miwon Kwon. (N.Y.: Minetta Brook, 2002), pp. 45-55.

Editor, *Seen From the Other Shore: English and American Landscapes*, by David Lowenthal. (John Christie Lecture Series) Poughkeepsie, NY: Vassar College, American Culture Program, 2001.

"The Hudson River Valley and the Geographical Imagination," in Ines M. Miyares, Marianna Pavlovskaya and Gregory A. Pope, eds., *From the Hudson to the Hamptons: Snapshots of the New York Metropolitan Area.* (Washington, D.C.: Association of American Geographers, 2001), pp. 8-15.

"Following 'the pleasant paths of Taste': The Travelers Eye and New World Landscapes," in *Humanizing Landscapes: Geography, Culture and the Magoon Collection*, exhibit catalogue. (Poughkeepsie, NY: Vassar College, Frances Lehman Loeb Art Center, 2000), pp. 69-102.

"The Parlor in the Landscape: Nineteenth Century Mountain House Resorts and the Shaping of Nature," in *European Identity and its Expression in Philosophy, Science, Literature and Art.* CD-Rom. Bergen, Norway: International Society for the Study of European Ideas, 2000.

"War won when power plants lost" and "Modern roads rooted in the past," in *The Hudson Valley: Our Heritage, Our Future* (Poughkeepsie, NY: Poughkeepsie Journal, 2000), pp. 128 and 136-7.

"Kyrgyzstan" and 200 other entries in *The Columbia Gazetteer of the World*. (NY: Columbia University Press, 1998)

"Country Clutter: Visual Pollution and the Rural Roadscape," in *The Annals of the American Academy of Political and Social Science*, vol. 553 (Sept., 1997), pp. 117-129.

"Matthew Vassar's Springside: '... the hand of Art, when guided by Taste'," in *Prophet with Honor: the Career of Andrew Jackson Downing*, ed. by George W. Tatum and Elizabeth B. MacDougall. (Dumbarton Oaks Colloquium on the History of Landscape Architecture XI). (Washington, D.C.: Dumbarton Oaks Trustees for Harvard University, 1989), pp. 219-257.

"Hudson Valley Landscapes: Fieldtrips in the Hudson River Valley, New York State," in *North American Culture*, vol. 5, no. 2 (1989), pp. 39-63.

"A Time of Readjustment: Urban Renewal in Poughkeepsie, New York, 1955- 75," in *Poughkeepsie's Past: New Perspectives*, ed. by Clyde Griffen. (Poughkeepsie, N.Y.: Dutchess County Historical Society, 1988), pp. 152-180.

"Meaning (and Morality) in Preserved Landscapes," *North American Culture*, vol. 4, no. 2, pp. 4-21.

"Preserving 'Springside': Andrew Jackson Downing's only extant landscape," *Bulletin of American Garden History*, Vol. II, 1 (Spring, 1987), pp. 2, 5.

"The Country and the City," in *Meeting the Future on Purpose: Papers in Honor of Lewis Mumford*, edited by Richard C. Wiles. Annandale-on-Hudson, N.Y.: The Bard College Center, 1983).

"Preservation of an Historic Rural Landscape: Roles for Public and Private Sectors," co-authored with Robbe Stimson, in *Farmsteads and Market Towns: Preserving the Cultural Landscape*. (Albany, N.Y.: Preservation League of New York, 1982), pp. 32-36.

"The Hudson River Shorelands Task Force: Citizen Participation in the Preservation of an Historic Landscape," *Partnership in Conservation* (Second Conference of National Trusts), (Edinburgh, Scotland: The National Trust of Scotland, 1980), pp. 57-62

RESEARCH REPORTS

The Philipstown Turnpike: An Historic Cultural Landscape Study. Prepared for the Putnam Preservation League, Patterson, New York, 1988.

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Historic Preservation and Tourism in Dominica: Recommendations for Scotts Head and Soufriére. Prepared for the Government of the Commonwealth of Dominica, Ministry of Cultural Affairs and Tourism. Submitted in behalf of Dominica/Dutchess County Partners, 1986

Scenic District Management Plan for the Mid-Hudson Historic Shorelands Scenic Area, co-authored with Robert M. Toole and Robbe Stimson. Albany, N.Y.: NYS Department of Environmental Conservation, Heritage Task Force for the Hudson Valley, 1983.

EXHIBITS, VISUAL AND GRAPHIC PRODUCTIONS

A Digital Tour of Poughkeepsie, DVD. Produced by Urban Studies Program, Vassar College. (Script researcher, writer, and narrator), Vassar College, 2006; uploaded to Vassar YouTube, 2010.

"Humanizing Landscapes: Geography, Culture and the Magoon Collection". Gallery exhibit. (Co-curator of gallery exhibit). Frances Lehman Loeb Art Center, Vassar College, Oct. 5-Dec.20, 2000.

"Panorama of the Hudson River from New York to Albany," map reproduction of original engravings by William Wade, 1845, republished in five panels with additions and changes over 135 years by Hudson River Sloop Clearwater 1980. (Principal project consultant); team also included artist Alan Gussow, art historian John K. Howat, and cinematographer Jack Ofield.

United States Geography, filmstrip program produced by the Encyclopedia Britannica Educational Corporation, Chicago, IL. (Principal program and design consultant of five series), 1977-1980. Coordinator of individual consultants in geography (Harm deBlij, Merle Prunty, James Vance, Richard Morrill, and Wilbur Zelinsky). Series 17111K, published 1979-80.

Hyde Park, 16mm film, produced and directed by Ralph Arlyck; co-produced by the Hyde Park Visual Environment Committee, with additional funds from NYS Council on the Arts. (Researcher and interviewer on the historical, social, and visual aspects of the "Sense of Place"). Poughkeepsie, NY: Ralph Arlyck Film, 1977. Winner of First Prize, National Trust for Historic Preservation Film Festival, Mobile, Ala., October, 1977. National television showing on PBS (Channel Thirteen, New York sponsoring station), April, 1978. Available on video-cassette from Timedexposures.com.

OTHER PROFESSIONAL ACTIVITIES (selected)

CONSULTATION AND EXPERT TESTIMONY

Historical consultant, Greater Walkway Region Discovery Zone / Gateway signs, Branding subcommittee, Walkway Over the Hudson and Scenic Hudson, 2012-14.

Historical consultant, *The Seer of Poughkeepsie*, documentary film, produced and directed by Julia Johnson, Vassar College film department, 2013. Available on Vassar College Youtube.

Curatorial consultant, "Hudson River Panorama: 400 Years of History, Art & Culture," Albany Institute of History and Art, Hudson 400 exhibit for the Hudson-Fulton-Champlain Quadricentennial, 2009.

Cultural landscape consultant, "Landscape Character," Scenic Hudson, *et. al.* In visual impact assessment of Kingston Harbor proposal, 2006.

Cultural landscape consultant, "Community Character," Scenic Hudson, *et. al*. In visual impact assessment of St. Lawrence Cement proposal, Hudson, NY. Albany, NY: Department of State, 2005.

Editorial consultant, National Geographic Society, "Heart of the Hudson" by Patrick Smith in *National Geographic*, vol.189 (March, 1996), PP. 72-95.

Geography consultant, United States Information Agency (USIA), technical assistance to University of Klaipeda, Lithuania, 1995.

Cultural landscape consultant, Delaware County Historical Association, for exhibit on ethnic resorts in the Catskills, NEH and NYS Council on the Arts Folk Arts Program grants, 1994.

Cultural Landscape consultant, The Berkshire Museum, Pittsfield, MA, for exhibit "Labor and Leisure in Berkshire County," 1987-88. National Endowment for the Humanities, 1988.

Expert witness, "Prepared Testimony in the Matter of Central Hudson Gas & Electric Corp. Danskammer Coal Conversion", NYS Department of Environmental Conservation, submitted on behalf of Scenic Hudson, Inc., co-authored with John F. Sears, 1984.

Expert witness, "Prepared Testimony on Aesthetic Impact of Greene County Nuclear Power Plant," submitted on behalf of Columbia County Historical Society, et al, U.S. Nuclear Regulatory Commission, and Power Authority of the State of New York, Case 8006, Docket No. 50-549, Albany, NY, March 2, 1979. (60 pp.)

COMMISSIONS/BOARDS/PANELS

Mohonk Preserve, 1982 - present

Waterfront Advisory Commission, City of Poughkeepsie, 1986-1997, 2011-present.

Advisory panel, Manitoga-The Russel Wright National Historic site, 2003-present.

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Annual Meeting, of the Association of American Geographers, New York, 2000-01 and 2011-12.
Science Advisory Panel, Smithsonian Photography Initiative, Smithsonian Institution, 2004.
Faculty host, Visiting Fulbright Scholars from Vietnam (1997-98) and Central Asia (2001)
Board of Review, New York State Archives, New York State Library, 1999-2000.
A.A.G. Committee on the Status of Women in Geography, 1998-2000
Founding member of Environmental Studies caucus, American Studies Association, 2000
Faculty, NEH Summer Institute for College Teachers, "Hudson River Valley Images and Texts: Constructing a National Culture in Nineteenth-Century America," Vassar, 1993.
National Panel, Division of Preservation and Access, National Endowment for Humanities, 1991-92.
Advisory Panel, The Hudson River Valley--A Heritage for All Time, NYS D.E.C., 1979-80.

REVIEWS

Book reviews, professional journals: *Geographical Review* (2004); *Journal of Regional Science* (2004, 2012); *Society and Natural Resources* (2004); *H-Net Reviews in the Humanities & Social Sciences* (2011)
Manuscript reviews – both professional journals and scholarly publishers

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Exhibit 6

Economic Development Report
Susan M. Christopherson, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

Sources of Economic Development in the Finger Lakes Region: The Critical Importance of Tourism and Perceptions of Place

January 14, 2015

Susan M. Christopherson, Ph.D.

NYSDEC OHMS Document No. 201166576-00026

1. Introduction

The proposal of Finger Lakes LPG Storage, LLC to build a new liquid petroleum gas (LPG) storage and transportation facility (Project) in the Town of Reading, New York, raises concerns about how increased industrialization of the western shore of Seneca Lake will affect economic development around the lake and in the wider Finger Lakes region.[1] In this report, I address that question by exploring the socio-economic context of the Project, with special attention to the branding of the region as a destination for tourism. I draw on 28 years of economic development research and analysis as a Professor of City and Regional Planning at Cornell University.[2] My assessment is based on review and analysis of: (1) academic research on the role of branding in tourism, particularly wine tourism; (2) reports on the economic impact of the Finger Lakes wine, vineyard, and tourism industries; (3) Quarterly Census of Employment and Work (QCEW) data for 2000 and 2013, for four counties surrounding Seneca Lake (Ontario, Schuyler, Seneca, and Yates); (4) historical information on the region and counties from *The Encyclopedia of New York State*;(5) websites for marketing and economic development organizations for the Finger Lakes region; (6) websites and publications on the wine industry and international wine regions; (7) websites describing academic training and technical assistance to the Finger Lakes wine industry; and (8) interviews with experts on the wine industry in the region, business operators, and economic development officials.

That research reveals a conscious and successful effort to leave behind traditional agriculture and manufacturing, to develop one of the most important wine production regions in the US (Asimov, 2011; 2013; Helper, 2012), and to transform that region into a center for agri-tourism and recreation. Regional growth now is increasingly dependent on investment by wineries and by hundreds of small businesses that serve tourists, who come to the region to experience one of the major glacial lakes in North America and its wine country environment. The character of the community created by those businesses—reflected in regional branding—in turn supports development of other industries with skilled workers, who demand a high quality of life. Because the industrialization of Seneca Lake is inconsistent with the community's vision and plans, I conclude that construction of the Project is likely to damage the regional brand and therefore may have a significant adverse impact on economic development around the lake and in the wider Finger Lakes region.

2. The Regional Economic Development Trajectory

In this section, I summarize what is known about the direction of the vineyard, winery, and related tourism industries in the Finger Lakes economy and describe the value of these interrelated industries to the regional economy and to its economic development potential.

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[1] The facility would be based on a 576-acre site in Schuyler County, NY, located in the town of Reading, about 2.5 miles north of the village of Watkins Glen. Surface facilities would extend uphill to the west, with compressors, brine ponds, bullet tanks, a flare, and distribution and transportation operations on the western side of Seneca Lake.

[2] My abbreviated curriculum vitae for 2000 to the present is attached as Appendix B to this report.

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These industries have grown significantly in the counties surrounding Seneca Lake and in the broader Finger Lakes region since 2000, expanding employment and business activity even during the long, recent recession. The vineyards and wineries represent long-term investments in land and wine-making facilities. As they have expanded, they have supported additional employment growth in retail, food services and accommodations, construction, and other beverage manufacturing industries. This regional industry cluster arguably is poised to reach new heights, as evidenced by national hotel chain investment in Geneva and Watkins Glen and the prospect of international investment in new wineries. Despite all these positive signs, the continued growth of these interrelated industries, and of the regional economy, is dependent on maintaining a regional brand that emphasizes scenic beauty and lake-based leisure. Damage to the regional brand from the risks posed by the Project is likely to have a significant adverse effect on the growth trajectory in the region.

Since the 1980s, one set of industries in the Finger Lakes region, including the four counties surrounding Seneca Lake, has come to define the regional economy. These interrelated industries include: (1) specialized agriculture, particularly wine grape vineyards; (2) the wine-making industry, including tasting rooms and an expanding array of firms serving the vineyards and wineries; and (3) tourism businesses associated with the vineyards, wineries, and other lake-based leisure activities. The growth of these industries reflects the transformation of the Finger Lakes region and Seneca Lake counties from economies based largely on manufacturing to economies based on tourism, services, and specialized agriculture.

Although vineyards, wineries, and tourism have been growing in the region since the 1980s, they have become leading industries in Finger Lakes region and in the counties surrounding Seneca Lake since 2000. At that time, the State of New York and Finger Lakes counties, as well as numerous regional private sector organizations, began to make significant investments designed to alter the industrial composition of the region and the regional "brand." The goals of this aggressive campaign have been three-fold: (1) to build an internationally recognized wine production region; (2) to attract tourists to this new "Finger Lakes wine country;" and (3) to use the appeal of an area of scenic beauty and abundant leisure activities to attract business investment and high-skilled workers (Tarleton and Robertson, 2014; White and Wynne, 2014). Location experts analyzing how quality of place affects corporate and labor decisions have recognized that: "In today's highly competitive environment for talent, a compelling quality of place—a community's attractiveness to existing and future residents and workers—is a competitive advantage" (Tarleton and Robertson, 2014).

The success of the economic development and re-branding efforts is evident from employment figures presented in Section 3 below, which demonstrate that, in Schuyler, Seneca, and Yates Counties, the field grain agricultural production and diversified manufacturing that characterized the local economy in the 1960s have been replaced by a combination of dairy farming, specialized agriculture (vineyards), and more recently, wineries and tourism (including accommodation and food services). Ontario County has a more diversified employment base, including knowledge-based employment related to the

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photonics (laser optics and imaging) and other advanced technology industries (Eisenstadt, 2005), although the Seneca Lake counties generally have sought and attracted highly educated employees and entrepreneurs.

Both public officials and private sector leaders in these counties have marketed the entire region to a skilled workforce and year-round visitors, as a place offering scenic vistas, lake-based leisure activities, and the experience of small town life. That conscious decision on the part of policy makers and the business community to promote industries that can take advantage of the region's natural beauty, abundance of recreational options, and high quality of life has been expressed at the regional and county level. The mission statement of the Finger Lakes Regional Economic Development Council (REDC) provides:

> The Finger Lakes region will accelerate its transformation to a diverse, knowledge-based economy by building on strengths that include renewable natural resources, a talented and highly educated workforce, a historic commitment to innovation and philanthropy, leadership as the state's top agricultural region … enhancing the region's quality of life to attract and retain business and our citizens.

(http://regionalcouncils.ny.gov/content/finger-lakes). Similarly, the Schuyler County Countywide Comprehensive Plan (Schuyler Cnty. CWP) recognizes the increasingly important role of tourism and investment by small businesses:

> The region's thriving tourism industry continues to be a strong economic driver for the County, towns and villages. Visitors come to our villages to indulge in the small-town atmosphere while enjoying the quality goods and services we offer. The visitor experience can be further enhanced with efforts to retain and attract local, niche businesses to the commercial cores of our villages.

(Schuyler Cnty. CWP (2014), http://www.schuylercounty.us/DocumentCenter/View/2215, p. 118). For more detail, on private and public investment, see Appendix A.

The investments made by private businesses in the region have represented long-term commitments and a model for building an economically sustainable regional economy. After all, as a report prepared for the New York State Empire Development Corporation notes:

> By their very nature, wine and grapes are long-term investments and long-term employers: newly planted vineyards need four years to produce a harvest. Another year to three years are needed to turn those grapes into wine. Not only are these long-term investments but they are inherently tied to "place." Unlike manufacturing or service enterprises, New York vineyards, once

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> planted, cannot simply get up and move to another state which might offer a better business climate or tax incentives. . . . New York wine is about New York.

(MRK, 2005: 1). The state-level branding illustrated in the quoted passage in turn has supported rapid local and regional economic growth.

The Stonebridge (2014) study of the economic impact of the wine and grape industry in New York provides information on the recent expansion of the winery industry. Since 2008, the number of wineries in New York has increased from 240 to 320, and the number of winery satellite stores has grown from 27 to 52. Much of this increase has occurred in the Finger Lakes region.

The Northern Grapes (Tuck and Gartner, 2013) analysis states that growth in New York wineries is expected to continue. Of the wineries they interviewed, 70 percent indicated that they intended to expand their vineyards. In addition, recent indications of interest from international investors in the development of wineries in the Finger Lakes suggest that property values and tax revenues will be increasing in the region (Dawson, 2014).

Though it still exists in some places in the region, heavy industry is less and less part of the vision for the region's future. The proposed butane and propane storage at the Reading site is at odds with the direction of the contemporary regional economy and potentially threatens its continued successful development. The creeping industrialization up the west side of Seneca Lake—from salt manufacturing, to natural gas storage, and potentially to LPG storage—endangers the hard-fought-for brand (for world-class wines in a world-class natural environment) that is central to the region's economic development future.

3. Wine Production in the Finger Lakes Region and around Seneca Lake

According to the state-supported New York Wine and Grape Foundation (http://www.newyorkwines.org), there are 133 wineries and tasting rooms in the Finger Lakes region, with approximately 40 located on Seneca Lake. Of these wineries, 35 collaborate as part of the Seneca Lake Wine Trail (http://www.senecalakewine.com), a non-profit organization formed in 1986. The counties surrounding Seneca Lake constitute one of the two major concentrations of the wine industry in New York State, with 113 wineries in Ontario, Seneca, Schuyler, and Yates Counties. The wineries in these four counties account for 35 percent of the total (320) wineries and tasting rooms in New York State. The 40 wineries located on Seneca Lake represent 12.5 percent of the total wineries in the state.

The Finger Lakes region is among the top wine-producing regions in the US. The new, more specialized high-end wines have been built on an older base of growers and acreage that supplied Taylor Wine Company, Constellation, and Hermann Wiemer Vineyard. Indeed, the cultivation of grapes and production of wine dates back as far as the 17th

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century.[3] The attraction of the region for vintners is its unusual, favorable 'microclimates' for growing cold-sensitive grapes.

Many US states with cold climates produce cold-hardy grape varieties. New York is able to grow a wider range of grape varieties, however, because of the microclimates adjacent to Seneca Lake. One area on the eastern side of the Lake is referred to as the "banana belt" because of its warmer winter temperatures, produced by warm breezes across the deep lake, which because of its depth does not freeze in the winter.

The Finger Lakes wineries are now considered the primary producers of Riesling wines in the US (Asimov, 2013; Patterson, 2003). According to a wine expert writing in the early 2000s: "[T]he New World's best Rieslings, hands down, come from the Finger Lakes region of upstate New York — in my book, the only ones that give the Germans a run for their money" (Patterson, 2003).

The Finger Lakes region's specialization in cold-sensitive grapes, the increasing popularity of Riesling in the US, and the award-winning caliber of the wines have been stimulating interest from international investors and producing a reputation as an international center for wine production. In 2014, New York State was named "Wine Region of the Year" by *Wine Enthusiast* magazine for its wine, restaurants and tourism opportunities (http://www.winemag.com/Web-2014/Announcing-Wine-Enthusiasts-2014-Wine-Star-Award-Winners/index.php/slide/Wine-Region-of-the-Year/cparticle/3). Seneca Lake wineries are at the heart of this region, in quantity of wine produced as well as in quality, and they have received many awards for their wines (http://www.senecalakewine.com/seneca-lake/winery-awards.html).

Since 2000, the Seneca Lake wineries have been characterized by two types of wine production:

- A large number of small and very small wineries, selling directly to consumers and some restaurants and retailers, primarily in their local regions. These wineries tend to produce a large variety of table wines, from Vitis vinifera, hybrids and native grapes. These wineries tend to be visitor-driven, at times called "destination wineries."

- A small number of small wineries producing primarily Vitis vinifera grapes. While direct sales are also critical to these wineries, some will have national third-party distributors for as much as 30-50 percent of their sales.

4. The Key Role of Tourism in Economic Development of the Finger Lakes Region

Tourism is central to the growth of the Finger Lakes wine region. According to a study of wine production in cold climate states (Tuck and Gartner, 2014), New York wineries are

[3] For more detail, see Section 2.4 of the Community Character Analysis prepared by Harvey Flad, Ph.D., for this proceeding.

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more likely to operate a tasting room than wineries in other states producing cold-sensitive grapes. According to Miguel Gómez, the Ruth and William Morgan Assistant Professor in the Charles H. Dyson School of Applied Economics and Management at Cornell University, and an expert on the New York wine industry: "On average, nearly 60 percent of New York wine sales occur during visits to tasting rooms. . . . For this reason, they play a strategic role in the overall business and marketing strategies of New York state wineries" (Garris, 2014). The tasting rooms draw in tourists already in the region for other leisure activities as well as new tourists interested particularly in wine-making or who are wine enthusiasts.

The Finger Lakes wineries have worked to expand tourism in New York, and the wineries in turn depend on a flow of tourists to sustain their businesses. According to one analysis of the economic impact of the wine and grape industry:

> New York wineries and their satellite facilities received more than 5.29 million visits in 2012, spending more than $401 million, compared with 4.98 million visitors spending $376 million in 2008—and 4.14 million wine related tourists in 2004, generating $312 million in tourism related spending. Tourism is an important facet of the local economy, impacting several different industries, from wineries to hotels and restaurants, retailing and transportation. Winery tourism contributes over 6,400 jobs to the state, for a total of more than $213 million in wages, compared with 6,000 jobs in 2008 and about 5,000 in 2004.

(Stonebridge, 2014: 7).

Another indicator of the importance of tourism to the regional economy is growth in hotel occupancy taxes in the small cities in the region. In addition to Bed and Breakfast establishments serving visitors to the region, major hotel chains have begun to make investments in cities such as Watkins Glen and Geneva. Between 2010 and 2013, occupancy taxes in Geneva hotels grew from $178,000 to $198,000. A total of $203,000 is anticipated for 2014. These taxes frequently are used to support tourism activities, such as community festivals, and marketing. They are re-invested to increase visitor knowledge of the region's attractions.[4]

Also attesting to the importance of tourism to regional economic development is the presence of multiple marketing organizations, supported by the wineries. These organizations include the Cayuga Lake Wine Trail; the Seneca Lake Wine Trail; the Finger Lakes Wine Alliance; and Finger Lakes Wine Country. The wineries' goal is to establish the Finger Lakes as one of the nation's primary wine production and tourism regions. The wine and tourism industries are also supported by county-level tourism promotion agencies. All of these organizations and agencies promote a consistent brand for the region, focused on wineries and tourism in a scenic lakeside leisure setting.

[4] Interview: Sage Gerling, Director of the Office of Neighborhood Initiatives, Geneva, NY, January 6, 2015.

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Tourism is a particularly important industry in Schuyler County, which hosts more than 1.5 million visitors a year. This is an extraordinary number of visitors for a county that ranks as the second smallest county in New York State and whose resident population numbers under 19,000 residents. The 2013 annual report of the Schuyler County Partnership for Economic Development describes numerous projects supportive of tourism: main street redevelopment, improvement of signage, community gateway development, and Marina development for Seneca-Lake-based leisure activities (Schuyler County Partnership for Economic Development, 2013). The County's Hazard Mitigation Plan states: "Because Schuyler County's economy relies heavily on tourism and agriculture, numerous efforts are underway to preserve the county's scenic rural character and productive agricultural sector" (Schuyler County Emergency Services, 2008: 5). The Project moves the county in the opposite direction, potentially under-cutting both public and private sector investments in re-branding the region.

5. The Critical Role of Branding to Tourism and Regional Economic Development

The growth and expansion of the Finger Lakes economy and of its inter-related wine and tourism industries is deeply dependent on potential visitors' perception of the region. Visitors, in fact, substantially sustain the emerging high-value wine industry.

The US Travel Association (USTA) highlighted the Finger Lakes region in an undated case study of how tourism promotion can also promote the broader economic development objectives of a region and a state. Developing a region's travel-related assets serves the dual purpose of attracting both more visitors and more businesses—a win-win proposition for a local economy. The USTA notes that more than one fifth (22 percent) of corporate executives surveyed in 2013 cited "quality of life concerns" as the primary reason for relocating a facility, ahead of factors such as healthcare costs (19 percent), infrastructure (17 percent) and labor availability (17 percent).

Likewise, *Forbes* magazine includes cultural and recreational opportunities among other critical factors, such as job and income growth, when ranking its "Best Places for Business and Careers." Not surprisingly, young professionals in particular favor locations offering diverse activities such as outdoor recreation, arts, and cultural attractions, when deciding where to start their careers (http://www.forbes.com/sites/kurtbadenhausen/2014/07/23/best-places-for-business-2014-behind-the-numbers/).

My own research into workforce development in the Southern Tier (Christopherson et al., 2007) reinforced this finding. Our interviews and focus groups identified four key factors in attracting high- and mid-level skilled workers to the Southern Tier:

- Previous experience with the area. The mostly likely candidates to take jobs had family connections in Upstate New York or had attended school in the Upstate area. Many of our focus group participants had undergraduate or graduate degrees from an Upstate University.
- The quality of life. Our interviewees identified the "sense of community," outdoor sports (hunting, fishing, hiking, running, golf), and short commute times to work as

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significant advantages.
- The quality of schools and educational opportunities at every level, from primary school through college.
- The quality and range of cultural opportunities, which was noted as exceptional for a region of this population size.

Overall, the evidence indicates that investments in regional tourism facilities, businesses, and amenities will also pay off by attracting businesses and workers looking for a high quality of life. By contrast, the construction of facilities that reduce the attractiveness of the area are likely to impair the potential for regional economic development.

6. The Impact of the Vineyard, Winery and Tourism Industries on Employment and Taxes in the Finger Lakes and the Four Counties Surrounding Seneca Lake

The tourism and wine and grape industries are contributing substantially to the regional and state economy. Outside of the New York City, Long Island and Hudson Valley Corridor, the Finger Lakes region is the major regional contributor to traveler spending in the State of New York, with five percent of total spending. Finger Lakes traveler spending is equal to that in the Hudson Valley (Oxford Tourism Economics, 2012:24). Tourism in the Finger Lakes counties is a $2.8 billion industry supporting approximately 58,000 jobs (ibid.: 31). Tourism contributed almost $200 million in local taxes and $152 million in state taxes (ibid.: 32). Among all the Finger Lakes counties, Schuyler County, where the LPG facility is proposed, is the most dependent on tourism employment, with 12.4 percent of total employment sustained by visitors (ibid.: 41).

Several studies of the economic impact of the wine and grape industries in New York have been conducted since 2005. These studies examine the New York State those industries from different perspectives—some, for example, include the broader grape growing industry, rather than focusing only on wine grapes. Although they use different methods and focus on different aspects of the interrelated industries, these economic analyses concur in showing dramatic growth in enterprises and employment across the grape production and winery industries in the region.

The most extensive of the recent economic analyses, conducted for the New York Wine and Grape Foundation, pegs the economic impact of the entire wine and grape industry, including wineries, associated suppliers, and tourism at $4.6 billion per year (Stonebridge, 2014). This study includes the broader table grape and grape juice industry and generally does not break out the winery industry, but the study's executive summary indicates important trends in the wine production and winery industries in New York:

> The last study reported on data for 2008, as the "Great Recession" was building. The increased impact reflects the growth since 2008 in both the volume and value of wine sold in New York. We have also succeeded in capturing more supplier sectors (such as warehousing, trucking, ports, marketing services, vineyard maintenance), and more tourism related expenditures—the latter

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> based on state studies—and better information on sales and property taxes. Over this period, the industry has expanded investment in these sectors, and in infrastructure development and construction. New York wines also represent a larger share of the wines sold in New York State than was true in 2008, responding to the industry's persistent marketing efforts . . . .

(Stonebridge 2014). Stonebridge estimates that the 320 New York wineries employ the equivalent of 3,600 full time workers. Since 2008, the number of full time workers as well as the number of owner operators has grown significantly in response to increasing demand for direct services and sales. This growth is directly linked to increasing tourist expenditures in the wine regions, especially the Finger Lakes.

Looking at federal employment statistics for the four counties directly surrounding Seneca Lake (Seneca, Schuyler, Ontario, and Yates), the impact of the wine industries on the county economies is easily visible.[5] Using QCEW data it is possible to get an approximation of changes in employment in the Seneca Lake counties, though the available numbers are likely underestimated because they do not count self-employed workers. The analysis uses NAICS 72 (consisting of 721: Accommodations, and 722: Food Services and Drinking Places) as the generally-accepted surrogate to measure employment change in tourism, and NAICS 312 to measure employment change in Beverage Product Manufacturing (which includes the wine industry). For ease of reference below, I refer to "Accommodations and Food" and "Beverage Manufacturing."

In Schuyler County, total private sector employment grew 15 percent between 2000 and 2013. Although the real numbers are small, with 662 people employed in Accommodations and Food in 2013, this industry category grew by 47 percent in Schuyler since 2000. Beverage Manufacturing employment grew at an even faster pace, by 125 percent, attesting to the role of winery employment in a county where other types of employment have not shown rapid growth.

In Seneca County, private sector employment grew by 7.5 percent between 2000 and 2013. After declining in the early to mid-2000s, employment numbers have begun to rise, and employment in the Accommodation and Food is now at 97 percent of its total number in 2000 (932 jobs). Employment in Beverage Manufacturing increased from 102 in 2000 to 420 in 2013, an increase of 312%.

In Ontario County, one of the most prosperous counties in Upstate New York, private sector employment grew by 12 percent between 2000 and 2013. Beverage Manufacturing was not present in county employment figures until 2008, and in 2013 had reached 286 jobs. Accommodation and Food grew by 33 percent between 2000 and 2013.

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[5] This analysis uses data from QCEW, a federal-state cooperative program that collects employment and wage information for workers covered by State unemployment insurance laws, and for Federal workers covered by the Unemployment Compensation for Federal Employees program. The data are made available by the U.S. Bureau of Labor Statistics.

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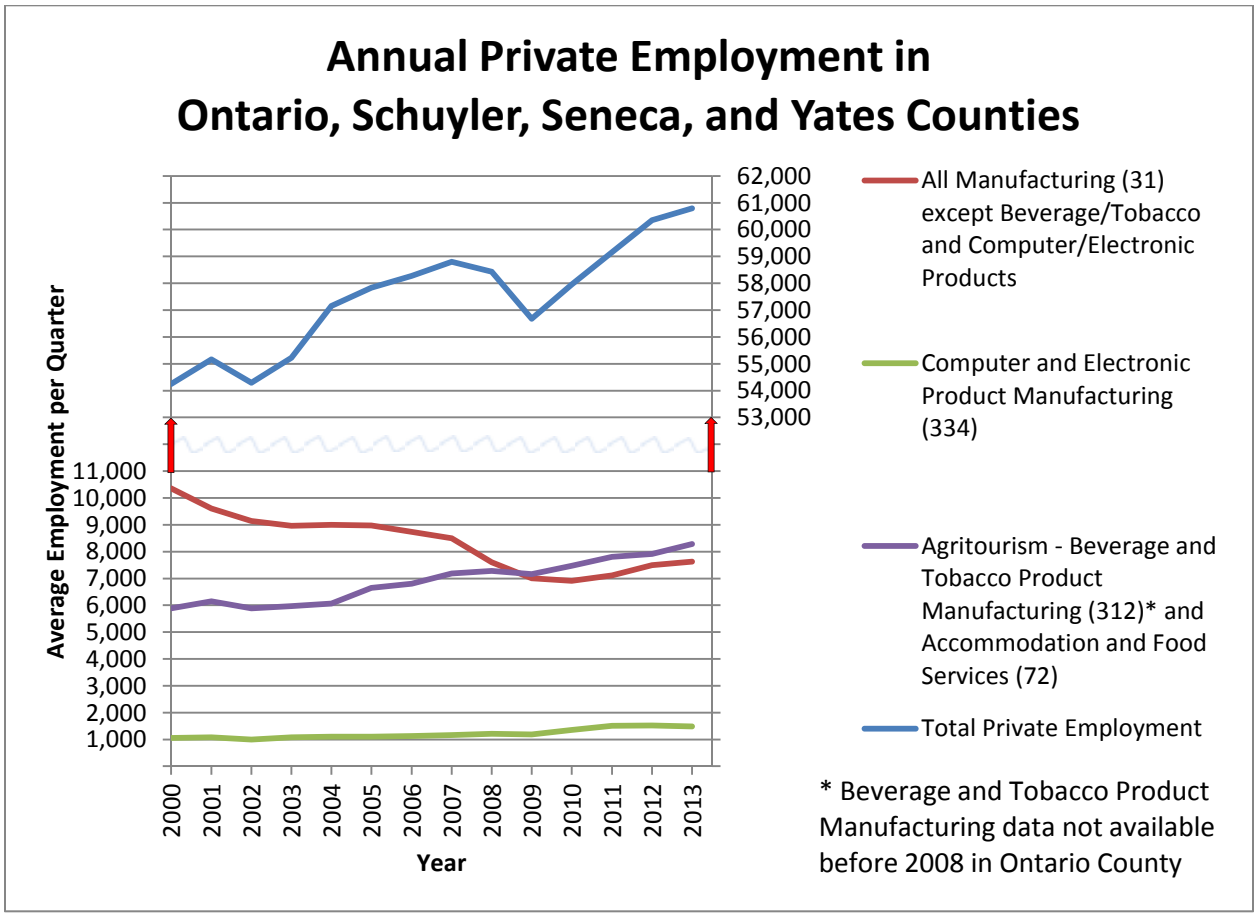
In Yates County, private employment has increased 18 percent during the 2000 to 2013 period. Employment in Accommodation and Food rose by 21 percent. Employment in Beverage Manufacturing rose 145 percent to 324 jobs in 2013.

As is shown in Figure 1, below, the winery and tourism industries are making a positive contribution to employment in these counties, in contrast with traditional manufacturing.

Figure 1



Much of this employment growth comes from expenditures by tourists, who visit the Finger Lakes and the Seneca Lake counties in response to the regional brand.

7. Conclusion

Finger Lakes vineyard, winery, and tourism firms have made long-term investments in this region, but they must have a stable business environment to reach their full potential as contributors to a healthy and increasingly vibrant regional economy. That environment

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depends on a continuous positive image for New York wine country, nationally and internationally.

The wineries have been leaders in branding the region as a tourist mecca. This is evident from a look at their website (http://www.senecalakewine.com/communities/activities-attractions.html), which advertises a variety of regional attractions and services for tourists throughout the full year. Conversely, damage to the Wine Trail brand could impact a wide range of hotels, restaurants, and other businesses that directly or indirectly rely on regional wine tourism.

The Seneca Lake vineyards and wineries already face significant challenges, ranging from finding skilled labor to unpredictable weather. Particularly crucial is access to financial capital—to build tasting rooms, winery facilities, and vineyard operations. Access to that capital depends on a stable brand and low risks from contradictory uses of the Finger Lakes landscape.

Based on my experience conducting economic development research in New York, it is my opinion that construction and operation of an LPG storage facility on Seneca Lake will have significant unmitigated adverse impacts on the region's economic success. The prominent growth industries in the area—vineyards, wineries, and tourism—are heavily dependent on a regional "brand" that features a scenic landscape and specialized agriculture. That brand invokes a very specific picture of the Finger Lakes, and the continuing economic success of the region depends upon consistency of visitor perceptions with the image projected by the wineries. The incompatibility of the Project with the surrounding natural landscape and lake-based recreation tarnishes that image, and presents risks to the business prospects of many regional firms—including, but not restricted to, the 40 wineries along Seneca Lake. Even a minor industrial accident could do serious brand damage and dampen investment in New York wine country.

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Appendix A

Private and Public Investment in the Regional Industries

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Appendix A

Private and Public Investment in the Regional Industries

The development of the strong vineyard, winery and tourism industries in the Finger Lakes region has benefited from significant private and public investment. There has been significant private investment especially since 2000 in building and marketing these interrelated industries. The US Travel Association (2013) indicates that in 2000, the first year of funding, the Finger Lakes Wine Country Marketing Association invested $156,000 in media and marketing. The yearly budget in 2012 was 873,000 (U.S. Travel Association: 16)

New York State has taken an active role in supporting the development of the Finger Lakes wine industry. The most prominent example of this role is the Farm Winery Act of 1976, which enabled New York's grape producers to find a new, higher value market for their crops, as demand for traditional juice products and traditional Concord grape wines diminished. The Farm Winery Act enabled small wineries to sell their product directly to consumers, retailers and restaurants in the state.

Since the passage of the Farm Winery Act in the 1970s, the number of wineries in New York increased dramatically each decade (MFK, 2005). The 1980s saw an additional 69 wineries established in the state, more than doubling the number of established wineries. In the 1990s, 74 additional wineries were established in the state, and 30 were added in the early 2000s. This growth has been almost entirely in the development of "farm wineries."

Legislation to allow out-of-state shipping has also been significant in building the industry in New York. A 2004 survey found that 23 percent of the more than 4 million visitors to New York wineries in 2003 came from other states. The direct shipment legislation facilitated sales to these visitors and had a major impact on New York's small wineries. (MFK, 2005: 12)

The New York Wine & Grape Foundation was created by State legislation in 1985, during an economic crisis in the grape and wine industry, as a private not- for-profit statewide trade organization to support the industry through promotion and research.

Along with the New York state legislature, Governor Andrew Cuomo has encouraged legislation, regulatory reform and promotion programs to support New York's and the Finger Lakes wine industry. A "One Stop Shop" office was formed to handle any and all questions from the industry about government policies and regulations. The State of New York has made significant efforts and investments to support the vineyard, winery, and associated tourism industries in New York State because of their economic development benefits.

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Appendix B

Abbreviated Curriculum Vita of Susan M. Christopherson, Ph.D.

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Abbreviated Curriculum Vitae[1]

December 2014

SUSAN M. CHRISTOPHERSON
Professor and Chair, Department of City and Regional Planning
Cornell University
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Ithaca, New York 14850
Phone: 607-255-8772
Fax: 607-255-1971
Email: smc23@cornell.edu

Susan Christopherson is a Professor and current chair in the Department of City and Regional Planning at Cornell University. She is a geographer (Ph.D. UC Berkeley 1983) whose career has been based on a commitment to the integration of scholarly work and public engagement.

Her research interests are diverse, but focus on economic policy, especially its spatial dimensions. Much of her research is comparative and she has published a series of articles and a book on how different market governance regimes influence regional development. Since 2010, her funded research, publications, and public engagement have focused on the issue of energy transitions and the economic and social effects of shale gas and oil development.

Susan Christopherson's public engagement has spanned arenas from the local to the global. She has acted as a consultant to the Organization for Economic Cooperation and Development and to the United Nations Conference on Trade and Development as well as to national, state, and local governments in the US and Canada. She was recently a member of a US National Academy of Science committee on the identification and governance of shale gas development.

EDUCATION

Ph.D.	University of California – Berkeley	Geography	1983
B.A.	University of Minnesota – Minneapolis	Urban Studies	1972

TEACHING

Economic Geography; Urban Theory; Economic Development; Urban Sustainability and Energy Transitions.

AWARDS and HONORS

Writing Awards

Best Book Award, Regional Studies Association for *Remaking the Region, Labor, Power and Firm Strategies in the Knowledge Economy*. Awarded September 2009.

Three books in which I have articles have won book awards: Gray, L. and Seeber, R. (eds.) *Under the Stars: Essays on Labor Relations in Arts and Entertainment*, Ithaca, NY: Cornell University Press, 1995, which was recognized as a "Noteworthy Book in Industrial Relations and Labor Economics"; A. Pike (ed.) *Whither Regional Studies?* New York: Routledge, 2009, which was awarded the Best Book Award 2010 by the Regional Studies

[1] This abbreviated CV reports on my activities from 2000 forward. A complete CV documenting my career activities is available on request.

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Association and Mark Deuze (ed.) *Managing Media*, which was awarded the 2011 Pickard award for best book by the Association for Journalism and Media Education.

Professorships and Other Awards

Hallsworth Professorship, University of Manchester, Manchester England. Awarded in the Department of Geography. 2014-15. (Visit will take place in Spring 2015).

J. Thomas Clark Professorship for Entrepreneurship and Personal Enterprise, Cornell University 2006-2011

Cornell Institute for Social Sciences Research Team Award for a 3-year project on Persistent Poverty and Upward Mobility, 2008-2011

Queens University Distinguished Lectureship, November 20-25, 2009, Kingston, Ontario, Canada

Visiting Scholar, The Centre for Urban and Regional Development Studies at Newcastle University, Newcastle Upon Tyne, January, 2009

Bousfield Distinguished Visitor in Planning and Geography, University of Toronto (I gave a series of seminars and public lectures at the University of Toronto in September, 2007 and again in March, 2008.)

Cornell University, Community and Regional Development Institute Award for Faculty Contribution to Community and Economic Vitality, awarded November 2007

Visiting Fellow, St Catherine's College, Cambridge University Spring semester, 2007

Visiting Distinguished Fellow, School of Management, Kings College, London
October 2004

PUBLICATIONS

BOOKS

I have a book contract with the Everett Parker series (devoted to books that intersect communications and the public interest), published jointly by Fordham University Press and Oxford University Press. The book, with a working title of *Lessons from the Search for Hollywood East* brings together and expands on my long-time work on the creative workforce in entertainment media and economic development policy. The book will be published in 2015.

Remaking the Region: Power, Labor, and Firm Strategies in the Knowledge Economy (with Jennifer Clark). New York: Routledge Press (Special Series on the New Economic Geography), 2007. Paperback edition, 2009.

MONOGRAPHS

Net-Working: Patterns and Policies for the New Media Industry (with Rosemary Batt, Danielle Van Jaarsveld and Ned Rightor) Washington: Economic Policy Institute, 2001.

NEW YORK'S BIG PICTURE: Assessing New York's Role in Media Production (with Lois Gray, Damone Richardson, Maria Figueroa, and Ned Rightor). The New York Film, Television, and Commercial Initiative and New York NY: School of Industrial and Labor Relations, Cornell University, 2006.

ARTICLES FOR PUBLIC POLICY JOURNALS (Editor reviewed)

"Frack or Bust: Shale Gas Extraction Brings Local Planning Challenges" 2012. in *Planning* (The Magazine of the American Planning Association) Vol. 78, No.4 (April) pp.8-13 (with Tom Knipe and David West).

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"Not So Fast – Why a Transportation System Designed for Wal-Mart Limits Our Export Economy," " in *Democracy, A Journal of Ideas*. (Forthcoming 2014)

"Manufacturing: Up from the Ashes" in Democracy, A Journal of Ideas. 2009. Special Issue on Innovation, September 9, 2009. Available online at: http://www.democracyjournal.org/index.php

Building Phoenix Industries in Our Old Industrial Cities, The Smith Institute Policy Reports October 2009. Available online at: http://www.smith-institute.org.uk/default.htm London: The Smith Institute.

ARTICLES IN REFEREED JOURNALS:
(PUBLISHED, OR ACCEPTED AND FORTHCOMING)

"Risks and Risk Governance in Unconventional Shale Gas Development," *Environmental Science and Technology* 2014: 48(15): 8289–8297 (with members of The National Academy of Science Panel).

"Reindustrialising regions: rebuilding the manufacturing economy?," *Cambridge Journal of Regions, Economy and Society* 2014: 7(3): 351-358 (with Ron Martin; Peter Sunley; Peter Tyler) Special introduction

"NIMBYs or Concerned Citizens? How Communities Evaluate the Costs and Benefits of Shale Oil and Gas Development ," *Progressive Planning* 2014 : 194 (Winter): 40-49 (with Ned Rightor).

"Hollywood in Decline? US Film and Television Producers Beyond the Era of Fiscal Crisis," *Cambridge Journal of Regions, Economy and Society* 2013: 6(1) (March): 141-158.

"Financialization: Roots and Repercussions," *Cambridge Journal of Regions, Economy and Society*. 2013: 6: 351-357 (with Ron Martin and Jane Pollard) Special issue editorial introduction.

"Job Creation Strategies to Accelerate the Return of U.S. Manufacturing," *Progressive Planning* 2012: 190 (Winter): 13-17.

"Local Consequences of Natural Gas Drilling in the US Marcellus Shale," *International Journal of City and Town Management* 2012: 2(4): 350-368 (with Ned Rightor).

"Never Let a Good Crisis Go to Waste: Re-imagining Resilience in the Light of the Great Recession," *Critical Planning Theory* 2010: 17 (Summer): 108-123.

"Limits to 'The Learning Region" What University-Centered Economic Development Can (and Cannot) Do to Create Knowledge-based Regional Economies," *Local Economy* 2010: 25.2 (May): 120-130 (with Jennifer Clark).

"Regional Resilience: Theoretical and Empirical Perspectives" 2010. *Cambridge Journal of Regions, Economy and Society* Volume 3, No. 1: 3-10 (with Jonathan Michie and Peter Tyler) (reviewed by the editorial board).

"Afterword: Contextualized Comparison in Local and Regional Economic Development: Are United States Perspectives and Approaches Distinctive?" *Regional Studies* 2010: 42(2) (March): 229-233.

"The Creative Economy as "Big Business": Evaluating State Strategies to Lure Film Makers," Special issue on The Creative Economy and Economic Development, *Journal of Planning Education and Research* 2010: 29(3) (March): 336-352 (with Ned Rightor).

"Transforming Work: New Forms Of Employment And Their Regulation," *Cambridge Journal of Regions, Economy and Society*, 2009: 2(3) (November): 335-342. (with Linda McDowell) (reviewed by editorial board).

NYSDEC OHMS Document No. 201166576-00026

"Integrating Investment and Equity: A Critical Regionalist Agenda for a Progressive Regionalism" in *Journal of Planning Education and Research*, 2009, vol. 28 (March): 341 – 354 (with Jennifer Clark).

"Beyond the Self-expressive Creative Worker, An Industry Perspective on Entertainment Media," in *Theory, Culture and Society*, 2008 Vol. 25 (7-8): 73-95.

"The World is Not Flat: Putting Globalization in its Place," (with Harry Garretsen and Ron Martin) in *Cambridge Journal of Regions, Economy and Society*, 2008 1 (3): 343-349, (reviewed by editorial board).

"Innovation, Networks and Knowledge Exchange" 2008. (with Michael Kitson and Jonathan Michie) in *Cambridge Journal of Regions, Economy and Society*, 1 (1): 165-173, (reviewed by editorial board).

"Power in Firm Networks: What it Means for Regional Innovation Systems" in *Regional Studies* Volume 41 Issue 9, December 2007:1223-1236 (with Jennifer Clark).

"Barriers to 'U.S. Style' Lean Retailing: The Case of Wal-Mart's Failure in Germany" in *The Journal of Economic Geography*.Volume 7 Number 4, July 2007: pp 451-469.

"The Politics of Firm Networks: How Large Firm Power Limits Small Firm Innovation" (with Jennifer Clark) in *Geoforum* Volume 40 Issue 10, January 2007.

"Placing the Creative Economy: Scale, Politics and the Material" (with Norma Rantisi and Deborah Leslie) in *Environment and Planning A* Volume 38 Number 10, January 2006.

"Behind the Scenes: How Transnational Firms are Constructing a New International Division of Media Labor" in *Geoforum* Volume 37 Issue 5, September 2006: pp 739-751.

"Neither Global Nor Standard: Corporate Strategies in the New Era Of Labor Standards" (with Nathan Lillie) in *Environment and Planning A* Volume 20 Number 6, November 2005.

"After the Boom': Entrepreneurial and Professional Paths in New Media Work" (with Danielle Van Jaarsveld) in Special Issue of *The International Journal of Cultural Policy* Volume 11 Number 1, 2005.

"Divergent Worlds, Sustaining Careers in the Creative Economy" in *Review of Policy Research* Volume 21 Number 4, 2004: pp 543-558.

"The Limits to 'New Regionalism' (Re) Learning from the Media Industries" in *Geoforum* Volume 34 Issue 4, (November) 2003: pp 413-415

"Project Work in Context: Regulatory Change and the New Geography of Media" in *Environment and Planning A*, Volume 34 (11), 2002: pp 2003 – 2015.

"Why Do National Labor Market Practices Continue to Diverge in a Global Economy" in *Economic Geography* Volume 78, January 2002.

"Bennett Harrison's Gift: Collaborative Approaches to Regional Development" in *Antipode* Volume 33 Number 1, January 2001.

CHAPTERS IN BOOKS

"Risks Beyond the Well Pad: The Economic Footprint of Shale Gas Development in the US" (forthcoming 2015) in Madelon Finkel (ed.) *The Human and Environmental Impact of Fracking: How Fracturing Shale for Gas Affects Us and Our World.* New York: Praeger Publishers.

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"Confronting an Uncertain Future: How US Communities are Responding to Shale Gas and Oil Development. 2014. In *Our Energy Future: Socioeconomic Implications and Policy Options for Rural America*, Oxford, UK: Taylor & Francis Group (with Ned Rightor)

"Regional Innovation Networks and University-based Tech Transfer Models: The Potential for Hybrid Collaborative Models," 2012, in Jaana Puuka (ed,) Higher Education and Regional Economic Development Program, IMHE. Paris: OECD.

"Collaboration in Regional Innovation Networks and University-based Tech Transfer, Models" 2012 in Hans Christian Garmann Johnsen and Richard Ennals (eds.) The Collaborative Advantage London: Gower Press.

"Labor Politics in a De-centered Global Media Industry" in Dwayne Winseck and Dal Yong Jin (eds.) 2011 *Media Political Economies: Hierarchies, Markets, and Finance in the Global Media Industries.* Bloomsbury Academic.

"Connecting the Dots: Structure, Strategy and Subjectivity in Entertainment Media" 2010. in Mark Deuze (ed.) *Managing Media Work*. Thousand Oaks: Sage.

"The Geographies of Capitalism," 2010. in Roger Lee, Andrew Leyshon, Linda McDowell, and Peer Sunley (eds.) *A Compendium of Economic Geography* London: Sage Publications.

"Behind the Scenes: How Transnational Firms are Constructing a New International Division of Labor in Media Work 2009. in Toby Miller (ed.) *The Contemporary Hollywood Reader*. London and New York: Routledge.

"Green Dreams in a Cold Light" 2009 in Andy Pike, Andrés Rodríguez-Pose and John Tomaney (eds.). Routledge Handbook of Local and Regional Development, New York: Routledge.

"The Next Move: Metro-Regions and the Transformation of the Freight Transport and Distribution System," (with Michael Belzer) in Nancy Pindus, Howard Wial, and Harold Wolman (eds.) *Urban and Regional Policy and Its Effects.* Washington, D.C.: The Brookings Institution. 2009.

"Working in the creative economy: Risk, adaptation, and the Persistence of Exclusionary Networks. 2009. In *Creative labour: working in the creative industries*, ed. Alan McKinlay and Chris Smith. 72-90. Basingstoke, UK: Palgrave McMillan.

"The Big Squeeze, Labor Politics in a Consolidated Media Industry" in Janet Wasko and Paul McDonald (eds.) *The Contemporary Hollywood Film Industry* Oxford: Blackwell, 2008.

"Behind the Scenes" in Janet Wasko, Paul MacDonald and Mary Erickson (eds.) *Cross-Border Cultural Production: Economic Runaway or Globalization?* Amherst, MA: Cambria Press, 2008.

"Divide and Conquer: Regional Competition in a Concentrated Media," in Greg Elmer and Michael Gasher (eds.) *Contracting Out Hollywood, Runaway Productions and Foreign Location Shooting* Boulder: Rowman & Littlefield, 2005.

"Women and the Restructuring of Care Work - Cross-National Variations and Trends in Ten OECD Countries" in Ulrike Liebert and Nancy Hirschman (eds.*) Women and Welfare* Rutgers University Press, 2001.

"Women's Changing Status in a Global Economy" in R. Johnson, P. Taylor, M. Watts (eds.) *Geographies of Global Change.* Oxford: Blackwell, 2001.

"Lean retailing in marketliberalen und koordinierten Wirtschaften (Lean Retailing in Liberal Market and Coordinated Economies) in H. Rudolph (ed.) *Aldi oder Arkaden? Unternehmen und Arbeit im europaischen Einzelhandel*. (Aldi or Arcade? Enterprise and Work in European Retailing) Berlin: edition sigma, 2001.

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BOOK REVIEWS

Journal of Work and Occupations. Review of: Vicki Mayer, *Below the Line*. Duke University Press, 2011. (forthcoming Spring 2012).

Economic Geography Vol. 83, 2007. Review of: Allen Scott, *On Hollywood: The Place, The Industry*. Princeton University Press, 2005.

Economic Geography 2008 Volume 84, 2008. Review of: Andy Pike, Andrew Rodriguez Pose, John Tomaney, *Local and Regional Economic Development*. Routledge: 2006.

POLICY BRIEFS and REPORTS

A New Era of Crude Oil Transport: Risks and Impacts in the Great Lakes Basin. 2014 (November) Cornell Community and Regional Development Policy Report series. (with Kushan Dave) Available at: **http://cardi.cornell.edu/cals/devsoc/outreach/cardi/publications/cardi-reports.cfm**

Are We Unprepared for "Pipelines on Rails"? Oil Pipeline Risks and Policy Challenges. Cornell Community and Regional Development Policy Brief Series No. 58 (February) 2014. Available at: **http://cardi.cornell.edu/cals/devsoc/outreach/cardi/publications/research-and-policy-brief-series.cfm**

A Vote of No Confidence: Why Local Governments Take Action in Response to Shale Gas Development Cornell Community and Regional Development Policy Brief Series No. 54 (June) 2013. Available at: **http://cardi.cornell.edu/cals/devsoc/outreach/cardi/publications/research-and-policy-brief-series.cfm** (with Ned Rightor and Clay Frickey).

Economic Implications of Marcellus Shale 2011. CaRDI Report, available at www.greenchoices.cornell.edu.

Building Regional Economies Through Targeted Workforce Development (with Warren Brown and Ned Rightor). Albany: New York State Association of Counties, 2009.

New York State's Approach to The Emerging Energy Environment and Its Implications for Economic Development. Boston: Massachusetts State Technology Center Project on State Policies in Alternative Energy, 2008.

An Industry Perspective on Surface Transportation and the Location of Transport Hubs and Facilities: The Trucking Industry (with Michael Belzer) Presented at Brookings Institution Conference on Industries and Regions, June, 2008, Washington, D.C.

Connecting Campus and Community to Foster A Creative Economy: Strategies and Lessons From Upstate New York. New York Campus Compact Occasional Papers. Available at: http://www.nycc.cornell.edu/Documents/Publications/Occasional%20Papers/Occasional%20Papers%20summer2007.pdf

Advanced Manufacturing in New York's Southern Tier: A Report to the New York State Association of Counties (with Warren Brown and Ned Rightor) Albany NY: New York State Association of Counties, 2007.

Taking Hold of the New Economy: A New Economy Model for Upstate New York and the Finger Lakes Region Ithaca NY: Cornell University Department of City and Regional Planning, Summer 2005.

Growing Apart: Income, Poverty, and Inequality in Upstate, 1980-2000 (with Rolf Pendall) Washington DC: The Brookings Institution, August 2004.

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Transition and Renewal: The Emergence of a Diverse Upstate Economy (with Rolf Pendall and Matthew Drennan) Washington DC: The Brookings Institution, January 2004.

Optics, Imaging, and Photonics, Building a 21st Century Industry in Rochester Department of City and Regional Planning, Cornell University, March 2003

Diversifying and Rebuilding Local Economies: A Progress Report on the Department of Housing and Urban Development's Canal Corridor Initiative U.S. Department of Housing and Urban Development, August 2000.

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RECENT RESEARCH CONTRACTS AND GRANTS

Principal Investigator 2012-14
Risk Assessment of Crude Oil Transport in US Associated with Shale Oil Surge
New York State Department of Environmental Conservation
Albany, New York

Principal Investigator, 2011-15 (Two grants)
The Economic and Social Impacts of Shale Gas and Oil Development
The Heinz Endowments, Pittsburgh, Pennsylvania

Principal Investigator, 2010-11
A Comprehensive Economic Impact Analysis of the Marcellus Shale Natural Gas Drilling
Funded by: The Park Foundation, Ithaca, New York and the Heinz Endowments, Pittsburgh, Pennsylvania

Consultant Expert, 2009-11
Organization for Economic Cooperation and Development, Paris
Higher Education and Regional Economic Development
(I participated in regional studies, including in the Paso Del Norte region on the U.S. Mexico border, Sonora, Mexico; Catalonia in Spain, and Lombardy in Italy making presentations at project meetings in Paris (September 2010) and Seville (February 2011).

Principal Investigator, 2011-13
How Food Hubs Contribute to Economic Development in Rural Economies
United States Department of Agriculture

Co-Principal Investigator, 2009
Assessing the Impact of Renewable Energy on Rural Communities
Cornell Center for a Sustainable Future

Collaborating Researcher, 2009-11
The Impact Of Economic Integration On Workplace Governance in a Canada-United States Cross-Border Region
Canadian Social Sciences and Humanities Research Council

Publication Marketing and Promotion Grant, 2008-9
Alfred P. Sloan Foundation
To market and promote 2007 book, *Remaking Regional Economies*

Principal Investigator, 2008-9
Hatch-Stennis Grant Program, US Department of Agriculture
Evaluating the Economic Development Impact of Alternative Energy Development in Upstate New York

Principal Investigator, 2007-2009

NYSDEC OHMS Document No. 201166576-00026

Advanced Manufacturing and Its Impact on the New York Economy
New York State Association of Counties and New York State Department of Labor

Principal Investigator, 2003-06
The Creative Economy in Upstate New York
Hatch-Stennis Grant Program, U.S. Department of Agriculture

Principal Investigator, 2007
Retaining and Attracting a Skilled Workforce in Upstate New York
U.S. Economic Development Administration, New York State Technology Assistance Program, and the University Economic Development Center, Cornell University

Principal Investigator, 2004-06
High-Skilled Out-Sourcing – The Case of Media
The Rockefeller Foundation

Principal Investigator, 2002-06
The Restructuring of the Film and Television Industries in New York City
New York Production Alliance

Principal Investigator, 2001-03
Labor Market Processes in Rochester's Optics, Imaging, and Photonics Industry
U.S. Department of Labor

Principal Investigator, 2001-03
Workforce Development in Rochester, New York
Annie E. Casey Foundation

Visiting Fellowship, April-May 2001
Wissenschaftszentrum (Sciences Center) Berlin, Germany

Consultant, 1999-2000
Planning for Privatization of the Audiovisual Media Sector in Jordan
United Nations Conference on Trade and Development

Principal Investigator, 1999-2000
Evaluation of the Erie Canal Corridor Initiative
U. S. Department of Housing and Urban Development

Consultant, 1999-2000
Coordination of Ten Country Study of Impact of Changes in the Public Sector on Women's Occupations Paris: Organization for Economic Cooperation and Development (OECD)

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PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Chair, Editorial Board, Regional Studies Book Series with Taylor and Francis on Cities and Regions.

Chair, Advisory Committee on Higher Education and Economic Development, The International Economic Development Council. 2012-13.

US National Research Council. 2013. I was a member of an appointed panel to examine governance and socio-economic risks associated with hydraulic fracturing.

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One of my major professional responsibilities consists of publication review and editorial board work for key journals in my field and participation in establishing a new journal: *The Cambridge Journal on Regions, Economy and Society*. I have been an issue editor (responsible for soliciting articles and overseeing the editorial process and writing a synthesis piece to introduce the issue) for six issues of the journal.

Editorial Board Memberships

Current active memberships:

- *The Cambridge Journal on Regions, Economy and Society (founding editor)*
- *Geoforum*
- *The International Journal of Planning Studies*
- *Urban Studies*
- *Economic Geography*
- *Regional Studies*

CURRENT INTERNATIONAL PROFESSIONAL BOARD MEMBERSHIPS

Canada Research Chairs Program Review Panel,
Social Science and Humanities Research Council of Canada

International Advisory Board,
Centre for Urban and Regional Studies, Newcastle University

International Advisory Board,
Program on Globalization and Regional Innovation Systems, The Munk Center, University of Toronto

International Advisory Board,
The Institute of Communications Studies, Leeds University

MEDIA COVERAGE OF MY WORK

My research has resulted in interviews with and quotes in numerous newspapers including *The Los Angeles Times, The New York Times, The Boston Herald, The Philadelphia Inquirer* and *The Cleveland Plain Dealer* as well as on US National Public Radio and Television.