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January 31, 2016

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Re: Additional comments on DEC Application ID#0-9999-00075/00001 (Cargill Mine Shaft #4) focusing on Spectra Environmental Group's Well Survey

Dear Mr. Dlugolenski:

These comments, which supplement my comments dated December 9, 2016, focus on why DEC should require Cargill to produce a new well survey.

1. Abstract

In September 2015, Cargill consultant Spectra Environmental Group (hereafter Spectra), conducted a survey of well water quality in the area of Cargill's proposed Shaft 4 project. On September 3rd, 2016, the NYSDEC released to the public two documents relating to this survey. However, neither document establishes a credible base line for residential well water quality in the vicinity of Cargill's proposed Shaft 4 project. Nor does the NOIA[1] response letter accurately respond to issues raised by the NYSDEC. The two documents contradict one another and fail to make a valid scientific argument that residential wells and groundwater resources in the area of the proposed project will not be adversely-affected by the proposed reaming of Shaft 4 and by groundwater leakage into the shaft thereafter. Spectra's NOIA response letter is rife with misstatements about the hydrogeology involved.

It would therefore be inappropriate for the NYSDEC accept this pair of wildly inconsistent documents as a substitute for a valid and sufficient well survey. The public has not yet seen descriptions of survey objectives and methodology or any compilation and analysis of the laboratory findings. The absence of most information regarding the sampling of Cargill's own residential well on the project property suggests that Cargill and Spectra may have engaged in evidence suppression. Issuance of a permit for Shaft 4 should at least be delayed until Cargill can engage a contractor to redo the well survey and issue a credible report that does not engage in conflicted, unsubstantiated claims. Of particular importance, a saline beach well included in Spectra's survey needs to be investigated to identify the source of the salinity and whether the well's salinization has been caused by salt mining perturbations below this portion of the lake.

[1] NOIA stands for Notice of Incomplete Application.

2. The documents released. Two well survey documents were made available to the public at the beginning of the first public comment period which began on September 3, 2016:

a) **NOIA Response letter w Figure and Plates.pdf** 17 pages

b) **Resident Well Survey Data Final Letters.pdf** 123 pages

The 17-page "NOIA response letter" was sent to NYSDEC on Spectra Environmental Group letterhead and was signed by "Edward G. Davidson, project environmental scientist." In the two pages of text devoted to well survey issues, Mr. Davidson, makes the flawed argument that even if reaming Shaft 4 affected ground water resources, all residential wells are either too far away and too shallow to be affected. Mr. Davidson makes assertions about ground water and well issues that do not square with the findings of Spectra's own survey or with standard hydrogeology. For example, he states that no residential wells are located within the same drainage pathway as the proposed Shaft 4 shaft, when in fact two of the 11 wells sampled by Spectra are clearly in that pathway. He incorrectly asserts that presence of relatively-shallow ravines (<15 feet deep) would effectively isolate all water table draw-down effects of Shaft 4 reaming to within these "discharge boundaries." He greatly under-estimates the distances that drawdown impacts might extend to by an order of magnitude.

The 123-page document is a compilation of 1-page cover letters with attached water analysis results that were sent to each of 10 owners of the 11 drinking water wells that were sampled in the area surrounding the proposed Shaft 4 site. The 11th well sampled is on the 57-acre parcel proposed as the site of Cargill's Shaft 4 project. No explanation is given for why no letter to Cargill and no laboratory analysis for this well were released as part of the public disclosure process.

Spectra may have limited the information made public about Cargill's residential well because they knew that such data undermined their already suspect claim that there was little or no well water in the area of the proposed Shaft 4 and therefore no residential wells could be harmed by the construction of Shaft 4.

None of Spectra's letters to homeowners warned any of them of any water quality issues associated with their well water. However, as can be seen in Table 1 below, all ten wells for which data are available exceeded EPA's secondary drinking water standard for manganese.[2] In addition, the samples collected indicated that eight wells were at or above EPA's secondary drinking water standard for sodium, and five well samples were in exceedance of EPA's secondary drinking water standard for iron. Samples from four wells were positive for total coliform.

The most contaminated well, however, was a "beach well," on the shore of Cayuga Lake owned by local residents, Frederick and Lisa Campbell. When Mr. Campbell heard that a

[2] https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

salt company was conducting a well survey, he asked that his saline beach well be sampled. The sample from his beach well exceeded primary drinking water standards for lead (1.4 times over standard), and barium (27 times over standard). It also exceeded EPA's secondary drinking water standards for chloride (40 times over standard), sodium (285 times over standard), iron (123 times over standard), and manganese (21 times over standard). The well also tested positive for total coliform and E. coli.

It is standard practice in water quality surveys to resample those sites that yield anomalous results. This is done to rule out the possibility that a contaminated sample bottle, laboratory error, or other similar incidental cause having resulted in the anomalous results. Based on my conversations with Frederick Campbell and Brian Oursler, it appears that Spectra made no attempt to resample their wells despite their wells having yielded anomalous results. Brian Oursler said that when he called Spectra with some questions, he was told that Spectra was not at liberty to discuss the results. He was directed to call county health officials.[3]

So, despite an invitation in Spectra's cover letter that accompanied the laboratory results to call them with any questions, it would appear that Cargill instructed Spectra to walk away from the survey and not, for example, delve further into the contaminated beach well findings or even discuss the initial findings with well-owners. Generally, project applicants are quite zealous about documenting any anomalous water quality issues that can be shown to exist pre-project so as to guard against their future project being subsequently blamed for causing any of pre-existing conditions. One possibility for ending the well survey work after the initial round of sampling is that Cargill didn't want any further attention brought to a) their own well and/or b) the highly-contaminated Campbell beach well. This could explain why no report may never have been produced.

Table 1. Water quality for 11 wells sampled by Spectra Environmental, Sept 2015

Analyte/ Owner	**CL 250***	**Na 20***	**Fe 0.3***	**Mn 0.05***	**Lead 0.015***	**Ba 2***	**Total Coliform**	**E. coli**	> stand.
Beckwith	36.6	**20**	0.15	**0.098**	0.00026	0.1925	Negative	Negative	2
Beckwith	48	**20**	**0.95**	**0.093**	0.00031	0.1414	Positive	Negative	4
Vanostrand	79.6	**71**	0.09	**0.11**	0.0035	0.3867	Negative	Negative	2
Koplinka-Loehr	5.54	5.7	0.07	**0.093**	.00039	0.1613	Negative	Negative	1
Bowman	20.1	13	0.27	**0.132**	0.01231	0.1328	Negative	Negative	1
Cargill Inc.	--	--	--	--	--	--	--	--	?
Gwilliam	82.3	**57**	**0.33**	**0.103**	ND	0.1739	Negative	Negative	3
Armstrong	117	**51**	**0.33**	**0.084**	0.00267	0.1316	Positive	Negative	4
Makela	126	**100**	**0.48**	**0.053**	0.00111	0.2114	Negative	Negative	3
Oursler	68.8	**120**	0.19	**0.191**	0.00821	0.317	Positive	Negative	3
Campbell	**10100**	**5700**	**37**	**1.04**	**0.02034**	54.3	Positive	Positive	8
*These numbers are all in mg/L and represent EPA drinking water standards.									
Source: derived from Spectra's Resident Well Survey Data Final Letters.pdf									31

[3] Telephone conversation between John Dennis and Brian Oursler on 23 Jan. 2017.

This raises the ethical question as to whether Cargill and its consultant incurred a scientific and moral responsibility to retest wells that had anomalous test results or to at least suggest to the owners that problems could exist and retesting was recommended.

The absence of analytical data for Cargill's well suggests that the project applicant may have engaged in data suppression. If the water table can be seen at, say, 15' below grade, this would contradict Spectra's "suggestion" that there is an "absence of producing zones in the normal depth range of residential wells." The absence of a report for any of the wells studied could be the result of Spectra having found sufficient methodological issues in the implementation of its survey and then concluding that no credible report could be issued without doing the fieldwork over. In any case, the two documents released to the public fall short of constituting a valid scientific report in these respects:

- -lack of any statement of survey objectives
- -lack of any description of the methodology used to select local water wells for sampling
- -lack of a sufficiently large sample size
- -lack of any description of the methodology used to collect, store, and transport the water samples to the laboratory
- -lack of any map showing the location of the sampled wells
- -lack of any table showing water quality findings and descriptive data for all 11 wells
- -assertions about wells and groundwater in the NOIA response letter that conflict with information provided to well owners and with other available information.

If a Spectra report on the research findings does exist, the DEC should release it.

3) Problems with survey methods.

3.1 Survey Objectives.

Without a report being submitted, the public doesn't know what the survey objectives were. One can simply infer that Cargill wished to demonstrate that it was unlikely that users of local well water would be adversely affected by the reaming of the proposed Shaft 4 or by any subsequent ground water leakage into the shaft over its likely 30+ year life span.

3.2 Lack of any description of the methodology used to select local water wells for sampling

Again, without a report, one can only deduce what sort of methodology went into selecting household wells for sampling. We do not know whether this was, for example, a random sample of all the households living within, say, one mile of the proposed project. Or, was it more of an ad hoc windshield survey: there is someone home here, let's see if they will participate?

I have created Map 1 below using the reported locations of the sample wells and so it is possible to report that all 11 sampled wells appear to be within 0.78 miles of the proposed vertical shaft component of the project. It is also possible to distinguish two types of well owners. Owners of sampled wells located on three east-west-running roads (Lansing Station Road, Sweazey Road, and Ross Road) have access to only their drilled wells for their water supply (and any purchased drinking water). On the other hand, residents living along the roughly north-south-running roads (Ridge Road & Bill George Road) have the option to invest in alternatives to drilled wells. Bolton Point municipal water supply is available along Ridge Road for a fee and residents living on Bill George Road have the options of sourcing water from the lake or from drilled wells or both. When Frederick Campbell asked to have his contaminated beach well at his rental property sampled, apparently no one asked him if his drilled well or his second beach well at his nearby residence could also be sampled.

3.3 Sample size. Larger numbers of samples are needed as variability between whatever is being sampled increases. There is no indication that the Spectra team field-tested water quality variability in order to identify an appropriate sample size. The sample that Spectra went with consists of 10 drilled residential wells and one contaminated beach well. The beach well was added to the survey about two weeks after the ten drilled wells had been sampled. Such an ad hoc addition of one instance of a new sample type to an existing sample of ten drilled wells would get flagged even in a high school science exercise as lacking methodological rigor. Having been given a heads up that the well was saline and non-potable, the Spectra field team should have been prepared to sample at least nine other beach wells as well as some nearby lake water which is understood to be the source of beach well water.

The fact that Spectra did not regard adding a highly-contaminated well to the survey as cause to increase sample size, especially the number of beach wells being sampled, indicates either an unfamiliarity with survey methodology or a disregard of it.

If the beach well data are set aside due to being from a different well category and as the laboratory data are missing for Cargill's well, the number of drilled wells with complete water quality data drops to 9. But, the User Inventory notes indicate that the Oursler residence sample was taken at the kitchen sink. The Ourslers do not recall where the sample was collected in September 2015, but Mr. Oursler confirms that any sample taken at the kitchen sink would have been after their water softener (telephone conversation between John Dennis and Brian Oursler on January 23, 2017). Thus, the sites for which reliable water quality data are available has dropped to 8. And among those 8, the User Inventory notes only indicate 3 of these wells as definitely being sampled before the water softener. Spectra could have rectified these problems by doing a second round of expanded water sampling, but evidently opted to not to write a report and hope that no one looked carefully at their household level results.

3.4 Lack of any description of the methodology used to collect, store, and transport the water samples to the laboratory.

Due to the lack of any well survey report being released to the public, there are a host of issues related to the collection, storage, and transportation of water samples about which we have no information. Under the heading "limitation of liabilities" Alpha Analytical, the laboratory used by Spectra to analyze the samples, has this text in their reports, "We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field." No information on any of these aspects of the survey methods has been provided. We don't know, for example, whether water lines were allowed to discharge for a specified period of time prior to collecting samples. We don't know the kind of containers samples were collected in, whether these samples were stored in coolers, or whether chain of custody procedures were followed between the each well and the laboratory.

However, the "comments" section of the two-page "inventory of groundwater users" that has been provided for each of the 11 wells, appears to confirm that for only four of the wells (Campbell, Vanostrand, Armstrong, Makela) was the sampling point definitely before a water softening device. This is a mission critical requirement for valid sampling.

As mentioned, Brian Oursler confirms that, if the water sample was collected at the kitchen sink, then the sample definitely consisted of water that had been altered by their water softening device.[4] This leaves six more samples for which the comments do not indicate whether the sample might have been impacted by water softener chemistry. The Oursler sample results are particularly anomalous in that the concentration of sodium is almost twice that of chloride. Normally, due to the molar ratio of chloride to sodium in the sodium chloride molecule, chloride generally exceeds the amount sodium in drinking water. An alert water quality survey manager, on seeing this high amount of sodium vis-à-vis chloride, would have immediately sought to resample the Oursler well.

3.5 Lack of maps. Without there being any maps released to the public, it is possible for Spectra's Edward Davidson to write that "there are no nearby residential wells" sharing the drainage pathway within which the proposed Shaft 4 would be located without it being immediately obvious that this is clearly an incorrect statement. As can be seen in Map 1 below, two of the 10 drilled residential wells sampled clearly exist within the same drainage pathway. They are Cargill's own residential well, located about 700 feet upgradient and due east of the proposed Shaft 4 site, and the Koplinka-Loehr well located about 1700 feet downgradient and due west of the proposed Shaft 4 site. Ground-truthing confirms that both wells are located within the drainage pathway that is bordered by ravines and where Shaft 4 is proposed to be located.

If DEC has received a map of the well survey well locations—as indicated in Davidson's NOIA response letter--, it's not clear why it was not released to the public. Map 1 below is based on the street addresses of the properties sampled and then dropping a pin at the home on the property in order to generate new GPS coordinates when those reported in Spectra's letters to well-owners were clearly in error. Map 2 shows well locations using the well coordinates recorded by Spectra. Spectra's coordinates for the well at 91 Ross

[4] Phone conversation between John Dennis and Brian Oursler on 23 January 2017.

Road, place it about a quarter of a mile out in Cayuga Lake. The Vanostrand well at 101 Ross Road, ends up three quarters of a mile away at the intersection of Lansing Station Road and Ridge Road. It appears that neither Mr. Straw nor anyone else at Spectra error-checked the GPS data.

3.6 Lack of any table showing water quality findings and descriptive data for all 11 wells.

Table 2 on the next page has been compiled from information contained within the 123-page document containing letters mailed to well owners. As can be seen, well yield data is provided for only the two Beckwith wells and the Koplinka-Loehr well. For the Cargill well, Cargill could have arranged for a pump test to determine their well's yield and a laser device could have been readily used to measure the distance to the top of the water table within the well casing. We do not know why Cargill did not enable this highly pertinent information to be collected as part of the well survey.

Without a report presenting complete and well-organized data, Edward Davidson may have felt at liberty to write on page 3 of his 26 Jan 2016 letter to DEC the following paragraph:

> "Only deep continuous drilling can detect and quantify water-bearing zones, so the record of Corehole #18 is the only reliable source. The record suggests an absence of producing zones in the normal depth range of residential wells. One can conclude that a potable groundwater resource is present but it is relatively shallow and is not produced from, or connected with, any deeper permeable zones of suspect or suitable water quality which might participate in Shaft 4 development."

The above paragraph is confusing because first Davidson writes that the "record" suggests an absence of producing zones in the normal depth range of residential wells. But, in the next sentence he writes that a potable groundwater resource ***is*** present. Clearly, it cannot be both present and absent. In any case, a close reading of the Corehole 18 report (RESPEC, 2013) reveals that the pertinent information for assessing the presence of water-watering formations was either not collected or left out of the report.

Table 3 on the subsequent page shows yield data highlighted in yellow for the three Town of Lansing wells registered in the DEC's water well data base that are located within one mile of the proposed Shaft 4 project. The takeaway from the DEC's data on these 32 residential wells is that the average well yield in the Town of Lansing is 8.5 gpm, whereas for the three wells close to the proposed Shaft 4, the average yield was only 1.5 gpm. By contrast, the average yield for the three wells in Spectra's sample for which yield data is available is 29.2 gpm, i.e, almost twenty times more productive than the three nearby wells that are in the DEC water well data base.

As can be seen from Tables 2 & 3, the Koplinka-Loehr well is the real stand-out amongst the 11 wells sampled by Spectra. It has by far the highest yield at 60 gpm and it has by far the best water quality with negligible amounts of chloride, sodium, iron, and barium.

Manganese and lead are on a par with the other 8 drilled wells for which data was provided. Total coliform and E. coli were both negative. And this well has twice the yield of the highest yielding well among the 32 wells in the Town of Lansing that are recorded in the DEC's water well data base. When one looks at the data in tabular format in conjunction with an accurate map of the well locations, it seems that a conclusion quite different from "absence of producing zones" paragraph above could be drawn along the following lines:

> Review of DEC's water well database for this part of the Town of Lansing indicates three water wells with an average yield of only 1.5 gpm. Of the three wells in 2015 Shaft 4 area well survey for which yield data are available, average yield is 29.2 gpm with the Koplinka-Loehr well at 60 gpm. And the water is some of the best quality water found in the area. As this 200' deep well is immediately down-gradient from the proposed Shaft 4 project, these well data seem to indicate that the drainage pathway chosen by Cargill for its Shaft 4 project has the best ground water resources in the entire Town of Lansing and significantly better water resources than do neighboring areas. Therefore, the potential for adverse consequences from the reaming of Shaft 4 could be high not only for the four or more well owners owning drilled wells within this drainage path but for the entire Town of Lansing. **The residential well on the Cargill parcel needs to be resampled and the depth to the water table measured so as to better describe ground water resources close to the proposed Shaft 4 site. The continuing absence of this data is a fatal flaw of Spectra's well survey and one that the DEC cannot overlook.**

Survey water quality findings. Using a "here-are-your-water-quality-results; call-us-if-you-have-any-questions" form letter, Spectra did send the survey's water sample laboratory results to 10 homeowners without comment and without any indication as to whether any drinking water standards had been exceeded. Homeowner Brian Oursler did call the number provided by Spectra to ask some questions, but he was informed that Spectra was not at liberty to discuss the findings and instructed to call his local state health department office.

Here are some deficiencies found in those letters to well-owners:

- Spectra did not mention to the ten sampled homeowners that all of their wells had tested out at or above EPA's secondary drinking water standard for manganese and that this condition sometimes causes black discoloration of the water as well as bad odor and taste.

- ♦ Spectra did not mention to eight of the sampled homeowners that sodium content in their water had tested at or above EPA's 20 mg/L secondary drinking water standard for sodium for people on low-sodium diets.

- ♦ Spectra did not mention to Frederick and Lisa Campbell that the beach well at their rental property on the east shore of Cayuga Lake tested out at 5700 mg/L or 285 times EPA's secondary drinking water standard for sodium of 20 mg/L for people on low sodium diets.

- ♦ Spectra did not mention to the Campbells that the beach well at their rental property had also tested out at 40 times EPA's secondary drinking water standard for chloride and just slightly under EPA's drinking water standard for arsenic.
- ♦ Spectra did not mention to that four well water samples had tested positive for total coliform and therefore should be retested to determine whether or not fecal contamination could be a problem in their well water. In their cover letter, Spectra did not inform the Campbell family that their rental unit's beach well had tested positive for both total coliform and for *E. coli.*

As research findings are typically owned by the client, DEC and the public would need to ask Cargill why their contractor walked away from these public health issues and no report was ever issued.

Table 2. Selected water quality parameters: eleven drinking water wells tested by Spectra Environmental Group in September 2015

address	surname	Year drilled	Yield (gpm)	Depth of Well(ft)	Depth to Water(ft)	Sampled after Softener	Water Quality Issues by interview	pH lab field	Spec. Cond. umhos/cm	Cl mg/L	Na mg/L	As mg/L
										250***	**20*****	**0.01*****
91 Ross Rd	Beckwith	2006	18	82	10	?	hard	7.2 7.22	780	36.6	**20**	ND
95 Ross Rd	Beckwith	1984	9.5	80	9	?	hard/S/Fe	7.3 7.26	860	48	**20**	ND
101 Ross Rd	Vanostrand	--	--	--	--	No	hard/S/Fe	7.5 7.38	900	79.6	**71**	ND
118 Ross Rd	Koplinka-Loehr	2008	60	200	24	?	hard/S	7.3 7.06	690	5.54	5.7	ND
952 Ridge Rd	Bowman	1979	--	55	14	?	hard	7.5 7.15	700	20.1	13	ND
1001 Ridge Rd	Cargill Inc.	--	--	--	--	?	--	--- 7.16	943§	--	--	ND
53 Lansing StRd	Gwilliam	--	--	--	19	?	hard/S	7.3 7.36	910	82.3	**57**	ND
33 Sweazey Rd	Armstrong	--	--	--	9	No	hard	7.4 7.16	940	117	**51**	0.0002
67 Sweazey Rd	Makela	1979	--	52	16	No	hard/S	7.6 7.42	950	126	**100**	ND
242 Bill George	Oursler	2008	--	225	35	Yes	S/Fe	7.4 7.16	950	68.8	**120**	ND
367 Bill George	Campbell	1964	--	10*	2**	No	saline	7.0 6.66	25,000	**10,100**	**5,700**	0.00602

Source: compiled from ***Resident Well Survey Data Final Letters.pdf*** approximated by owner* and by John Dennis from photo**
*** = EPA primary or secondary drinking water standard in mg/L. Numbers in **bold font** are in exceedance of EPA standards.
S = sulfur Fe = iron hard = hardness § = field measurement rather than laboratory

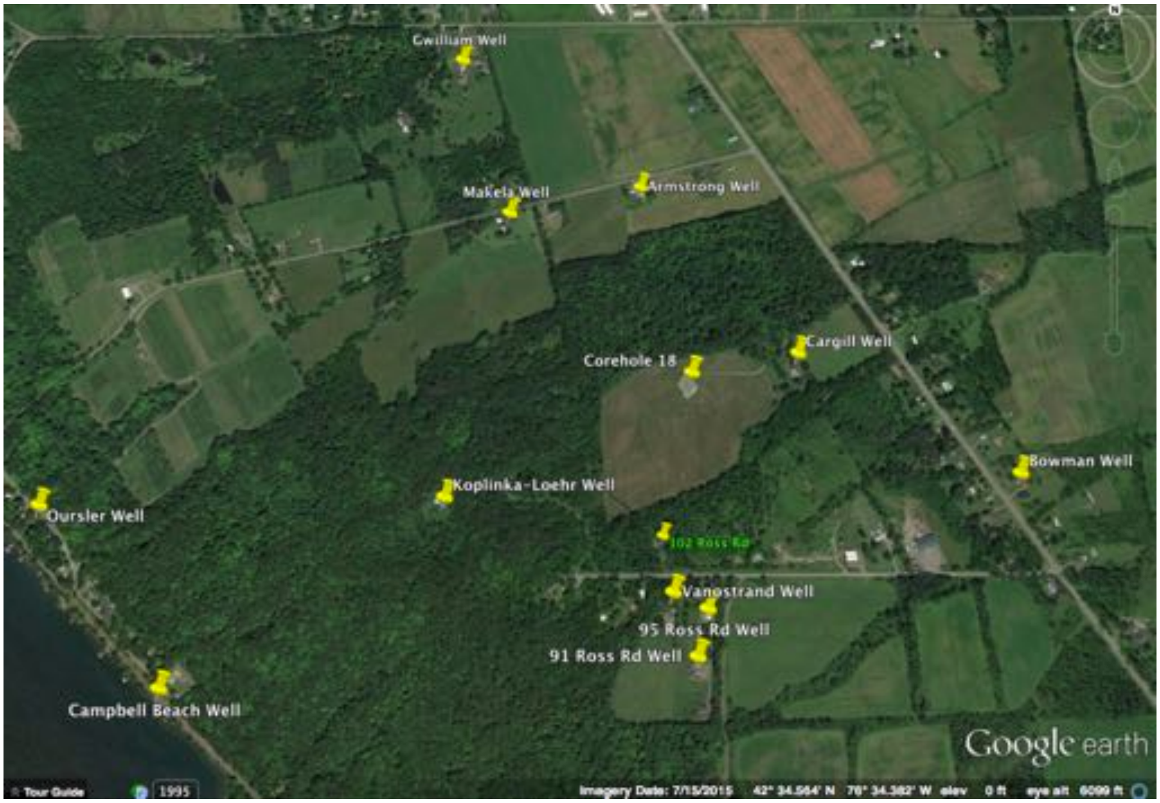
Table 3. NYSDEC water well data base data for Town of Lansing, Tompkins County

well no.	address	latitude	longtitude	well depth ft	rock depth ft	ground water depth ft	yield gpm
TM1944	ALGERINE RD	42 35 19.6	76 35 56.1	*	16	*	10
TM1257	ALGERINE RD	42 35 19.8	76 36 30.6	178	11	*	0
TM1397	BENSON RD	42 31 51.6	76 28 26.4	199	15	25	4
TM1208	BENSON RD	42 32 04.5	76 28 22.7	199	12	20	1.5
TM2250	BUCK RD	42 33 23.6	76 29 57.1	140	10	20	12
TM1449	BUCK RD	42 33 22.6	76 30 00.5	63	14	8	15
TM1709	BUCK RD	42 33 27.0	76 29 16.0	83	15	*	7
TM1862	BUCK RD	42 33 27.2	76 29 30.2	200	24	30	1.5
TM1690	DATES RD	42 36 17.6	76 33 57.2	77	*	76	15
TM1943	DRAKE RD	42 31 43.4	76 30 49.4	100	6	28	5
TM1737	DUBLIN RD	42 34 53.5	76 33 28.7	30	20	4	20
TM1701	EAST LANSING RD	42 34 06.6	76 28 48.0	42	22	*	12
TM2766	GOODMAN RD	42 34 34.7	76 27 41.2	250	15	40	2
TM1906	GOODMAN RD	42 34 34.3	76 27 27.7	140	15	*	15
TM1483	JERRY SMITH RD	42 35 43.8	76 34 00.8	30	NR	1	30
TM1470	LAKE RIDGE RD	42 37 10.0	76 37 04.0	140	25	*	12
TM1605	LANSING STAT. RD	42 34 35.4	76 36 02.4	180	26	13	0.5
TM1594	LANSING STAT. RD	42 34 54.5	76 36 45.6	160	39	*	0.5
TM3042	LANSINGVILLE RD	42 35 21.0	76 33 15.4	105	*	20	3
TM1416	LOCKE RD	42 36 43.2	76 29 06.0	300	140	5	5
TM1958	MYERS RD	42 32 44.2	76 33 06.5	200	52	40	2
TM1730	N/A	42 32 00.0	76 27 41.4	85	34	12	*
TM2074	N/A	42 35 40.7	76 34 14.5	55	43	22	10
TM1729	PERUVILLE RD	42 32 35.0	76 28 50.0	140	12	23	6
TM1731	ROSS RD	42 34 05.2	76 35 06.6	183	20	42.5	2
TM1902	RT 34	42 34 46.1	76 29 25.9	52	2	5	12
TM1615	SCOFIELD RD	*	*	203	5	*	2
TM1486	SHARPSTEEN RD	42 36 57.9	76 30 02.9	105	*	12	2
TM2092	ST RT 34	42 37 30.3	76 29 32.2	120	50	*	4
TM1484	SWEAZEY RD	42 34 27.0	76 35 34.8	70	*	10	2
TM1911	VAN OSTRAND RD	42 32 36.0	76 27 57.9	47	20	5	30
TM1305	VAN OSTRAND RD	42 32 41.5	76 28 10.3	95	32	11	20
	N=32		average:	128		21	8.5

yellow highlighting indicates wells within 1 mile of Corehole 18

* = missing data

source: table adapted from data at http://www.dec.ny.gov/cfmx/extapps/WaterWell/



Map 1. Google Earth image showing corrected locations of 11 sample wells

Map 2. Google Earth image showing locations of 11 sample wells as reported by Spectra

Note: I have added to both maps 102 Ross Road, referred to by Mr. Davidson as the "closest residential well" to the proposed Shaft 4 site.

3.7 Assertions about wells and groundwater in the NOIA response letter that conflict with information provided to well owners and with other available information.

On page 2 of Edward Davidson's January 26, 2016, NOIA response letter to DEC a DEC query is pasted in as:

> *Comment 4: Impacts to Groundwater:*
> *Per the observation points and Corehole#18, please identify all water bearing zones in the overburden, and uppermost bedrock zones. The groundwater head elevation in the shaft vicinity is identified at elevation 750', approximately 10' below grade. No supporting information is provided to support the conclusion that there will be no impacts to groundwater users during shaft construction resulting from depressed groundwater elevations. Please provide additional information/ evaluation.*

Before considering Davidson's response, let's look at the data from the well survey letters to homeowners and compiled here in Tables 1 & 2. The DEC indicates that it understands groundwater in the proposed Shaft 4 area to be "approximately 10' below grade." Water table depth for the 8 survey wells with this datum indicate an average depth of 17'. Samples were collected on 8-9 September 2015 and in the user inventory section of the laboratory results are comments that a number of water tables may have been lowered by recent watering of gardens. Missing from these data is the depth to water table for Cargill's own well. A note indicates that the Vanostrand well's water table depth was not measured due to the bolts holding the well casing cover being rusted but no reason is given for not determining the depth to water table for Cargill's residential well.

In other words, Davidson might have replied to DEC:

"Yes, our well survey data indicate that in three instances the water table was found to be a mere 8-10 feet below grade and on average water tables began at 17' below grade. We have omitted water table depth at Cargill's own residential well which is the well closest to the proposed Shaft 4 site.

"For the six wells for which we obtained well depth information, the range was 52 to 225 feet below grade with an average depth of 116 feet. During the drilling of Corehole 18, the thickness of the overburden was found to be 28.5 feet thick (RESPEC, 2013, p. 2 and confirmed in graphic on p. 21). If this overburden thickness is assumed to be representative for all 10 drilled wells, then all ten wells entered bedrock and on average were 75% within bedrock and probably drawing all or most of their produced water from water-bearing Hamilton Group shales. We know from the Spectra survey that depth to bedrock was 22' at the Oursler residence down at the lake. And we know that depth to bedrock was 41' at the Koplinka-Loehr well. These well bores were thus 90% and 80%

within bedrock, respectively, and drawing entirely from bedrock formations."

However, Spectra's Davidson goes down an entirely different route trying to make the case that shallow aquifer resources are relatively insignificant and in any case would not connect to bedrock aquifers, which he implies might be drawn down by Shaft 4 construction. Some of his NOIA response text appears below following his initials, EGD, and in bolded, italicized font. My annotations follow my initials, JVD, and are not bolded or italicized.

EGD: "As noted in the application narrative submitted October 20, 2015, completion of the stratigraphic test hole (Corehole #18) encountered no significant water bearing zones in the shallow geology, down to nearly 1,500 feet below ground."

JVD: What did the RESPEC authors means when they wrote, "No other significant water production zones were noted in the upper 1,555 feet of the borehole? It's perhaps useful to recall that representatives of RESPEC were only on site intermittently prior to the start of the coring work at about 1,555 feet. William Frey, owner of Frey Pump and Drilling, the company that drilled the first 1,555 feet, describes the water resources in the first 1,555 feet somewhat differently:

William Frey: "We put casing to rock at about 80 feet…and, yes, we encountered some water, perhaps 5 gpm--homeowner water. We then drilled from 80-500 ft, but to safeguard all the water, we cemented in 500' of casing" (telephone conversation between John Dennis and William Frey on 12 January 2017).

JVD: In order words, the Frey drilling team hit enough water in the first 500 feet that they felt obliged to install casing down to 500' to protect these groundwater resources. They conducted no pump tests to measure formation yield prior to a pump test at 1490' below grade.

EGD: "The residential well survey data can be utilized to estimate the depths of low-yield, shallow aquifers. However, from the residential well data sheets (enclosed), and from publicly available resources, it is apparent that information on any production zones throughout the hillside terrain cannot be known, because the rock has not been exploited for water resources to depth beyond 200 feet."

JVD: as noted above, for the six Spectra survey wells with depth information, an average of 75% of the boreholes are within rock and therefore it can be assumed that these wells are pumping from aquifers in shale or limestone. Corehole 18 runs from 28.5' to about 370' below grade in shale, but one must remember that the 225' deep Oursler well down near the lake would be reaching to about the 500' depth of Corehole 18 and, needless-to-say, finding an adequate supply of water at that level.

EGD: "Note that nearly all the surveyed hillside wells produce from a shallow groundwater zone, likely near the top of rock."

JVD: At an average well depth of 116' and with rock starting at 28.5' at Corehole 18, 22' at the Oursler residence, and 44' at the Koplinka-Loehr residence, these wells for most or even all wells are drawing from below the top of bedrock. For the six wells for which well depth information is available, these wells would not be producing "near the top of rock" but on average about 88' down into the rock. The Oursler well is reportedly 203' into rock; the Koplinka-Loehr well is reportedly 159' into rock and screened so that all produced water is from the last 25' of the borehole.

EGD: "This may be required either because lower productive zones are not present, or because sulfurous water occurs at lower depths. Well drillers are aware of this likelihood in shale aquifers, and avoid deeper zones, even if any are, indeed, present in the hillside area."

JVD: Davidson is sharing "conventional wisdom" about well drilling in Central New York but pointedly ignoring his survey's own data: the Oursler and Koplinka-Loehr wells, both drilled in 2008, went as deep as they did because the water quality and/or supply got better with depth.

EGD: "Fortunately, in many places in glaciated terrain the base of the till is commonly an important water-bearing zone where it contacts the weathered top-of-rock rubble. The thickness of the till in the hillside area can be inferred from the length of casing for each well, where identified. Note also that the length of open borehole is less than what may be expected for storage – perhaps to avoid a quality issue."

JVD: Here again, Davidson is sharing "conventional wisdom" without referencing *any* information from his company's own survey. The Spectra survey recorded casing diameters but not casing lengths.

EGD: "Only deep continuous drilling can detect and quantify water-bearing zones, so the record of Corehole #18 is the only reliable source. The record suggests an absence of producing zones in the normal depth range of residential wells. One can conclude that a potable groundwater resource is present but it is relatively shallow and is not produced from, or connected with, any deeper permeable zones of suspect or suitable water quality which might participate in Shaft 4 development.

JVD: As already mentioned, Davidson contradicts himself here, saying first that "an absence of producing zones in the normal depth range of residential wells" is "suggested." And, then, in the next sentence he writes that "a potable groundwater resource is present but it is relatively shallow and is not produced from or connected with, any deeper permeable zones of suspect or suitable water quality which might participate in Shaft 4 development." His own survey indicates that from a number of wells in his survey, the produced water is entirely from bedrock formations. And furthermore, unless information was withheld from the Corehole 18 report, with the exception of the pump test conducted at 1490' bgs, that operation did not collect the information needed to identify water-bearing formations.

JVD: And, what evidence does Davidson provide to rule out connectivity with deeper permeable zones? Apparently, he has not read the RESPEC 2013 Corehole 18 report carefully or read through Cargill Cayuga Mine. Expanded Environmental Assessment Volume II, a document that his company produced for Cargill in year 2000. On page 38 of the Corehole 18 report, the authors write,

RESPEC: "What is significant to note is the presence of tritium in the formation water samples and their stable isotopic signatures. The detectable tritium indicates the presence of some modern (i.e., post-1960) water."

And, on page 40,

RESPEC: "RESPEC believes these results reflect the presence of modern (i.e., post-1960) meteoric waters in the formation."

JVD: In other words, RESPEC believes that there is connectivity between formation water at about 1555' below grade and meteoric sources. This flatly contradicts Mr. Davidson's data-free assertion that there is probably no connectivity between shallow aquifers (<300 feet) and deeper formations which "might participate in Shaft 4 development."

JVD: Figure 1 below shows major joint sets in the central New York area. These joint sets offer one means of hydraulic connectivity between shallow groundwater resources and deeper groundwater resources. Figure 2 below shows a depiction of the likely shallow groundwater flow regime in the area of Cargill's operation at Portland Point. The flow regime south of Waterwagon Road may be analogous to the topography at Cargill's proposed Shaft 4 location: water moving consistently downgrade toward the lake through glacial till.

JVD: Figure 3 below is known as Plate 3.1-9 Profile B in a year 2000 Spectra document. It shows the expected groundwater flow patterns as ground waters approach Cayuga Lake from bedrock zones located to the east and west of the lake. This "section" reaches the east shore of Cayuga Lake between Lansing Station Road and Sweazey Road, i.e, more or less due west of Cargill's proposed Shaft 4 project. In this figure, the hydrosphere—shown in green and yellow—is essentially continuous down to the Oriskany formation located in this figure at about 1,100 feet below grade at the far left of the figure.

EGD: As illustrated on Plate 4 of the October 2015 submission, from the proposed Shaft 4 location, the nearest residential well is located about 1100 feet south, diagonally downslope, and on the opposite side of two ravines (among many others across the hillside) that carry intermittent streamflow.

JVD: Mr. Davidson evidently has not visited the Cargill parcel. There is one ravine—not two—between the proposed Shaft 4 location and the residential well at 102 Ross Road he refers to and which I have located on Maps 1 & 2 using a green font. 102 Ross Road was not part of Spectra's well survey. A walk across the Cargill parcel with a neighbor who has Cargill's permission to access the property did not reveal any additional ravines, let alone, "many others across the hillside." For some reason plates 3 & 4 were missing from the NOIA response letter that DEC released to the public.

EGD: Some deflection and partial isolation within the shallow, water-table groundwater flow regime is required by the significant boundary conditions imposed by this drainage configuration. Periodic convergent groundwater discharge to the ravines, cited elsewhere, creates a discharge boundary, across which groundwater does not transfer. Shaft 4 is thereby hydraulically isolated from other wells to an extent that prevents any accurate measurements of head interactions, even if these were possible given the separation distances involved.

JVD: Whether or not the 12-foot deep ravines running along the north and south boundaries of Cargill's 57-acre parcel could be expected to act as discharge boundaries for meteoric waters percolating into that shallow glacial till is debatable. RESPEC found this till to be 28.5' thick at the Corehole 18 location. However, for wells drawing water from the shale bedrock that RESPEC found to exist from 28.5' to 370', a draw-down of the aquifer could readily extend north and south of the ravines Davidson refers to, especially if fracture and joint connectivity exists as would be expected in this geology. And, more to the point, Davidson ignores the findings in this own survey that the Cargill and Koplinka-Loehr wells exist within the discharge boundary he is discussing, as do other wells on Ridge Road and Bill George Road that were not identified in his survey.

EGD: Refer to Plate 4 and note again that the down-slope topography (and its contained groundwater gradient) of the proposed Shaft 4 facility is bordered laterally by ravines. If any interference of Site 4 were to occur it would have to be limited to, and measured in, the area between the ravines, in either an up- or down-gradient direction. There are no nearby residential wells sharing this pathway.

JVD: "There are no nearby residential wells sharing this pathway." is a false statement. The Cargill residential well is about 690' upgradient from the Corehole 18/proposed Shaft 4 site. The Koplinka-Loehr residential well is located 1,725 feet down-gradient from the Corehole 18/proposed Shaft 4 site. Additional wells exist further east and west.

EGD: As discussed within the October 2015 submission, development of the proposed Shaft #4 may expose several water-bearing zones. The shape of the outflow head complex as expressed to the walls of the shaft would be a series of seepage faces, each of which causes a local "cone of depression" that extends into the host rock, a usually short distance, limited by the seep hydraulic conductivity. Experience shows that even with fairly high hydraulic conductivities of limestones, the seepage drawdown will moderate significantly within a short distance of up to a few hundred feet, and become negligible.

JVD: "Up to a few hundred feet" underestimates the likely distance of "seep hydraulic conductivity" by an order of magnitude. Davidson is forgetting to factor in that the bedrock adjacent to the Finger Lakes tends to be highly-fractured and jointed as a result of serial glacial loading and unloading. It is these north-south running fractures and joints that would be more likely to determine the extent of water table draw-down events related to the proposed construction of Shaft 4 and to expected leakage into the shaft subsequent to the proposed construction.

Here are descriptions of joint sets in a report by Sear-Brown regarding geology north of Cayuga Salt Mine:

"Two strong joint sets are reported in the shales. The first set strikes N 09°-25° W (azimuth 335°-351°) and dips 85°-30°. The spacing of these joints at the NYSEG power plant site range between 2 ft and 30 ft. …..The second joint set strikes N 68°-70° E (azimuth 68°-70°). The spacing of these joints at Cayuga Station ranges between 2 ft and 22 ft." (Sear Brown. n.d. Geology/Hydrogeology of the Cayuga Salt Mine. Lansing, NY. draft. p. 3.)

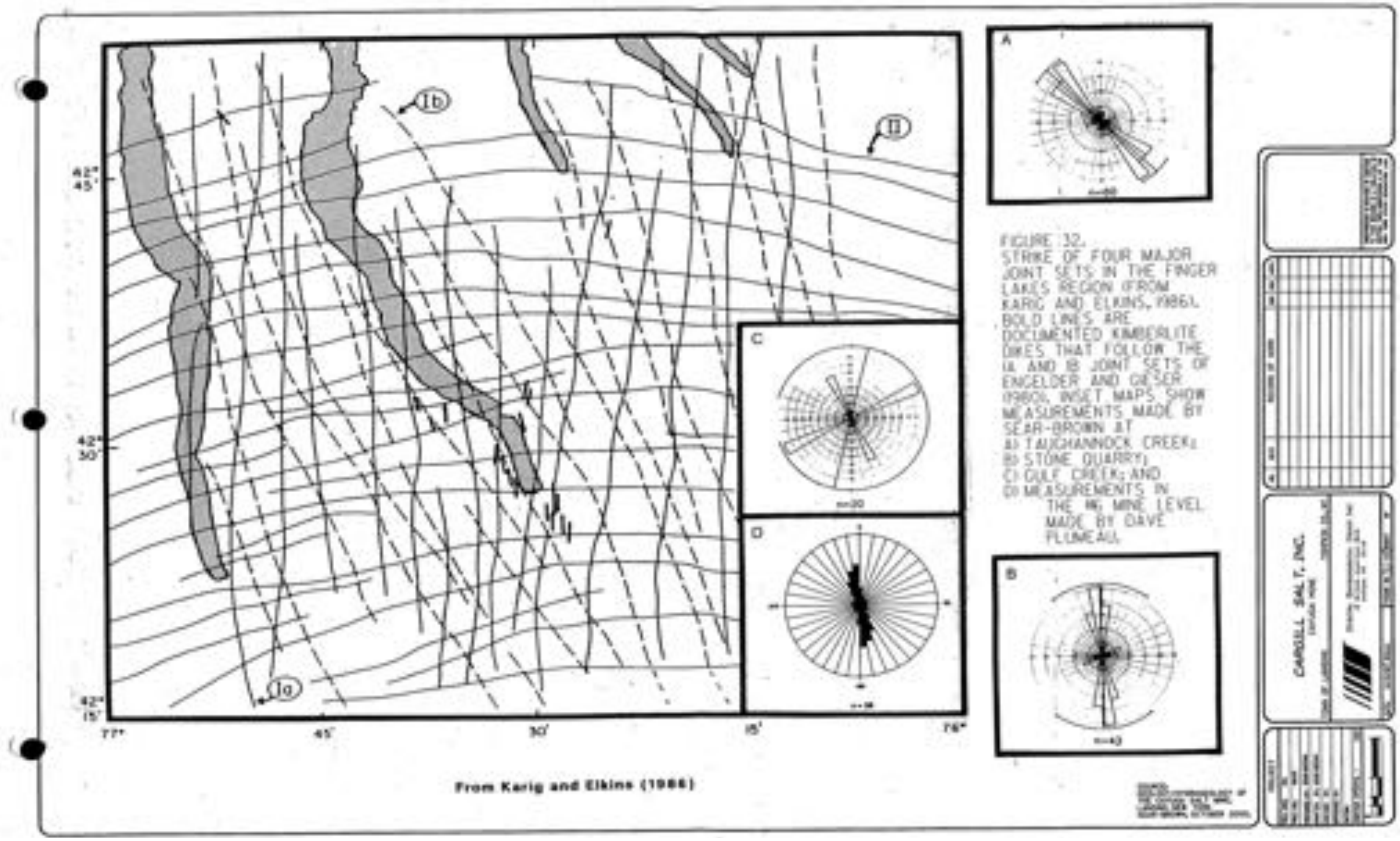


Figure 1. Strike of Four Major Joint Sets in the Finger Lakes Region.
Source: Sear-Brown. 2000. Geology/Hydrogeology of Cayuga Salt Mine, Lansing, NY, cited in Spectra Environmental Group. 2000.

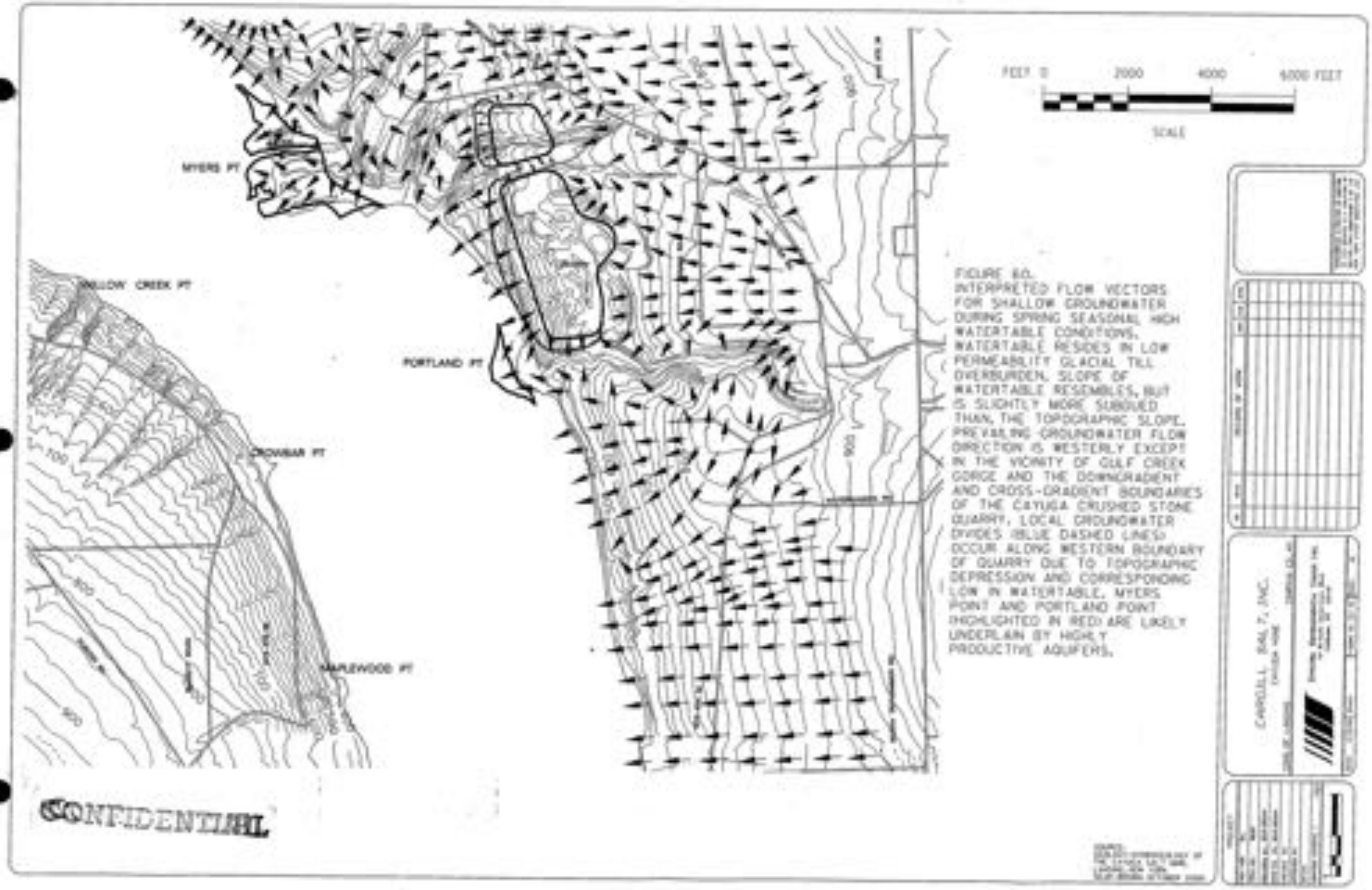


Figure 2. Flow vectors for shallow groundwater in the Portland Point area.
Source: Sear-Brown. 2000. Geology/Hydrogeology of Cayuga Salt Mine, Lansing, NY, cited in Spectra Environmental Group. 2000.

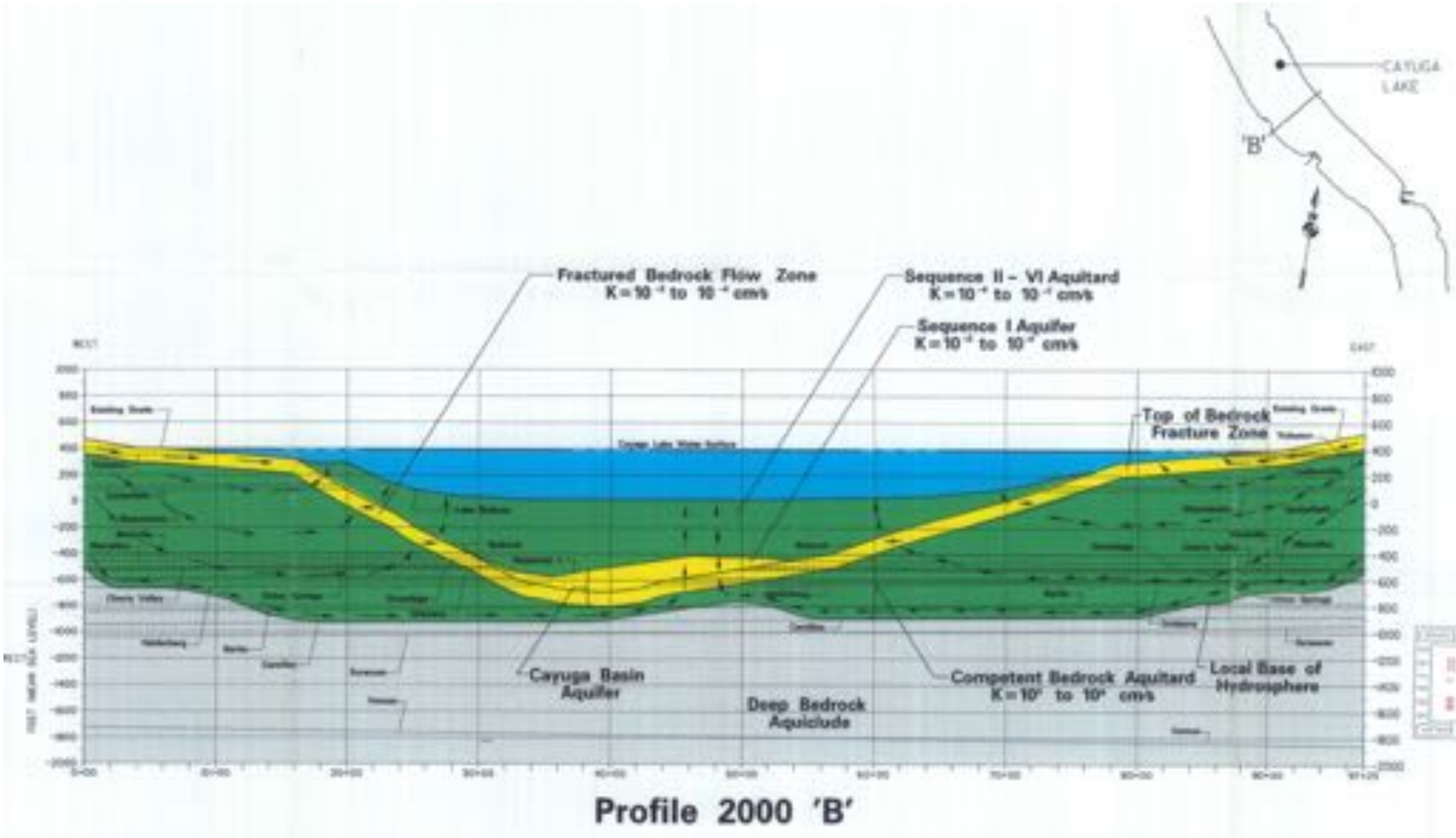
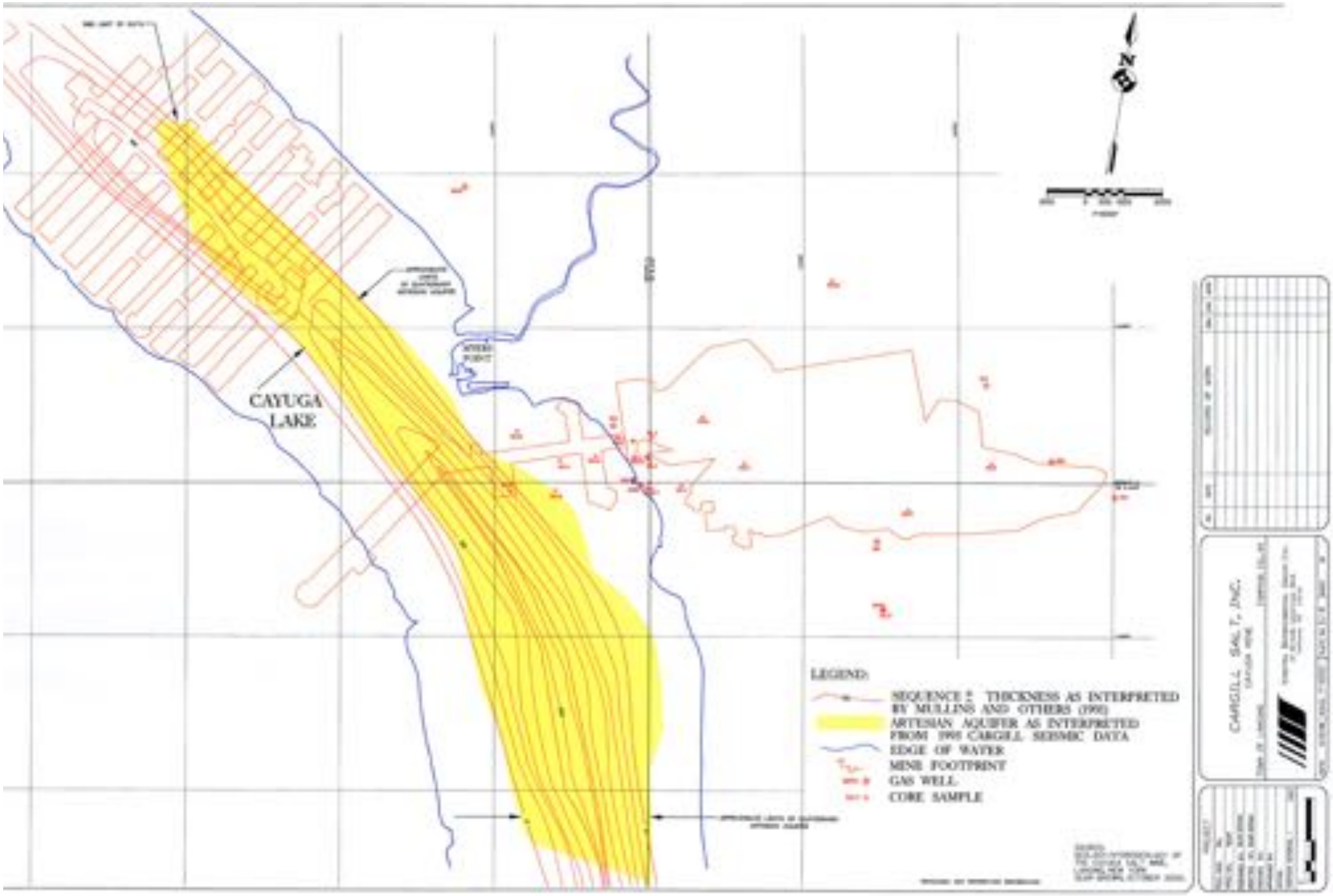


Figure 3. Profile B across Cayuga Lake (source: Sear Brown. 2000. Geology/hydrogeology of Cayuga Salt Mine. Lansing, NY.) scale in original image: 1" = 400'



gure 4. Existence of an "artesian aquifer" under Cayuga Lake as interpreted from 1995 Cargill Seismic Data.
ource: Plate 3.1-8 in Spectra Environmental Group. 2000. Volume II.

4.0. The salinized and highly-contaminated beach well at 367 Bill George Road.

In September 2015, long-time lake shore resident, Frederick Campbell heard that “the salt company was doing a well survey”, so he contacted the survey team and asked that they include his salinized and contaminated beach well at his rental property at 376 Bill George Road. Like the beach well serving his home at 357 Bill George Road, this well was constructed in 1964 and had provided good quality drinking water for many decades. Mr. Campbell discovered the salinity and contamination issues when he purchased the property from the estate of his neighbor in 2012. The neighbor’s husband—who according to Mr. Campbell would not have tolerated any water quality issues--predeceased her in 1990. Mr. Campbell suspects that the water quality problems first emerged in the 2000s.

On 22 September 2015, Mr. Campbell pumped out the well to enable the Spectra surveyor, David Straw, to collect a sample from the bottom of the beach well which was about 6-8 feet below the lake surface. Analytical results were mailed to Campbell on 16 October 2015. Data shown in Table 1 above were compiled in part from laboratory data mailed to Mr. Campbell and released by the DEC in September 2016.

The cover letter from Spectra Environmental contained no indication that any drinking water standard had been exceeded. Nor did it contain any information about water quality standards that might have enabled Mr. Campbell to determine that they might be some issues. However, water from this beach well had already damaged the plumbing in his rental property, so he already knew there were issues and had already disconnected the well from the house. In a December 20, 2016, conversation with John Dennis he asked,

“What if the salinization of this well is just one incident among many along the lake? What if brine is seeping into the lake causing damage to our Cayuga Lake?”

Suffice it to say, although Spectra learned of a highly-anomalous water quality situation more or less directly over the Cayuga Salt Mine and less than three quarters of a mile from the proposed Shaft 4 project, Spectra did not ask to resample the well or—as far as we know—seek to figure out what may be causing the on-going contamination and salinization of this well.

Consultation with geologists suggests two possible explanations: road salt and venting of brine from the top of bedrock fracture zone which is understood to contact the first 1500 feet of the lake floor when going west from the shore (Profile B on the page above).

The road salt scenario. 367 Bill George Road is the last residence at the south end of Bill George Road and so it is possible that Highway Department trucks spill additional salt when they are turning around about 130 feet from the contaminated Campbell beach well. Researchers Corsi et al., in a study published in 2010 about road salt levels found in streams at 168 monitoring stations in the Milwaukee area, did find one specific conductance reading as high as 30,800 uS/cm. This compares to a reading of 25,000 uS/cm for the sample drawn from the bottom of the Campbell beach well. Similarly, Corsi et al. (2010) found a chloride level as high as 7,730 mg/L, which is lower than the reading of 10,100 mg/L found for the Campbell well sample.

However, we know that high salinity tends to kill vegetation and there is no evidence of such a dead zone at the end of Bill George Road. Road salt contamination also does not explain the other contaminants shown in Table 1 above, namely the exceedances for iron, manganese, lead, and barium. Arsenic is only slightly below EPA's drinking water standard. Cargill would probably be the first to insist that the exceedances for iron, manganese, lead, and barium would not be associated with their road salt products. Also, a small stream flowing to the lake more or less just above the beach well was more conductive than the lake surface water, but not nearly enough to explain the order of magnitude greater specific conductance found at the bottom of the well as shown in Table 4 below.

Table 4. Specific Conductance of water sampled on 20 December 2016	
Water sampled	Specific Conductance uS/cm
1) Surface water in beach well	433
2) Bottom water in beach well	10,080*
3) Stream 9' SSE of beach well	407**
4) lake surface water	322

*This sample was collected using a 2-liter Niskin sampling bottle on the third lowering of the bottle to the bottom of the ≈6'-deep well, by which time significant mixing within the stratified beach well water column may have occurred.
**an initial reading of 458 uS/cm was recorded but the reading later stabilized at 407.
Source: laboratory readings taken by John Dennis using a Cole-Parmer pH-Conductivity PC100 meter calibrated using an Oakton 1413 uS/cm standard.

Brine venting to the lake shore area. "Profile B" (page 21 above), which Spectra included in one of their year 2000 documents (Spectra, 2000, Vol II) shows the near-shore bottom of the lake to be in direct contact with a water-bearing "top of bedrock fracture zone," with this contact area going west from the eastern lake shore about 1500 feet. The east end of Profile B is roughly midway between Lansing Station Road and Sweazey Road, or about 0.5 miles north of the contaminated Campbell beach well.

Assuming that similar direct contact between the top of bedrock fracture zone and the lake water column also exists in the vicinity of the contaminated Campbell Beach Well at 367 Bill George Road, there exists the reasonable possibility that the salinity found at the bottom of this well is the result of brine venting from the artesian aquifer shown to exist under Cayuga Lake in seismic data run by Cargill in 1995 (Sear-Brown. 2000).

The data shown in Table 4 above indicate that this beach well continues to be saline 15 months after it was sampled by Spectra. The lower specific conductance for the more recent well sample (10,080 vs 25,000 uS/cm) may be due to the different sampling techniques employed. On 22 September 2015, the well was pumped out and a sample taken from the mix of waters entering from the bottom of the well and from a perforated horizontal PVC pipe that conveyed water from the lake. On December 20, 2016, the well was not pumped out. Instead, a 2-liter horizontal Niskin bottle was lowered to the bottom of the well three times and a 2-liter sample collected on the third time down. The sampling bottle was 4" in diameter and about 19" long while in the "open" position. The raising and lowering of this device within a well whose inside diameter was roughly 32" may have caused significant mixing within the stratified well water column prior to the sample being collected.

It is absolutely critical that the source of the brine entering this well be identified prior to Cargill getting a license to build Shaft 4, a reportedly $45M investment that is supposed to enable—according to Cargill—a further 30 years of mining under the lake (Cargill. 2016. P. 4).

Figure 4 above shows in yellow the southern extent of an artesian aquifer under Cayuga lake. But, is this aquifer definitely saline? Analysis of water samples taken from the water-bearing Oriskany formation encountered at about 1490' below grade during the Corehole 18 drilling in 2013 resulted in chloride figures of 95,900, 130,000 and 220,000 mg/L and tritium levels of 0.84, 1.94, and 15.5 TU. The samples were taken about a month apart and the third sample was considered by the RESPEC authors to be the least contaminated by drilling fluids. It should be noted that the Corehole 18 borehole was located about 0.7 miles ENE of the lake shore and about 1 mile due east of where Profile B meets the east shore of the lake. The RESPEC authors wrote,

"The subglacial aquifer under the sediments in the lake could be the source of this water. However, RESPEC does not believe this is the likely source of the isotopic signature, because the isotopic signature of the fluid does not plot in the portion of the graph indicative of cold climate, glacial recharge." (RESPEC, 2013. p. 42.)

This assumes, however, that the aquifer under the lake has remained hydraulically-isolated since the glacial era. Hydrogeologist Andrew Michalski, after reviewing the RESPEC Corehole 18 document has written:

"Thus, the isotopic and geochemical evidence leaves no doubt about modern meteoric recharge being the source of water in the CH-18 inflow at the Onondaga/Oriskany contact that is also known as a regional unconformity. The very existence of this meteoric water there necessitates, by hydrogeologic reasoning, the occurrence of ongoing groundwater flow along this contact/unconformity, and water discharge into an aquifer at the base of the valley fill. Because of this hydraulic connection of the Onondaga/ Oriskany aquifer to a huge water reservoir in the valley fill, the meteoric (halite undersaturated) water that migrates along the Onondaga/Oriskany contact presents a serious risk of flooding of the proposed Shaft No. 4" (Michalski, 2017, p. 2).

The possibility of brine venting to Cayuga Lake and tied to recent salt-mining perturbations of the local geology could be precisely why Cargill was not interested in having Spectra investigate this highly-saline well in further detail.

5. Conclusions

In view of the egregious deficiencies of Spectra's well survey, including the lack of follow-up and analysis regarding a contaminated beach well, and in view of Cargill's argument that Shaft 4 is essential to enabling 30 more years of mining northward under the lake, and in view of the fact that unlike the Hamptom Corners Salt Mine, the Cayuga Salt Mine has never had a DEIS conducted despite being a "virtually new mine in 1984", the DEC should order a DEIS for the entire unsegmented Shaft 4 Project. This DEIS should include:

-A new well study with more careful methods and analysis. The study should include a new test well drilled at the Shaft 4 site to at least 500' by a water well drilling company that has been instructed to carefully assess ground water resources.

-Research to determine whether recent salt mining under the east shore of the lake (panels U-53 and higher) may have triggered trough subsidence that pressurized the saline aquifer under the lake and caused the salinization of the Campbell beach well and possibly other as yet undetected brine seepage sites along the Cayuga Salt Mine perimeter at the lake shorelines.

This study should include:

-Placement of monitoring wells to a range of depths at the site of the Campbell beach well, which time-series monitoring established.

-A bromine-chloride stable isotope study that seeks to identify the origin of the brine that continues to vent at the Campbell beach well;

-A conductivity-temperature-depth (CTD) study of the lake water column focused especially on the near-shore areas of the lake bottom thought to be in direct contact with top-of-bedrock fracture zones, but also including more widely-spaced transect grids over all 13,000 acres of Cargill's permitted mining reserves as well as over control areas located further north and south;

<u>Seismic data.</u>

-The release for third party review Cargill's 2016 seismic study of both Cayuga Lake and of the Shaft 4 area conducted by Bay Geophysical. This "transition zone project" encompassed over 40 miles of high resolution 2D transition zone seismic reflection surveying and relied on state of the art cable-less systems: the Wireless Seismic RT-2 real time data acquisition system (land) and the Geospace OBX bottom seismic acquisition system (marine) http://www.baygeo.com/

-Consideration of analysis of 2002 Cayuga Lake Seismic data gathered by geologist Christopher Scholz of Syracuse University and recently analyzed by geophysicist Angus Ferguson and evaporite geologist John K. Warren.

Given the existing concerns that bedrock separation at Milliken Station may be less than the 600’ that existed over the two failed panels at Retsof, no further mining of the northern reserves should be allowed until it can be determined where mining is currently taking place, what level of bedrock separation exists in the northern reserve areas and what extraction ratios are currently being implemented. Ideally, mining of the northern reserves should be halted until after a DEIS for Shaft 4 and for the overall mine has been completed. GTZ Geoenvironmental submitted to DEC an 850-page DEIS on the Hampton Corners Mine prior to that mine being allowed to open. The argument that Cayuga Salt Mine predates the April 1, 1975, threshold is specious. Cargill own team indicate that the mine that started under Cayuga Lake in 1984 was “in essence the start of a new mine” (Petersen, et al.1993. p. 264).

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