STATE OF NEW YORK
SUPREME COURT : COUNTY OF TOMPKINS

In the Matter of the Application, CAYUGA LAKE ENVIRONMENTAL ACTION NOW (CLEAN), an Unincorporated Association by President JOHN V. DENNIS, and LOUISE BUCK, BURKE CARSON, JOHN V. DENNIS, WILLIAM HECHT, HILARY LAMBERT, ELIZABETH and ROBERT THOMAS, and KEN ZESERSON

Petitioners,

AFFIDAVIT OF RAYMOND C. VAUGHAN IN SUPPORT OF PETITIONERS' MEMORANDUM OF LAW

For a Judgment Pursuant to Article 78 of the New York Civil Practice Laws and Rules

vs.

Index No. 2021-0422

THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, and CARGILL INCORPORATED

Respondents.

State of New York,
County of Erie, ss.:

RAYMOND C. VAUGHAN, being duly sworn, deposes and says:

1. I am a Professional Geologist (NY license no. 258) and Environmental Scientist with a Ph.D. in Geology from SUNY Buffalo. I am very familiar with the State Environmental Quality Review Act (SEQRA) as a result of my service on the Town of Hamburg Conservation Advisory Board (1980-1999) where I and other members regularly conducted SEQRA reviews of proposed projects referred to us by the Town Board and/or Planning Board. My familiarity with SEQRA and other administrative procedures was reinforced during the twelve years I was employed as an

Environmental Scientist at the NYS Attorney General's Office (2000-2012). My knowledge of geology is a combination of education and experience, including extensive work at the NYS Attorney General's Office on the evolving evidence of brine migration and associated long-term impacts from the 1994 salt mine collapse in Retsof, Livingston County, NY. My CV is already on file in this case (NYSCEF Doc. No. 7).

2. I have reviewed the relevant documents in this case including papers filed on the motion to dismiss and the Court's Decision dated December 23, 2021 (by former Acting Justice Cassidy, assigned, but now replaced by Justice Elizabeth Aherne) on that motion. In my understanding, that Decision concisely summarizes key points of the case. For example:

> The [permit] modification at issue precludes Cargill from mining salt under the FPA [Frontenac Point Anomaly] along with a 1,000-foot buffer, and further precludes mining under Anomalies A and B until further study is undertaken to determine whether it is safe to mine under those anomalies. Petitioners agree with the portion of the modified permit that recognizes the potential hazards of mining under the anomalies. However, Petitioners assert that the DEC failed to take a hard look at the full range and location of the FPA, as well as Anomalies C through E in violation of New York State Environmental Quality Review Act. ["SEQRA"].

Decision at 2; last set of brackets in original.

> … Petitioners contend that Respondents failed to make the required reasoned elaboration for the basis of their determinations. First, the DEC failed to provide a reasoned basis for drawing a 1000-foot buffer around only the short oval version of the FPA, when such version directly contradicts the map of the FPA produced by Cargill's consultant, RESPEC.... Instead, the DEC has accepted a generalized oval area included in a map sent to the DEC by their own Consultant. The DEC has offered no reasoned basis for why they do not believe the map produced by RESPEC is more accurate. Petitioners assert that Respondents have also failed to provide a reasoned basis for their decision to exclude mining under only Anomalies A and B, while not mentioning Anomalies C, D, and E.

Decision at 9; internal footnote and citation omitted.

> Here, Petitioners are challenging the DEC's determination of the location and configuration of the FPA and the Anomalies from which Cargill must refrain from mining under. Upon examination and comparison of the 2021 renewal/modification permit and the 2019 permit issued to Cargill by the DEC, it is clear that the DEC's

> decision as to the configuration of the FPA and these anomalies was not finalized until the issuance of the 2021 permit.

Decision at 10.

3. I offer this affidavit to supplement my prior affidavits dated June 7 and September 30, 2021 (Doc. Nos. 7 and 61, respectively) wherein my testimony, to a reasonable degree of scientific certainty in my field and based on the sources available to me, addressed faulting associated with the FPA, its geologic significance, the mine's global stability,[1] and associated risk factors.

4. I note and concur in, but need not reiterate here in detail, the expert opinions in John K. Warren's affidavit (Doc. No. 10) which engaged in more detail than I included in my affidavit dated June 7, 2021. (As stated by Warren in his ¶ 4, "Based on my review and my experience, I recognize the importance of a 1000-foot protective buffer around the Frontenac Point Anomaly (hereafter 'FPA'), surrounding both the oval version and the linear version of the FPA. However, I am also concerned that the problems of mine stability go well beyond the FPA, and involve the trough of thinning bedrock in far greater ways than indicated in the Vaughan affidavit.")

5. While issues of geology and safety remain at the forefront, the immediate issue is whether scientifically sound judgment was exercised by Respondents in delineating where the Frontenac Point Anomaly actually is, and in characterizing the trough of thinning bedrock that extends from Anomaly A to Anomaly E.

[1] The term "global stability" has been used by DEC's consultant, Vincent Scovazzo of John T. Boyd Co. He refers, for example, to concerns that were "focused on the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake." See Scovazzo's letter dated 2/22/18 ("Scovazzo/Boyd letter") attached as Exhibit D to my prior affidavit dated 6/7/21 (Doc. No. 7) and as Exhibit 4 to Wilczynski's prior affidavit (Doc. No. 76).

Attention to detail by Respondents is inadequate

6. In my work in environmental science and geology, attention to detail is crucial. Upon information and belief, attention to detail is similarly important in many other fields. In the present context where measures needed to ensure global stability of the Cayuga mine are at the heart of the disagreement, attention to detail is crucial.

7. One example of the need for attention to detail is as follows: The SEQRA requirement of a "hard look" is central to this case (Decision at 2, 8, 9), but without reasonably detailed and focused language it would be impossible to examine and compare the facts needed to show that a hard look either has or hasn't happened.

8. Upon information and belief, lack of reasonable detail in documents such as affidavits and regulatory permits may sometimes be the result of language that is inadvertently poorly worded (and thus capable of being reworded and clarified) or, alternatively, may sometimes be a conscious choice that reflects an affiant's or permit writer's limits of knowledge or the limits of what they're willing to divulge. Upon information and belief, courts can and should take such differences into account in weighing conflicting evidence, especially where one side of the "conflicting" evidence is clearly expressed while the other side lacks clarity and does not bear directly on the issue at hand.

The letter that the 2021 renewal/modification permit was said to memorialize

9. This is a small matter, perhaps nitpicking, but symptomatic of a lack of attention to detail. DEC's 7/29/20 Notice if Intent ("NOI") for the 2021 renewal/modification permit says

> By letter, Cargill has agreed to not mine under the FPA and to maintain a minimum 1000-foot setback from the FPA for all mining activities. The new condition memorializes the letter and the commitment not to mine under the FPA and maintain the minimum 1000-foot setback as part of the permit.

NOI ¶ 2 (https://www.dec.ny.gov/docs/permits_ej_operations_pdf/cayugasmnoi.pdf).

10. By any reasonable interpretation, the above-quoted phrase "By letter, Cargill has agreed..." refers to a letter from Cargill. No such letter from Cargill has been produced.[3] The affirmation by AAG Buttino (Doc. No. 63), footnote 1, avoids the question of who wrote the letter and simply says "A copy of a letter documenting that agreement is attached as Exhibit 6." In turn, Buttino's Exhibit 6 (Doc. No. 69) is a letter from DEC to Cargill dated 12/27/10. It thus appears either that the NOI was wrong in attributing the letter to Cargill or that the relevant letter from Cargill exists but has not been produced. On its own, such a small oversight should be too trivial to warrant attention, yet it is illustrative of a larger lack of attention to detail.

Material change

11. A key point in this case is whether there has been a material change between the 2019 permit issued to Cargill and the 2021 renewal/modification permit. This Court, in ruling against the motion to dismiss, opined that there may have been a material change and based this decision on a comparison of the permit language. In the Court's words, "There are significant differences between the language used in the two permits regarding the FPA and the Anomalies...." Decision at 12. Such comparison relies on the clarity and details of the permit language.

12. Mine manager Shawn Wilczynski, in his 10/22/21 affidavit (Doc. No. 72) at 5 ff., devotes a section of his affidavit to "Evolution of the FPA Location, Shape and Geographic

[3] See also my prior affidavit dated 6/7/21 (Doc. No. 7), suggesting that the letter should be produced.

Extent." While additional details of his affidavit are addressed below, a central theme of the affidavit appears to be that Cargill's recognition of the FPA, and its commitment not to mine within 1000 feet of it, can be dated back at least a few years prior to the 2021 renewal/modification permit wherein the permit language was actually changed.

13. I have no reason to doubt that Cargill's recognition of the FPA, and its commitment not to mine within 1000 feet of it, may have existed as an informal understanding for at least a few years prior to the 2021 renewal/modification permit. However – and even though I recognize that informal commitments may be effective in achieving goals – I question the wisdom of allowing legally binding permit requirements to diverge from informal understandings. Which prevails? Respondents, in their efforts to equate the 2019 and 2021 permit requirements, seem to be claiming that "Everyone knew what was meant" by the 2019 permit language – which, if true, makes the 2019 permit language an example of excessive inattention to detail.

14. The three preceding paragraphs focus on important procedural aspects – important because "material change" could be considered a threshold question. The following paragraphs address related substantive issues, particularly whether any of Respondents' filings rebut the 2016 evidence that the FPA is a linear feature which is much larger (longer) than the oval FPA specified in the 2021 permit requirements. In particular, do any of Respondents' filings "tee up" the 2016 evidence of a linear FPA with enough attention to detail that it can be compared to other evidence?

Mismatch in time between 2016 RESPEC work & pre-2003 events recounted by Wilczynski

15. RESPEC is a well-known geotechnical consulting company used by Cargill.[4] Shawn Wilczynski, as noted above, is Cargill's mine manager for the Cayuga salt mine.

16. Information currently available from these two Cargill sources cannot be reconciled. The 10/22/21 Wilczynski affidavit (Doc. No. 72), ¶¶ 14-15, attributes the linear FPA to a pre-2003 understanding of the FPA, namely the westernmost line of three pre-2003 seismic lines. But the Wilczynski affidavit is silent on the evidence presented by Petitioners that shows an apparently new understanding of the FPA as a linear feature in 2016. I see no other plausible reason why the linear FPA was being featured in a 2016 RESPEC presentation and circulated by DEC with an "FYI" tag. If the information wasn't new in 2016, why such emphasis? This flurry of interest in 2016 suggests that the linear FPA can't be silently dismissed as a pre-2003 misunderstanding that, by 2016, had been superseded by new information.

Spatial mismatch between 2016 RESPEC work & pre-2003 events recounted by Wilczynski

17. Mine manager Wilczynski's affidavit includes a map on which he drew three pre-2003 seismic lines (reproduced in my Fig. 1 below) and also includes the following paragraphs in which he states that only a single data point, on the westernmost seismic line, suggested that a possible salt disturbance was present:

> The seismic surveys performed prior to the 2003 Expansion Permit (and that identified the potential for a disturbed salt zone) had placed seismic sensors along three parallel lines running vertically up Cayuga Lake. I have inserted below a five-year mining plan

[4] For example, see prior Wilczynski affidavit dated 4/10/18 (Doc. No. 73), ¶ 19: "In 1995, Cargill commissioned RESPEC, global leaders in geoscience and engineering, to assess the stability of the mine workings and more specifically potential impacts of the continued mining northwest under Cayuga Lake."

map (from a later renewal application) on which I have drawn the three parallel lines. These lines depict the lake seismic lines from the pre-2003 studies.

Evaluation of the early seismic data (in conjunction with the issuance of the 2003 Expansion Permit) suggested that a possible salt disturbance was present on the westernmost line only. This single data point did not enable the scientists to fully understand the depth, location and geology of the potential disturbance and whether it would present a risk to mining—hence, the permit requirement for further investigation before any mining could occur. Therefore, the early maps could only approximate the FPA, representing it, conservatively, as a linear-like feature extending outward from the sensor that had indicated the potential disturbance.

Wilczynski affidavit dated 10/22/21 (Doc. No. 72), ¶¶ 14-15.

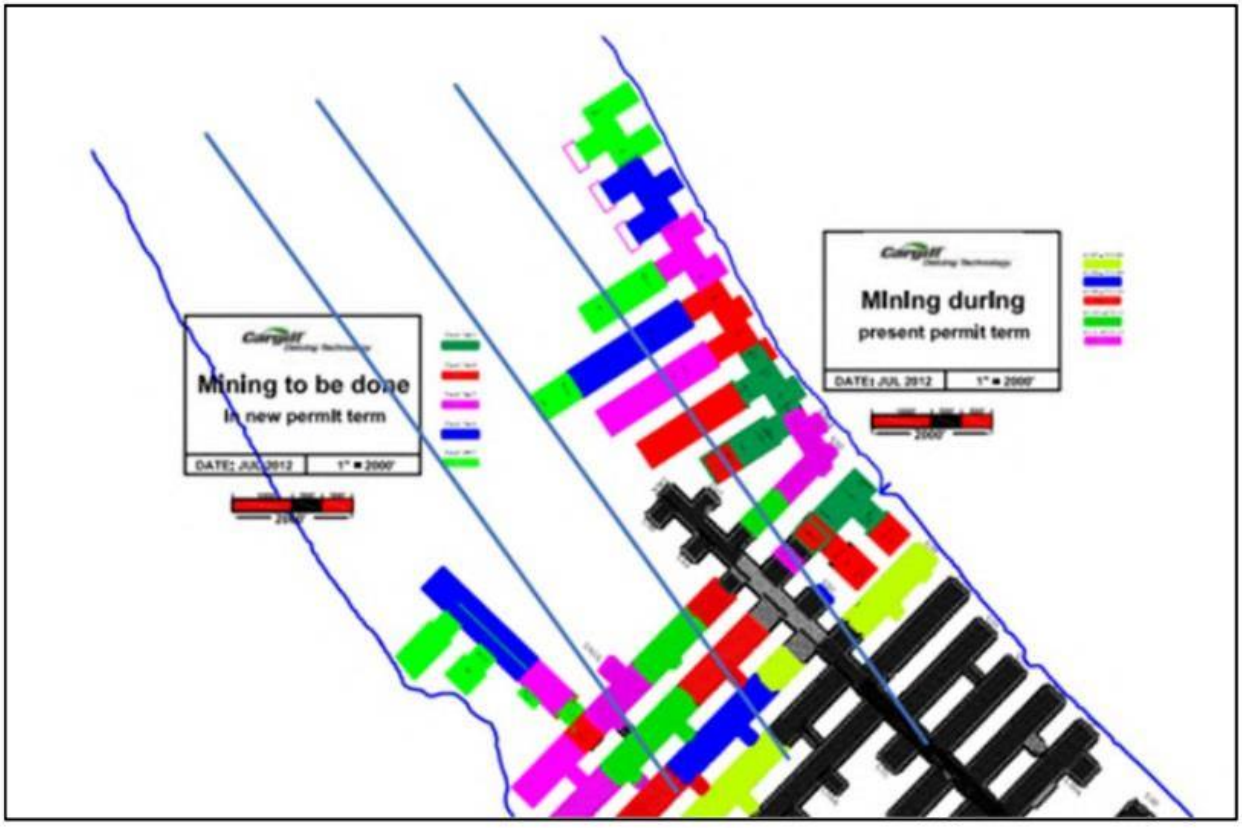

Fig. 1: Wilczynski map (from his 10/22/21 affidavit, NYSCEF Doc. No. 72)

18. In addition to the unexplained mismatch in time discussed above, there's an unexplained spatial mismatch here. RESPEC's 2016 linear FPA (Fig. 2 below) crosses not just one but two of Wilczynski's pre-2003 seismic lines, as can be seen in Fig. 3 below. Given the rapid pace of improvement in seismic instrumentation and interpretation techniques, a 2016-era seismic characterization of the FPA would be expected to be more accurate than a pre-2003 characterization. Thus, if the pre-2003 seismic studies failed to detect salt disturbance at points on Wilczynski's middle seismic line where RESPEC saw evidence of disturbance (i.e., the FPA) in 2016, some kind of reasoned elaboration would be needed before drawing any conclusions from pre-2003 studies, especially if they don't match what was known in 2016.

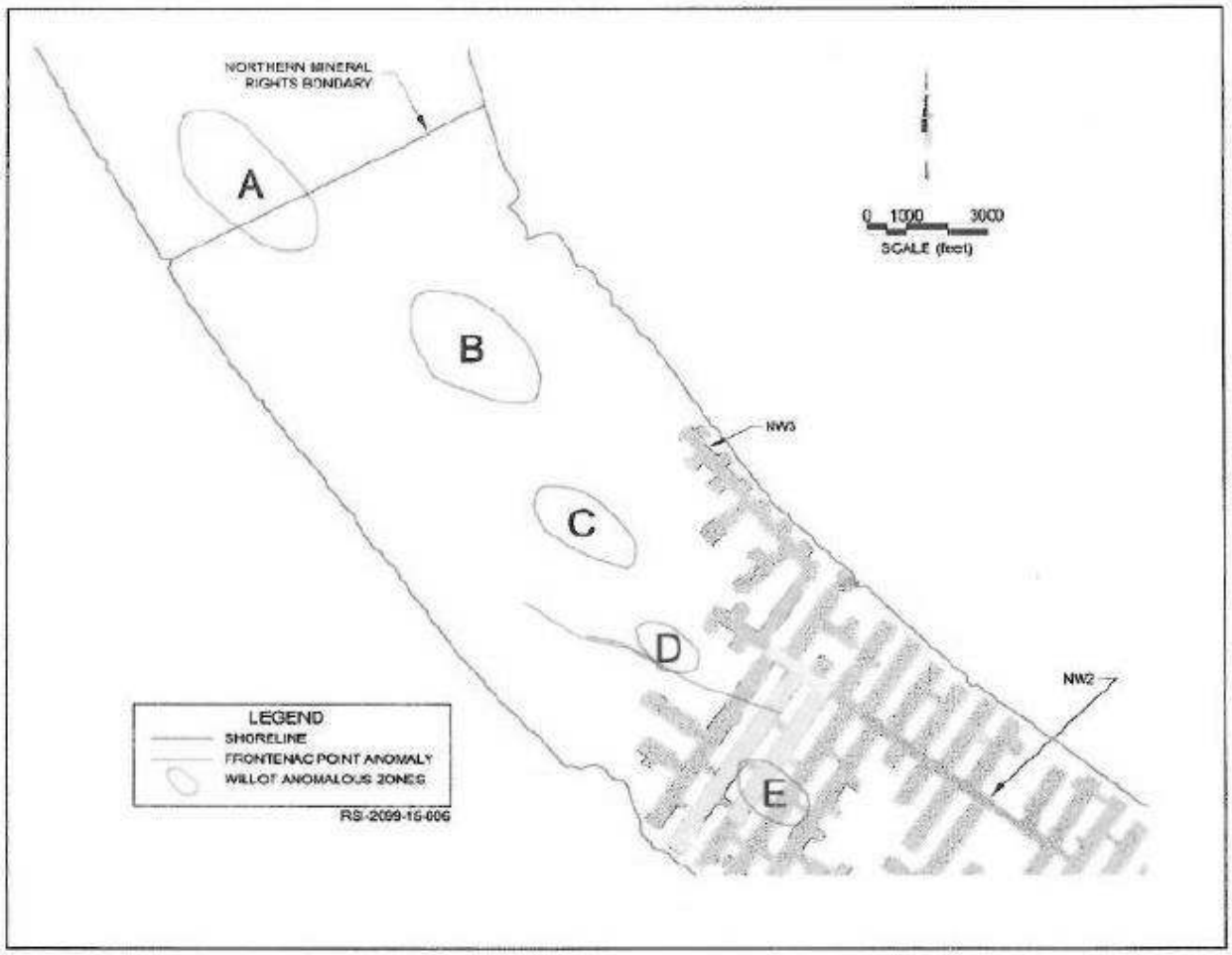

Fig. 2: RESPEC 2016 map showing linear Frontenac Point Anomaly (RESPEC image RSI-2099-15-006)

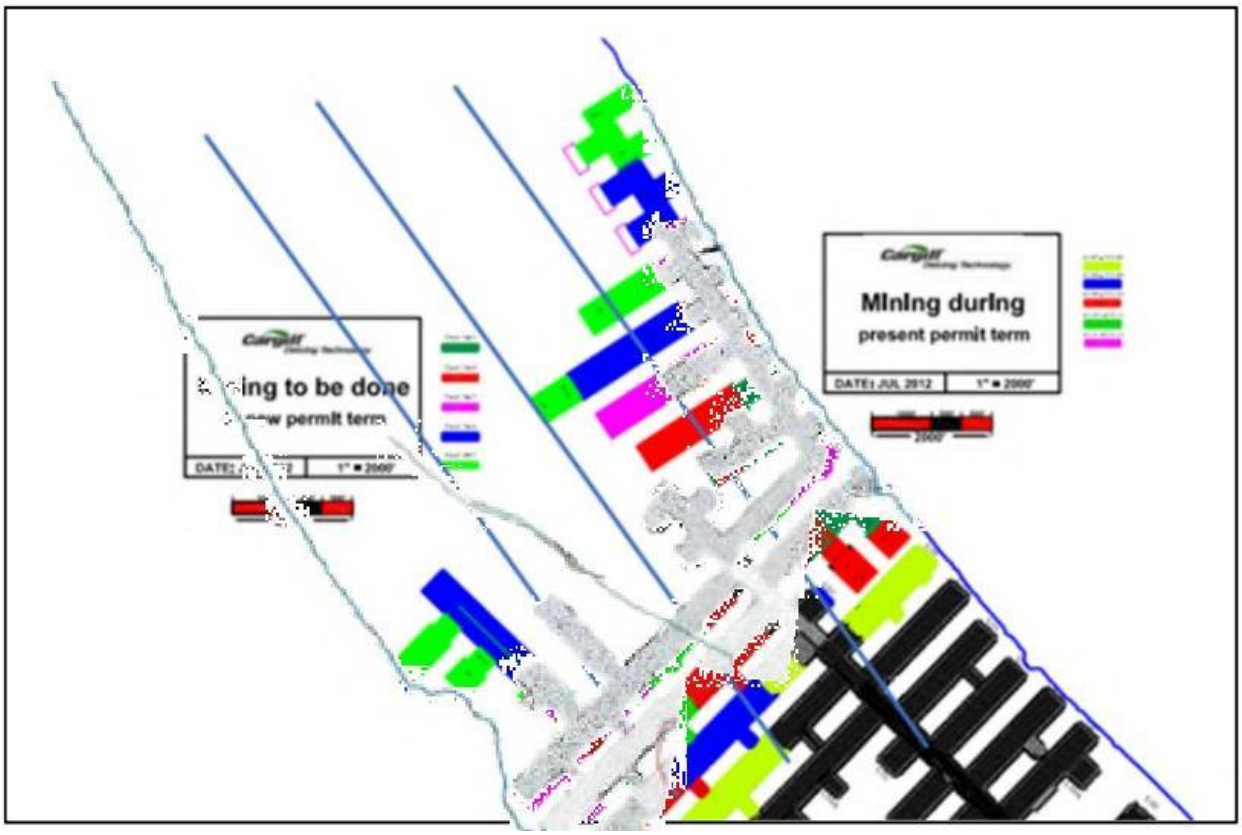

Fig. 3: Wilczynski and RESPEC 2016 maps accurately superimposed by affiant Raymond C. Vaughan, done by rotating and scaling the latter map so that both maps' shorelines are correctly aligned

Mismatch between 2016 events recounted by Wilczynski and by DEC's consultant Boyd

19. John T. Boyd Company is a well-known geotechnical consulting company that has advised DEC, and Shawn Wilczynski is Cargill's mine manager for the Cayuga salt mine.

20. Wilczynski, in his affidavit dated 10/22/21, says:

> Evaluation of the early seismic data (in conjunction with the issuance of the 2003 Expansion Permit) suggested that a possible salt disturbance was present on the westernmost line only. This single data point did not enable the scientists to fully understand the depth, location and geology of the potential disturbance and whether it would present a risk to mining—hence, the permit requirement for further investigation before any mining could occur. Therefore, the early maps could only approximate the FPA, representing it, conservatively, as a linear-like feature extending outward from the sensor that had indicated the potential disturbance.

> In 2009 and 2016, Cargill completed the additional lake seismic studies contemplated in the permit condition to more precisely determine the geology, location and geographic extent of the FPA. A letter from John T. Boyd Company, dated February 22, 2018 and written by Dr. Vincent Scovazzo, describes in some detail the nature of these studies and their subsequent interpretation and evaluation by multiple, well-recognized experts in the field (see Exhibit 4 hereto at pp. 4-5).[5]
>
> On the basis of these additional studies and analyses, Dr. Scovazzo depicted the actual area occupied by the FPA—now recognized as more ovular in shape—in his letter to DEC (id. at p. 4).[6]

Wilczynski affidavit dated 10/22/21 (Doc. No. 72), ¶¶ 15-17.

21. Wilczynski's affidavit lacks sufficient detail to "tee up" the linear FPA issue. As seen in the paragraphs quoted above, he suggests that early maps, long before 2016, had approximated the FPA as a linear-like feature – yet he remains silent on the 2016 RESPEC evidence for the linear FPA.

22. Wilczynski's affidavit says that additional seismic studies, conducted in or before 2016 "to more precisely determine the geology, location and geographic extent of the FPA," led to a conclusion that the FPA was "more ovular in shape." For supporting details, the affidavit cites the 2/22/18 letter from DEC's consultant (Dr. Vincent Scovazzo of John T. Boyd Company). I find such support lacking.

23. The Scovazzo/Boyd letter at 1-4 provides an overview of the pre-2016 understanding of the FPA which had been known initially as the "disturbed salt area." The Scovazzo/Boyd letter at 4 proceeds into the time span of interest by saying that "Two additional lake seismic studies were completed in 2009 and 2016 to define the depth, location, and geology of the anomalies…." This wording is in general agreement with paragraph 16 of the Wilczynski

[5] Wilczynski here cites 2/22/18 Scovazzo/Boyd letter, op. cit., at 4-5.

[6] Wilczynski here cites 2/22/18 Scovazzo/Boyd letter, op. cit., at 4.

affidavit and is not at issue. But what is missing from both the Scovazzo/Boyd letter and the Wilczynski affidavit is an explanation of whether/how such studies addressed and resolved the conflicting 2016 RESPEC evidence of a linear (not oval or ovular) FPA.

24. The Scovazzo/Boyd letter at 4-9 is arranged partly by date and partly by topic.[7] The only directly relevant information is found in two places on page 6:

> In 2014 RESPEC noted "Well data in the northern part of the Cayuga Lake Valley have determined that brine is present on top of and in between beds in the Salina Group. The Frontenac Point Anomaly may reflect the southern extent of water infiltration." RESPEC opined that the planned 1,000 ft buffer around the FPA should prevent a hydraulic connection with the mine.[8]

25. Note what the above-quoted paragraph says about RESPEC's 2014 opinion on the FPA and the adequacy of the 1000-foot buffer. This would be a central piece of evidence if it were dated 2016 or later – but such an opinion in 2014 doesn't show how RESPEC's opinion may have changed if new evidence emerged in 2016. Page 6 of the Scovazzo/Boyd letter goes on to provide a minor but relevant clue about what RESPEC was thinking in 2016:

> In 2016 RESPEC[12] designed large pillars for the C Anomaly that would reduce shear in the overlying salts and reduce shear to insignificant levels in the limestones.[9]

This is relevant because its footnote 12 cites "Devries, Kerry, 2016, Large Pillar Design, RESPEC, September 15. As Large Pillar Design 9-19-16 V2.pdf last modified on September 20, 2016." This appears to be exactly the same document that was supplied to CLEAN a few months ago under FOIL as "Large_Pillar_Design_9-19-16_V2_Redacted.pdf." This is the

[7] The topic headings are Further Seismic Studies by Cargill, Cargill Engineering Studies of the Anomalies, Drilling Investigation of Anomaly C, and Conclusions.

[8] Scovazzo/Boyd letter, op. cit., at 6; internal footnote omitted.

[9] Id.; internal footnote "12" *not* omitted because it is discussed above.

document in which the FPA is clearly mapped as linear and clearly labeled "Frontenac Point Anomaly" on page 7. The document is discussed in my prior affidavit dated 9/30/21 (Doc. No. 61) and attached thereto as Exhibit A. The map itself is included here as my Fig. 2.

26. DEC's awareness of the 2016 RESPEC map is also documented. DEC mining program supervisor Steve Army sent the map to four of his DEC colleagues on October 24, 2016 with the subject line "RESPEC update" and his comment "FYI." See my 6/7/21 affidavit (Doc. No. 7), ¶¶ 14-15 and Exhibit B thereto.

Conclusion

27. Thus, even though further explanation is lacking, it is clear that Cargill's consultant RESPEC had some reason in September 2016 to depict the FPA as a linear feature substantially larger (longer) than the oval or "ovular" version of the FPA. It is also reasonably certain that DEC understood the 2016 RESPEC map (depicting the FPA as a linear feature) to be new information in October 2016.

28. However, all sources cited by respondents are silent on RESPEC's basis for showing the FPA as linear in September 2016, and also silent on the reasoned basis for any subsequent determination by Cargill, DEC, RESPEC, and/or Boyd that the FPA is best represented as oval rather than linear.

29. Sources currently available to CLEAN, and thus to me, have been and continue to be limited by unavailability of numerous documents deemed confidential and thus not produced or producible under FOIL.

30. I know that Courts can rule on procedural missteps and may sometimes require agency determinations to be re-done, but typically cannot substitute their own judgment for such determinations, particularly when such determinations involve substantive technical matters in which an agency has expertise, as here. Upon information and belief, any re-done determination of the FPA's configuration and appropriate buffer zone should be supported by analyses or evaluations that afford some degree of public participation, structured as needed to balance claims of confidentiality against a need for access to underlying scientific and technical documents. Upon information and belief, the appropriate forum for such analyses and evaluations is an environmental review process under SEQRA.

This affidavit is based on information available to me at this time. Should additional information become available, I reserve the right to determine the impact, if any, of the new information on my opinions and conclusions and to modify or supplement this affidavit if necessary.

Sworn to before me this 25 day of March 2022.

Notary Public, State of New York

DAVID J. RUSH
NOTARY PUBLIC, STATE OF NEW YORK
QUALIFIED IN ERIE COUNTY
COMMISSION EXPIRES SEPTEMBER 28, 2024
#01RU6409562

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Respondents.

State of New York,
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RAYMOND C. VAUGHAN, being duly sworn, deposes and says:

1. I am a Professional Geologist (NY license no. 258) and Environmental Scientist with a Ph.D. in Geology from SUNY Buffalo. I am very familiar with the State Environmental Quality Review Act (SEQRA) as a result of my service on the Town of Hamburg Conservation Advisory Board (1980-1999) where I and other members regularly conducted SEQRA reviews of proposed projects referred to us by the Town Board and/or Planning Board. My familiarity with SEQRA and other administrative procedures was reinforced during the twelve years I was employed as an Environmental Scientist at the NYS Attorney General's Office (2000-2012). My knowledge of

geology is a combination of education and experience, including extensive work at the NYS Attorney General's Office on the evolving evidence of brine migration and associated long-term impacts from the 1994 salt mine collapse in Retsof, Livingston County, NY. My CV is already on file in this case (NYSCEF document 7).

2. I have reviewed the 2019 mine permit and 2021 modified mine permit issued to Cargill by the Department of Environmental Conservation (DEC). I have also reviewed DEC's Notice of Intent to issue the 2021 modified mine permit[1] as well as maps prepared by or for Cargill showing two different versions of the Frontenac Point Anomaly (FPA).

3. Questions about the FPA, including both procedural and substantive questions, are central to this case. Procedural questions include the undisclosed rationale for DEC's choosing one version of the FPA over the other. (One version of the FPA shows it as a linear feature; the other version shows it as an oval. Both versions are well-known to DEC. In this affidavit I will refer to the two versions as the linear-FPA and the oval-FPA.) Another procedural question is whether DEC's adoption of the oval-FPA in the 2021 modified permit is a *material change*. Substantive questions about the FPA include the risk to the mine's "global stability" if DEC has adopted the wrong (i.e., less accurate and less protective) version of the FPA in the 2021 modified permit.

"Global stability" of mine

4. Risk to "global stability" refers here to the risk of sudden or catastrophic mine collapse. This term is used, for example, in a February 22, 2018 report to DEC from DEC's consultant Boyd (see Exhibit D to my prior affidavit dated June 7, 2021, NYSCEF document 7).

[1] See https://www.dec.ny.gov/permits/89419.html for the 2019 mine permit, 2021 modified mine permit, and DEC's Notice of Intent.

On page 2 of that report, Boyd refers to "Concerns [that] focused on the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake."

Both the linear-FPA and the oval-FPA are well-known to DEC

5. Exhibits B and C to my prior affidavit dated June 7, 2021 (NYSCEF document 7) demonstrate DEC's knowledge of the linear-FPA. In that affidavit I showed the likelihood that the shape and extent of the linear-FPA came from a map prepared by Cargill consultant RESPEC.

6. Based on information recently released to CLEAN on September 1, 2021 under New York's Freedom of Information Law, it is now clear that the shape and extent of the linear-FPA did come from a map prepared by Cargill consultant RESPEC. See Exhibit A attached hereto, where slide 7 of a presentation by RESPEC shows the map of the linear-FPA. This linear-FPA map, which is the same as the linear-FPA map attached as Exhibits B and C to my prior affidavit dated June 7, 2021 (NYSCEF document 7), provides clearer context and provenance for the map, showing that it was created by RESPEC, the well-respected company that has served as a consultant to Cargill for about two decades.

7. At least three maps prepared by or for DEC show the oval-FPA. See, for example, Exhibit D to my prior affidavit dated June 7, 2021 (NYSCEF document 7). Exhibit D consists of a February 22, 2018 report to DEC from DEC's consultant Boyd. See map on page 4 thereof titled "Scour Anomalies A through E as identified by Willott, the FPA Placed on Figure by BOYD." The FPA is represented by a small oval on this map.

DEC's rationale for choosing oval-FPA over linear-FPA remains undisclosed

8. In reviewing the relevant papers filed in this case by both Respondents and their attorneys, I find no reference to the two competing versions of the FPA (linear-FPA and oval-FPA). Such an omission is problematic because the two different versions of the FPA are at the center of this case. See below and my prior affidavit dated June 7, 2021. See also the Petition, ¶¶ 18-20.

Geologic significance

9. The FPA is a fault, as determined and documented by DEC's and Cargill's consultants. There is apparently no dispute on this point, nor on the threat that faults pose to the global stability of subsurface mines. Since the risk depends on how close the fault is to the mine, it is important that the location of any nearby fault be accurately determined. This allows mining to remain at a safe distance.

10. For this reason, the difference between the linear-FPA and oval-FPA is crucial. Faults, by their nature, are linear features; they cannot be accurately mapped as ovals. If an oval is drawn around a linear fault, *and if the oval encompasses the full length of the fault*, then the oval may serve as a protective representation of the fault. However, if the fault is much longer than the oval that's meant to represent it, then the oval fails to serve its protective purpose. Such a problem exists here, where DEC has adopted the oval-FPA as a protective measure, despite the fact that the linear-FPA is about 4 times as long as the oval-FPA. This is neither justified nor protective, especially given DEC's silence on why the linear-FPA and its credible source (Cargill's consultant RESPEC) were dismissed in favor of an undersized oval-FPA. The net effect is an unwarranted risk to the mine's global stability and its miners.

Administrative process and the material change in permit terms between 2019 & 2021

11. Upon information and belief, the 2021 permit modification is intended to be both *protective* and *adequately protective*. Contrary evidence is presented here on the latter point.

12. Anyone familiar with administrative procedure will recognize the difference between the obligation imposed by the 2019 permit ("shall" conduct further investigations, with the prohibited mining area not fully or finally determined pending a deliberative DEC review) and the 2021 permit modification (prohibiting mining in a specified area, expressed as final):

> **9. Further Investigations**
>
> a. Cargill shall conduct further investigations of the disturbed salt zone, identified by seismic survey and shown on No. 6 Salt Structure contours (top of salt), which may exist near the west shore of the lake in the northern extended mineral lease area. Mine projections show that present plans are to extract this area sometime between 2016 and 2020. Further investigation of this disturbance needs to be completed and submitted to the Department for review before mining proceeds in this area.

2019 permit.

> **9. Frontenac Point Anomaly** No mining shall occur under the Frontenac Point Anomaly. No mining or mining activities shall be conducted within 1000 feet of the Frontenac Point Anomaly.

2021 modified permit.

13. This transition from a deliberative, investigative phase in 2019 (still pending DEC review), to DEC's specific and final prohibition on mining and mining activities within 1000 feet of the oval-FPA in the 2021 modified permit, is a material change with respect to administrative procedure. Moreover, the modification process and determination of the prohibited mining area are "material" due to the serious consequences for global mine stability if the 2021 modified permit has mistakenly relied on the oval-FPA rather than the linear-FPA, thereby misjudging the location or extent of the fault.

Discussion and conclusions

14. In more detail, the 2019 permit required Cargill to conduct further investigations. This served as a reasonable precaution, and the term "disturbed salt zone" served as a reasonable geologic description or working definition during the period when the location, extent, and other details were being determined. Upon information and belief, the term "Frontenac Point Anomaly" started to be applied to the disturbed salt zone during this period, and both DEC and Cargill's consultant RESPEC became aware of the conflicting definitions of the linear-FPA and oval-FPA. See my prior affidavit dated June 7, 2021 (NYSCEF document 7), and also my Exhibit A attached hereto.

15. Upon information and belief, regulatory agencies routinely and properly depend on relevant investigation, coupled with their own deliberative and discretionary review of the results, in order to finalize regulations or permit conditions. While such a process may explain the transition from the 2019 permit to the 2021 permit modification, the part of the process in which DEC decided between the linear-FPA and the oval-FPA remains unclear. This part of the process necessarily depends on investigation, and on DEC's subsequent deliberative review, in order to decide between the linear-FPA and the oval-FPA. However, based on information and belief, DEC has released no information on how it determined the oval-FPA to be better supported by the evidence than the linear-FPA. Failing this, and until the relevant investigation is done, and until DEC has relied on the results to exercise its discretion and reach a determination, a permit modification should not allow mining in an area of the FPA where the global-stability risks have not been properly and squarely addressed.

16. I recognize that the 2019 permit refers indirectly, without explanation or clear linkage, to the oval-FPA. The reference is found in a mining plan to which strict conformance is

required ("Mining Plan Renewal titled: 'Cayuga Mine 5 YR Mine Plan 2017/2018 Fiscal Yr': prepared by Cargill Deicing Technology: dated August 2017") and wherein a map shows several ovals with a label FPA + 1000'. While it is evident in retrospect that these map markings show the oval-FPA, I find no text in the permit itself that requires or prohibits any activity relating to the FPA or Frontenac Point Anomaly. On the contrary, the 2019 mine permit remains in the investigative/deliberative phase, requiring Cargill to conduct further investigations of the "disturbed salt zone" prior to mining in that area, thereby indicating that investigations had not yet reached resolution as of the 2019 permit.

17. The 2021 modified mine permit provides clarity by requiring that "No mining shall occur under the Frontenac Point Anomaly. No mining or mining activities shall be conducted within 1000 feet of the Frontenac Point Anomaly." The permit cites the same mining plan cited in the 2019 permit, to which strict conformance is required ("Mining Plan Renewal titled: 'Cayuga Mine 5 YR Mine Plan 2017/2018 Fiscal Yr': prepared by Cargill Deicing Technology: dated August 2017") and wherein a map shows several ovals with a label FPA + 1000'. In combination, the map and permit text create a clear prohibition against mining under or near the oval-FPA. What remains unclear is whether investigation has shown the oval-FPA to be a better, more prudent representation of the disturbed-salt-zone fault – or, alternatively, whether evidence in favor of the linear-FPA has simply been swept aside or suppressed.

18. In my professional opinion, and to a reasonable degree of scientific certainty in my area of expertise, DEC in issuing the modification did not exercise scientifically sound judgment in identifying the Frontenac Point Anomaly area and delineating where it actually is. Once the FPA has been identified and delineated by DEC, only then can DEC declare and rule such an area, including a protective buffer zone, as the area where no mining is allowed.

This affidavit is based on information available to me at this time. Should additional information become available, I reserve the right to determine the impact, if any, of the new information on my opinions and conclusions and to modify or supplement this affidavit if necessary.

Sworn to before me this 30 day of September 2021.

Notary Public, State of New York

LINDSAY M CRONMILLER
NOTARY PUBLIC STATE OF NEW YORK
ERIE
LIC. #01CR6382039
COMM. EXP. 10/15/2022

EXHIBIT A



LARGE PILLAR DESIGN

KERRY DEVRIES
VICE PRESIDENT
1.605.394.6400
KERRY DEVRIES@RESPEC.COM

September 15, 2016

RESPEC

Technical Approach

- **Use salt-pillar equations to compare predicted pillar shortening rates and expansion rates of existing pillars in the East Mine with those proposed in the northern reserves.**
  - First determine expected vertical stress in East Mine
    - Virgin in situ stress (unaltered by mining)
    - Under the 4 Level (protected, minimum stress)
    - Just outside the 4 level footprint (maximum stress)
  - Determine range for expected vertical stresses in the northern reserves area
    - Minimum undergorged lake bottom
    - Maximum at shoreline with most cover
    - Possible additional vertical stress caused by glaciation
- **Based on East Mine observations of good and poor ground conditions, tunnel life can be approximated based on magnitude and rate of deformation**

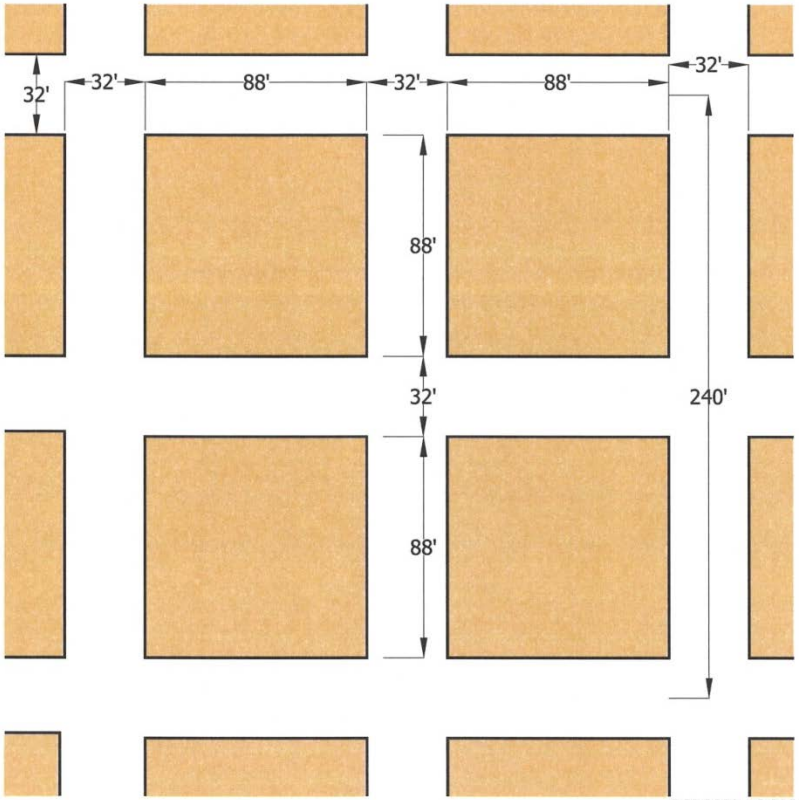
Consider Two East Mine Layouts

88′ by 88′ Square Pillars

32′ Wide Rooms

9′ Tall rooms

[redacted]% Extraction Ratio



Barrier Pillar Design

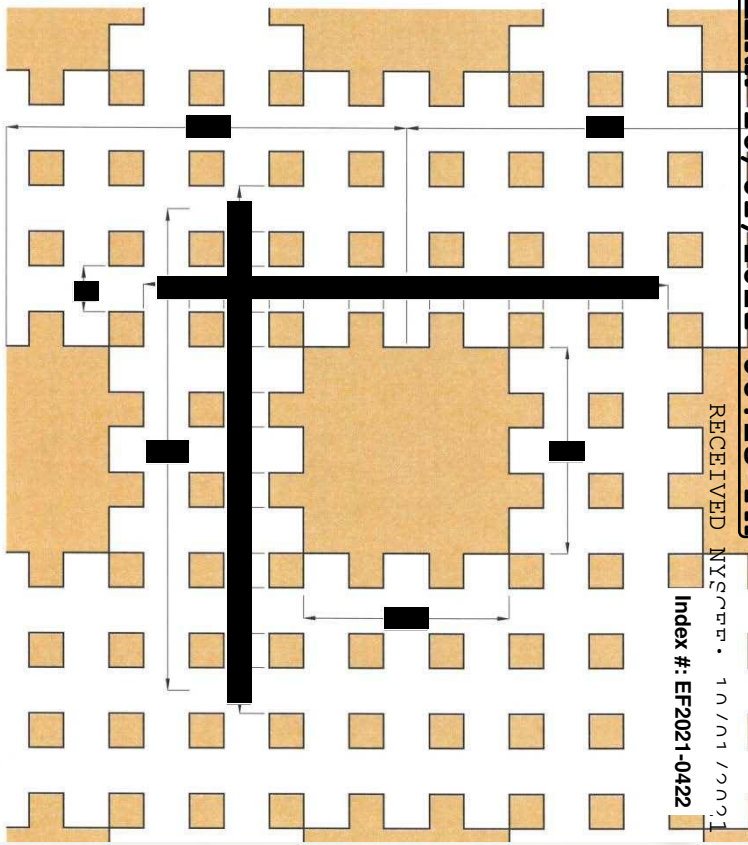
[redacted]′ by [redacted]′ Barrier Pillar

[redacted]′ by [redacted]′ Yield Pillars

[redacted]′ Wide Rooms

[redacted]′ Tall Rooms

[redacted]% Extraction Ratio



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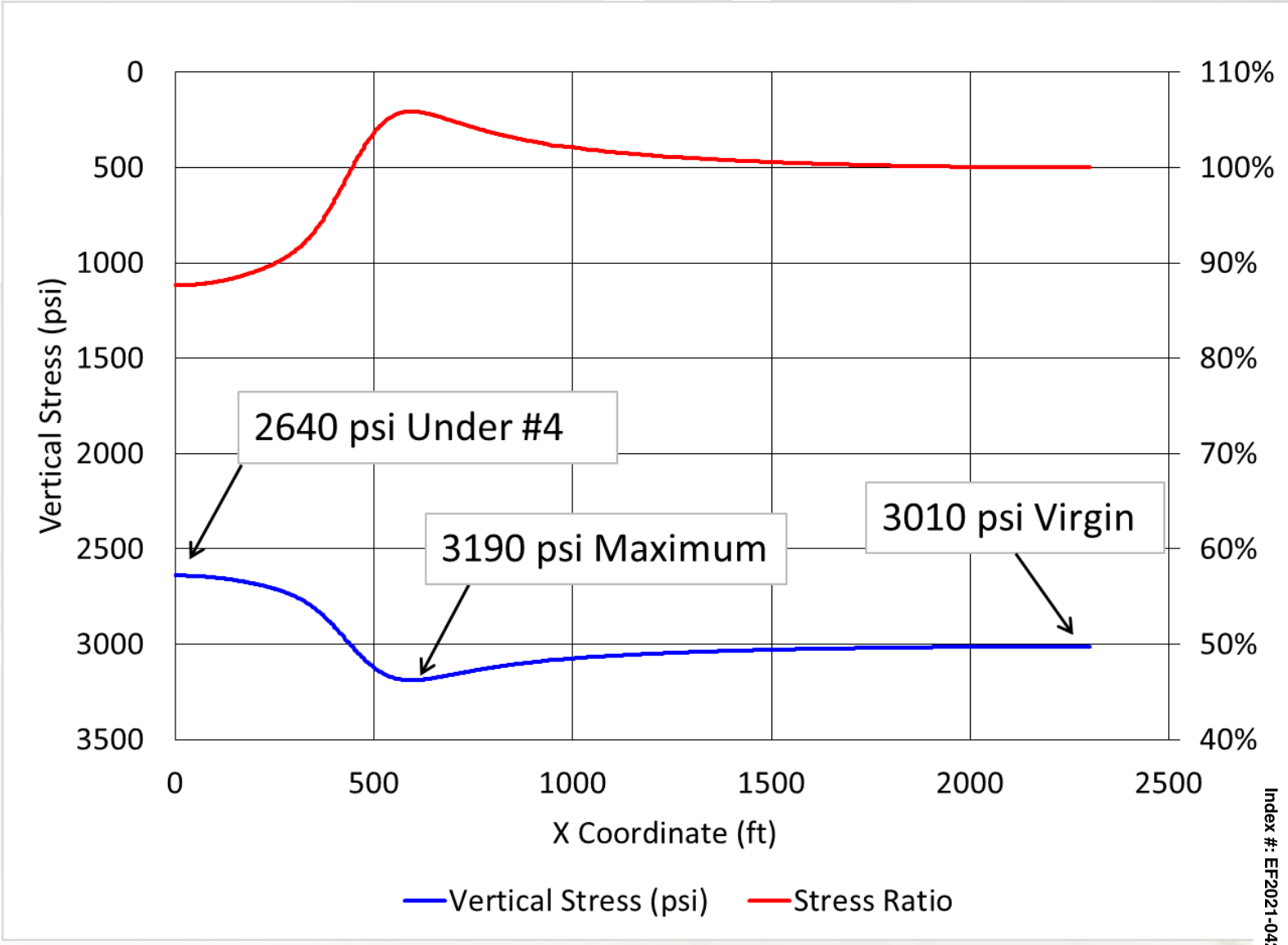
What is the Vertical Stress at East Mine?

- **Stress likely variable depending on location within the mine**
  - In Virgin Ground
  - Under 4 Level
  - Outside the Footprint of the 4 Level
  - Proximity to Other Mined Excavations
  - Topology and Formation Dip
- **Keffler [2015][1] used 3-D structural models to predict the approximate response of the East Mine. His results before mining the 6 Level were used to estimate the range for vertical stress of the East Mine workings (Depth 2640 ft).**
  - Minimum = 2460 psi
  - Maximum = 3490 psi
  - Virgin Ground = 3010 psi

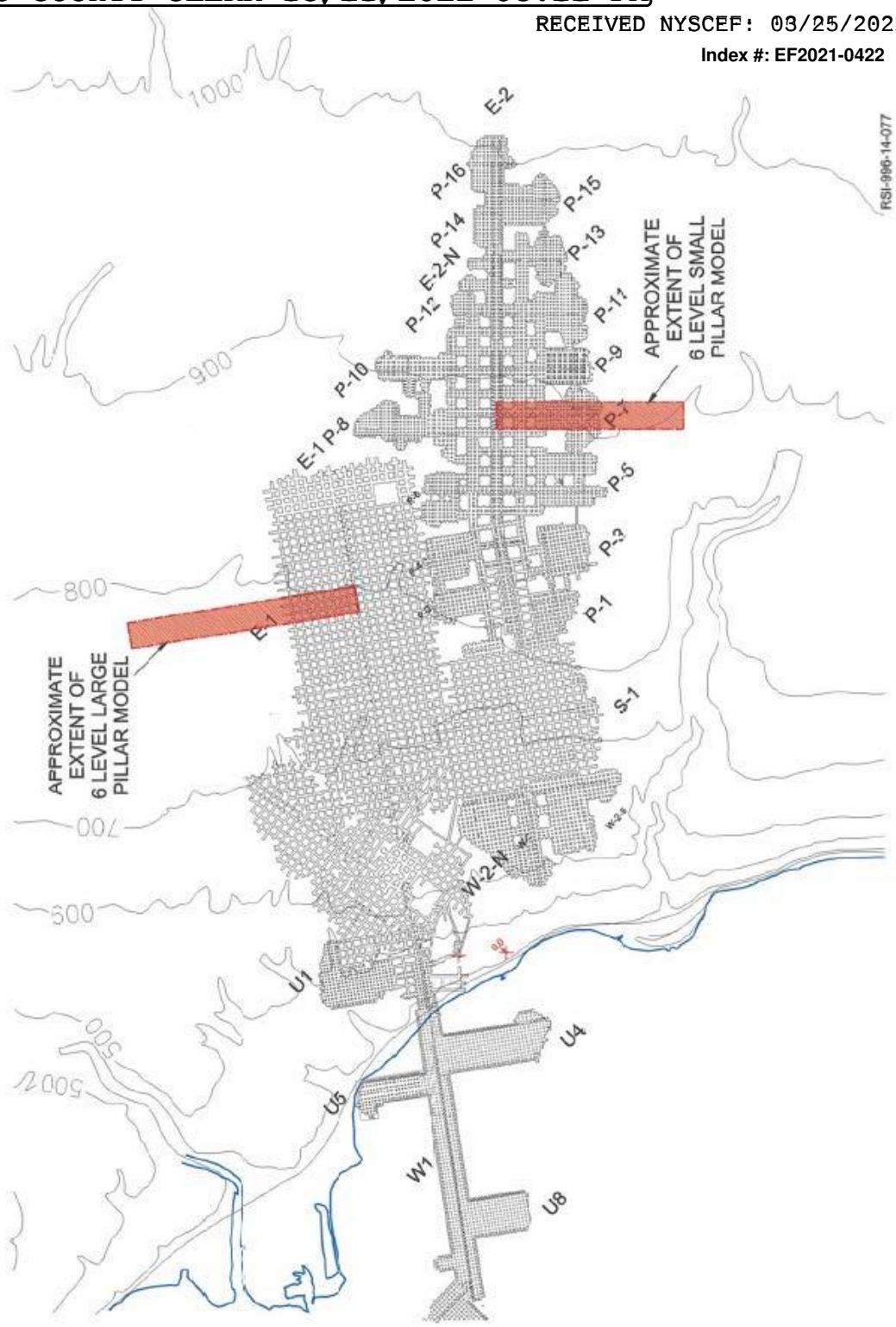
1. Keffler, E.R., 2015, *Preliminary Geomechanical Modeli to Assess the Feasibility of Multiseam Mining at Cargill's Cayuga Mine, Lansing, New York: Project Update*, RSI-24 prepared by RE/SPEC Inc., Rapid City, SD, for Cargil Deicing Technologies..

East Mine Predicted Stress After Keffler [201



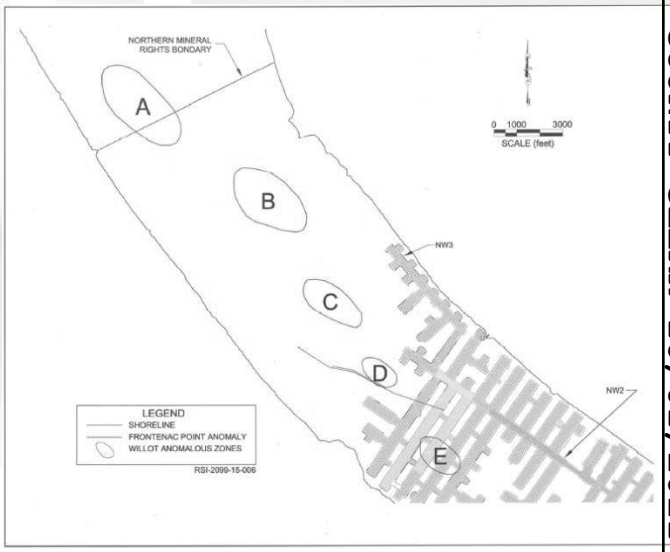
RESPEC

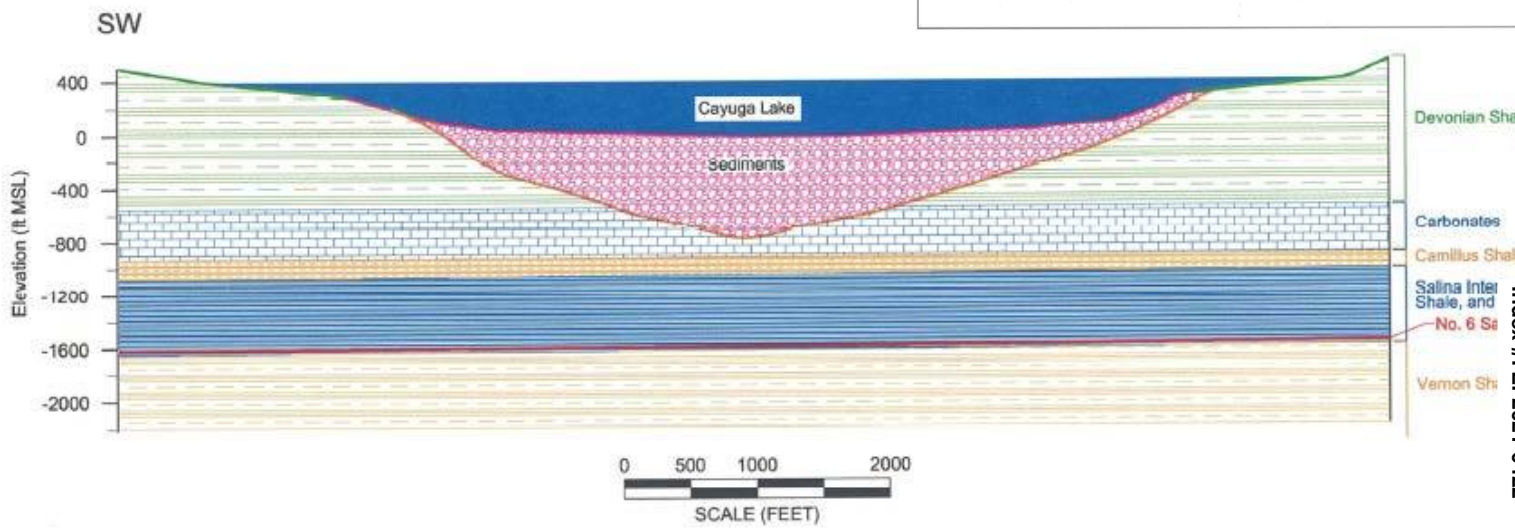
Keffler [2015][1] Models of East Mine



What is the Stress Below Lake Cayuga?

- Varies depending on location
- Use A-A' Profile from The Sear Brown Group [1995][2] and densities from Gage et al. [2013][3]



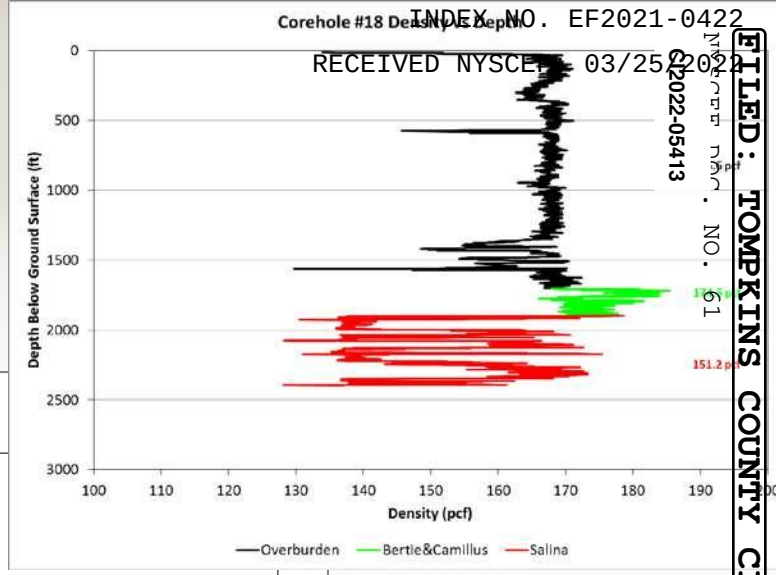


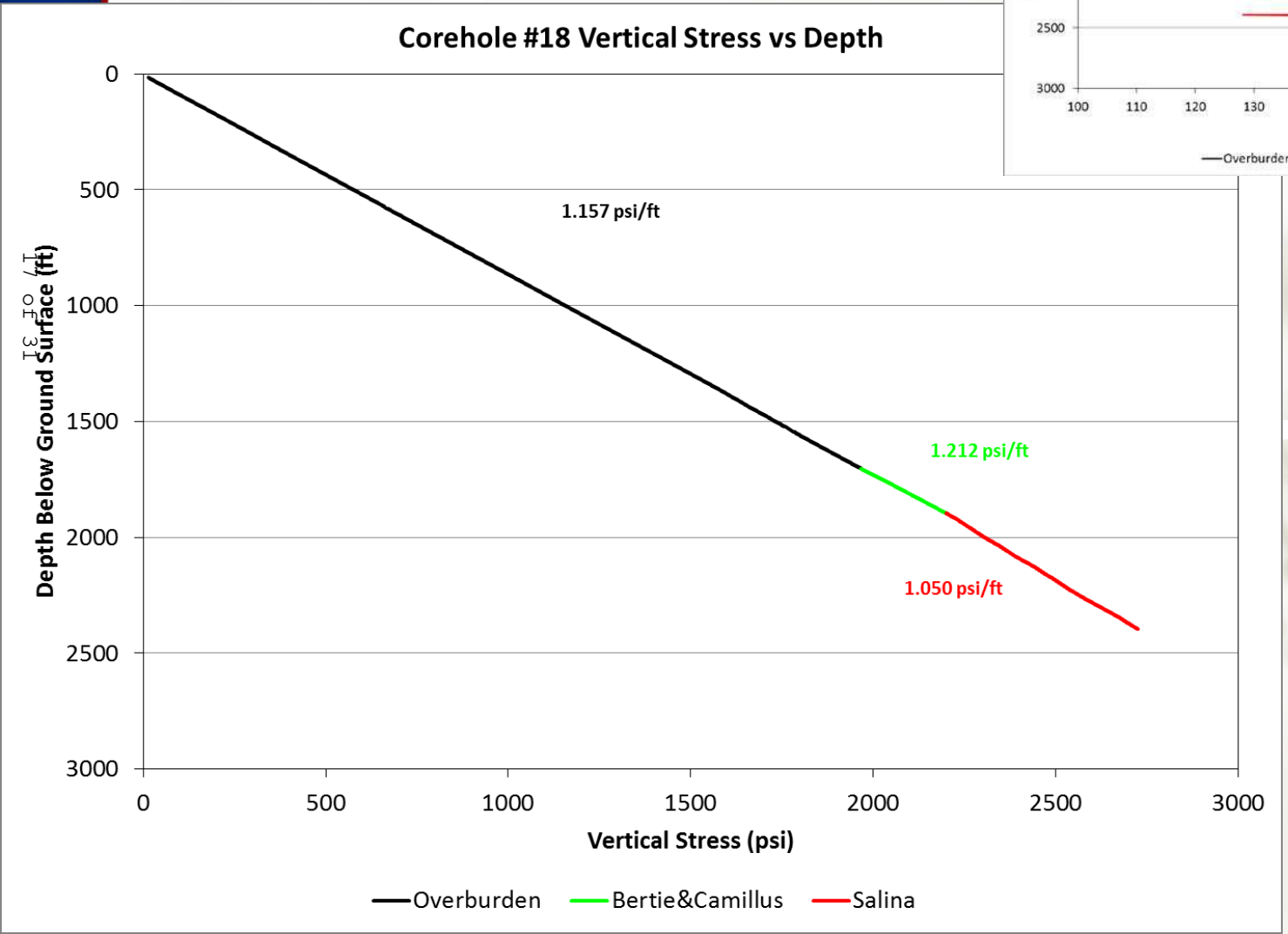
2. The Sear-Brown Group, 1995. *Geological Characterization Study, Cayuga Salt Mine, Lansing, N.Y.*, Project 12335, prepared by The Sear-Brown Group, Rochester, NY, for RE/SPEC Inc., Rapid City, SD.

3. Gnage, D. J., W. M. Goodman, and J. D. Osnes, 2013. *Cargill Deicing Technology Lansing Mine, Corehole #18 Stratigraphic Test Hole Installation and Data Collection*, RSI-2381, prepared by RESPEC, Rapid City, SD, for Cargill Deicing Technologies, Lansing, NY.

RESPEC

Stress vs Depth





Corehole #18 is in the area of the proposed mine shaft (#4 Shaft). Density logs of Corehole #18 were used to approximate overburden stress based on measurement the different lithologies.

Min & Max Overburden Stress Under Lake
Minimum = 1770 psi, Maximum = 2230 p

Geomechanical Unit	Density (pcf)	Northern Reserves Minimum Overburden Under Gorged Lake Bottom				Northern Reserves Maximum Overburden at Shoreline			
		Elevation Top (ft msl)	Elevation Bottom (ft msl)	Thickness (ft)	Vertical Stress (psi)	Elevation Top (ft msl)	Elevation Bottom (ft msl)	Thickness (ft)	Vertical Stress (psi)
Water	62.4	386	-10	396	172	386	386	0	0
Overburden Soils	140	-10	-880	870	1017	386	386	0	0
Upper Shales	168	-880	-880	0	1017	386	-550	936	1092
Carbonate	168	-880	-900	20	1041	-550	-900	350	1500
Shale	172	-900	-1000	100	1160	-900	-1000	100	1620
Salt	135	-1000	-1024	24	1183	-1000	-1024	24	1642
Shale	168	-1024	-1037	13	1198	-1024	-1037	13	1657
Salt	135	-1037	-1132	95	1287	-1037	-1132	95	1747
Shale	168	-1132	-1170	38	1331	-1132	-1170	38	1791
Salt	135	-1170	-1219	49	1377	-1170	-1219	49	1837
Shale	168	-1219	-1282	63	1451	-1219	-1282	63	1910
Salt	135	-1282	-1326	44	1492	-1282	-1326	44	1952
Shale	168	-1326	-1339	13	1507	-1326	-1339	13	1967
Salt	135	-1339	-1400	61	1564	-1339	-1400	61	2024
Shale	168	-1400	-1524	124	1709	-1400	-1524	124	2169
Salt	135	-1524	-1545	21	1729	-1524	-1545	21	2188
Shale	168	-1545	-1554	8.5	1739	-1545	-1554	8.5	2198
Salt	135	-1554	-1557	3.5	1742	-1554	-1557	3.5	2201
Shale	152	-1557	-1575	18	1761	-1557	-1575	18	2220
Salt	135	-1575	-1588	13	1773	-1575	-1588	13	2233
Carbonate	161	-1588	-1602	14	1789	-1588	-1602	14	2248
Salt	135	-1602	-1614	12	1800	-1602	-1614	12	2260
Shale	159	-1614	-2600	986	2889	-1614	-2600	986	3348

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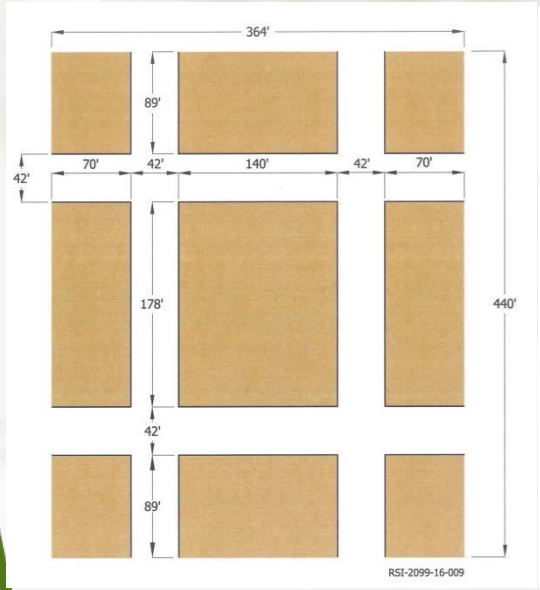
6 Different Configurations Evaluated

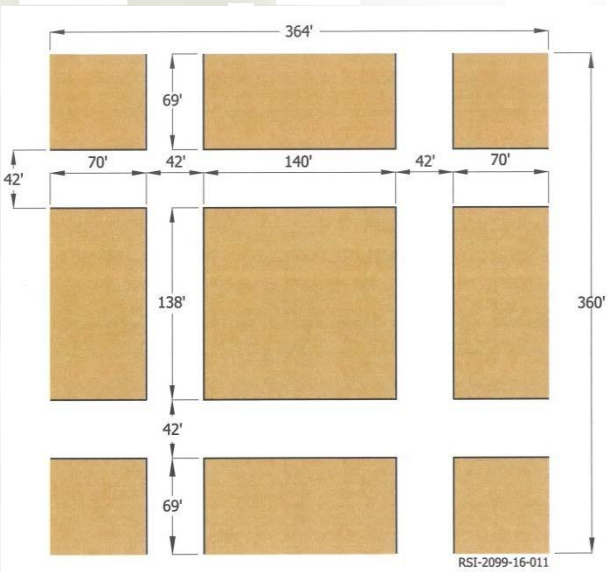
1. 140' x 178' Large Pillars – 42' Wide Rooms
2. 140' x 138' Large Pillars – 42' Wide Rooms
3. 120' x 120' Large Pillars – 42' Wide Rooms
4. Transition from Yield Pillar Panel to Large Pillars
5. 88' x 88' East Mine (shown earlier)
6. East Mine Barrier Pillar Layout (shown earlier)

Three Large Pillar Designs

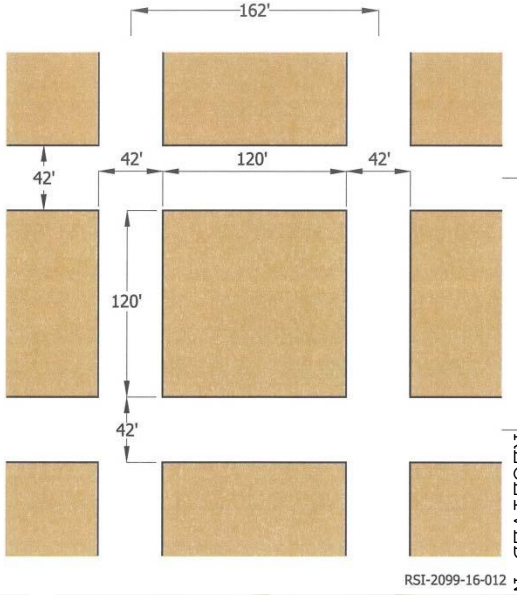
140′ by 178′ Pillars
42′ Wide Rooms
11′ Tall Rooms
[redacted]% Extraction Ratio



140′ by 138′ Pillars
42′ Wide Rooms
11′ Tall Rooms
[redacted]% Extraction Ratio

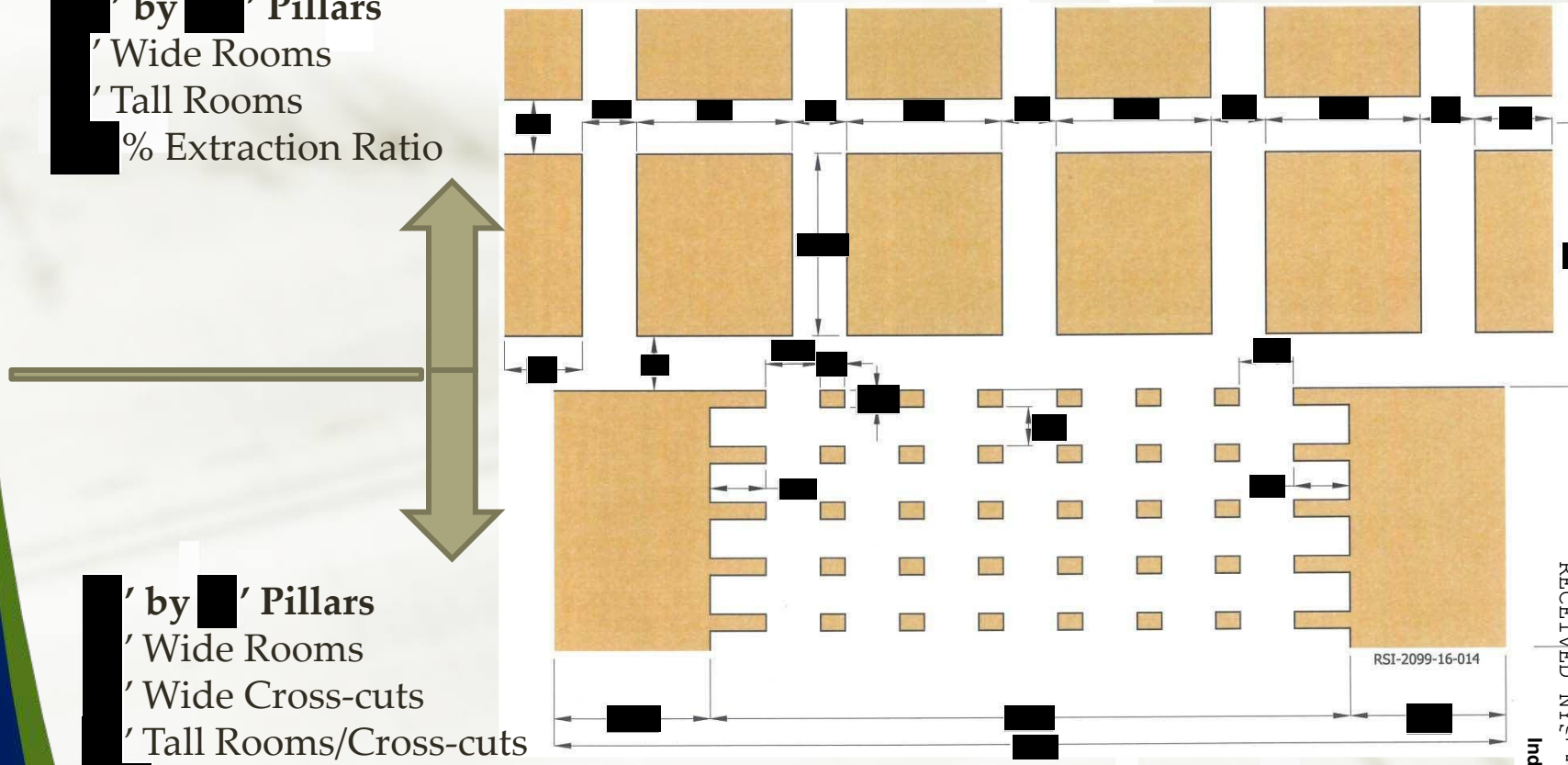


120′ by 120′ Pillars
42′ Wide Rooms
11′ Tall Rooms
[redacted]% Extraction Ratio



Transition from Yield-Pillar Panel to L[redacted] Pillar Layout – Local Extraction Ratio [redacted]%

[redacted]' by [redacted]' Pillars
[redacted]' Wide Rooms
[redacted]' Tall Rooms
[redacted]% Extraction Ratio



[redacted]' by [redacted]' Pillars
[redacted]' Wide Rooms
[redacted]' Wide Cross-cuts
[redacted]' Tall Rooms/Cross-cuts
[redacted]% Extraction Ratio*

* Assumes barrier pillars in yield pillar panel shed approximately 28% of load to large pillars.

Tunnel Life

- **Anecdotal information from Plumeau regarding the conditions of the East Mine can be summarized as:**
  - After [redacted] years, 88' x 88' under 4 Level rock bolts are maintaining the ground which is in good shape with minor slabs and few bolt failures
  - Roof failed within about [redacted] years in 88' x 88' outside footprint of 4 level – cribbing and bolt supports are crushing and failing
  - Roof failed fairly quickly in 88' x 88' in virgin ground with limited bolting - conditions currently poor but under more cover than other areas and some rooms were enlarged to 42 feet versus typical 32 feet.
- **Tunnel life can be approximated if its is directly proportional to an allowable closure magnitude and/or expansion magnitude.**
- **Here it is assumed the allowable closure magnitude is that of the 88 by 88' East Mine pillars under the 4 Level at [redacted] years based on Petersen [2016][4]**

4.Petersen, G., 2016, *Cargil Deicing Technology Cayuga Mine Thoughts on Mining the Northern Reserves*, prepared by Rocktec Solutions, Ishpeming, MI, for Cargill Deicing Technologies..

Results for Minimum Overburden Stress (1770 psi Under Gorged Lake Bottom)

Large Pillar Designs	Extraction Ratio (%)	In Situ Vertical Stress (psi)	Damage Potential	Average Pillar Effective Stress (psi)	Pillar Shortening Rate (in/yr)	Pillar Width Expansion Rate (in/yr)	Shortening Tunnel Life (Years)	Expansion Tunnel Life (Years)
140' x 178' Large Pillars	[redacted]%	1770	0.09	1044	0.05	0.28		
140' x 138' Large Pillars	[redacted]%	1770	0.10	1139	0.07	0.35		
120' x 120' Large Pillars	[redacted]%	1770	0.10	1295	0.11	0.52		
Yield Pillar to Large 120' x 140' Pillar Entry	[redacted]%	1770	0.10	1624	0.27	1.37		
East Mine 88' x' 88' Virgin Ground	[redacted]%	3010	0.11	2343	0.96	4.08		
East Mine 88' x 88' Under 4-Level	[redacted]%	2640	0.11	2055	0.57	2.41		
East Mine 88' x 88' Outside Footprint	[redacted]%	3190	0.11	2484	1.21	5.15		
East Mine Barrier Pillar Virgin Ground	[redacted]%	3010	0.09	3473	4.60	30.78		

Tunnel shortening and expansion life estimates based stand-up time of [redacted] years in East Mine under 4 Level.

In quantitative agreement with Plumeau estimate of failure within [redacted] year of mining – sometimes less.

- Tunnel life greater than [redacted] years for all 3 large pillar designs based on pillar shortening.
- Tunnel life greater than [redacted] years for all 3 large pillar designs based on pillar expansion.
- Tunnel life in transition area between yield-pillar panel and large pillar region ranges between [redacted] and [redacted] years

Results for Maximum Overburden Stress (2230 psi Under Shoreline)

Large Pillar Designs	Extraction Ratio (%)	In Situ Vertical Stress (psi)	Damage Potential	Average Pillar Effective Stress (psi)	Pillar Shortening Rate (in/yr)	Pillar Width Expansion Rate (in/yr)	Shortening Tunnel Life (Years)	Expansion Tunnel Life (Years)
140' x 178' Large Pillars	[redacted]%	2230	0.09	1315	0.12	0.70	[redacted]	[redacted]
140' x 138' Large Pillars	[redacted]%	2230	0.10	1435	0.16	0.89		
120' x 120' Large Pillars	[redacted]%	2230	0.10	1632	0.28	1.30		
Yield Pillar to Large 120' x 140' Pillar Entry	[redacted]%	2230	0.10	2046	0.68	3.45		
East Mine 88' x' 88' Virgin Ground	[redacted]%	3010	0.11	2343	0.96	4.08		
East Mine 88' x 88' Under 4-Level	[redacted]%	2640	0.11	2055	0.57	2.41		
East Mine 88' x 88' Outside Footprint	[redacted]%	3190	0.11	2484	1.21	5.15		
East Mine Barrier Pillar Virgin Ground	[redacted]%	3010	0.09	3473	4.60	30.78		

Tunnel shortening and expansion life estimates based stand-up time of [redacted] years in East Mine under 4 Level.

- Tunnel life greater than [redacted] years for all 3 pillar designs based on pillar shortening.
- Tunnel life greater than [redacted] years for all 3 pillar designs based on pillar expansion.
- Tunnel life in transition area between yield-pillar panel and large pillar region ranges between [redacted] and [redacted] years

Glacial Rebound

- ***"Does glacial rebound cause the vertical stress magnitude to be greater than that calculated from overburden weight at the Cayuga Mine?"***
- Post-glacial rebound is the rise of the land mass that was depressed by the huge weight of ice sheets during the last glacial period. This movement is continually changing the stresses in the lithosphere with time.
- **If glacial rebound exists, the actual loads supported by the pillars will be greater than those given in the previous slides.**
- Many papers are available in the public domains that discuss stress changes caused by flexure of the earth's crust and mantel during post-glacial rebound but discussion usually is limited to horizontal stresses and the desktop study became laborious and was discontinued without a definitive answer.

Glacial Rebound (continued)

- **To the best of my knowledge based on limited research, the actual mechanisms for time-dependent dissipation of vertical stress is not fully understood. Two papers presenting in situ measurements indicate the vertical stress is greater than that computed from overburden density in the Cayuga area.**
  - Bauer et al. [2005][2] conduced overcoring tests at the 700m level at the Norton Mine in Ohio. Determined vertical in situ stress was 1.26 times greater than that calculated from the overburden weight.
  - Haimson [1974][3] reported stress as a depth of 1600-1700 in Alma Township 80 miles south west of the Cayuga Mine. Keffler [2015][3] used the reported stresses given and determined vertical in situ stress was 1.19 times greater than that calculated from the overburden weight.
- **If glacial rebound is present, what is its impact on the large pillar design?**

2. Bauer, S.J., Munson, D.E., Hardy, MP, Barrix, J and McGunegle, B. 2005. In Situ Stress Measurements and Their Implications in a Deep Ohio Mine, ARMA/USRMS 05

3. Haimson, B.C., 1974, "A simple method for estimati sit vertical stresses at great depth," *ASTM Special Publicati Field Testing and Instrumentation of Rock, American Socie Testing and Materials*, Philadelphia, PA, pp. 156-182.

Overburden Stress & 19% Glacial Rebound

Geomechanical Unit	Density (pcf)	Rebound Density 1.19 % (pcf)	Keffler Northern Reserves Minimum Overburden Including 19% Glacial Rebound				Keffler Northern Reserves Maximum Overburden Including 19% Glacial			
			Elevation Top (ft msl)	Elevation Bottom (ft msl)	Thickness (ft)	Vertical Stress (psi)	Elevation Top (ft msl)	Elevation Bottom (ft msl)	Thickness (ft)	Vertical Stress (psi)
Water	62.4	62.4	386	-10	396	172	386	386	0	0
Overburden Soils	140	140	-10	-880	870	1017	386	386	0	0
Upper Shales	168	200	-880	-880	0	1017	386	-550	936	1300
Carbonate	168	200	-880	-900	20	1045	-550	-900	350	1786
Shale	172	205	-900	-1000	100	1188	-900	-1000	100	1928
Salt	135	135	-1000	-1024	24	1210	-1000	-1024	24	1951
Shale	168	194	-1024	-1037	13	1228	-1024	-1037	13	1968
Salt	135	135	-1037	-1132	95	1317	-1037	-1132	95	2058
Shale	168	194	-1132	-1170	38	1368	-1132	-1170	38	2109
Salt	135	135	-1170	-1219	49	1414	-1170	-1219	49	2155
Shale	168	194	-1219	-1282	63	1499	-1219	-1282	63	2240
Salt	135	135	-1282	-1326	44	1540	-1282	-1326	44	2281
Shale	168	194	-1326	-1339	13	1557	-1326	-1339	13	2298
Salt	135	135	-1339	-1400	61	1615	-1339	-1400	61	2356
Shale	168	194	-1400	-1524	124	1782	-1400	-1524	124	2523
Salt	135	135	-1524	-1545	21	1801	-1524	-1545	21	2542
Shale	168	194	-1545	-1554	8.5	1813	-1545	-1554	8.5	2554
Salt	135	135	-1554	-1557	3.5	1816	-1554	-1557	3.5	2557
Shale	152	181	-1557	-1575	18	1839	-1557	-1575	18	2580
Salt	135	135	-1575	-1588	13	1851	-1575	-1588	13	2592
Carbonate	161	192	-1588	-1602	14	1870	-1588	-1602	14	2610
Salt	135	135	-1602	-1614	12	1881	-1602	-1614	12	2622
Shale	159	189	-1614	-2600	986	3175	-1614	-2600	986	3916

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Results for Minimum Overburden Stress Assuming Post-Glacial Rebound (1850 psi)

Large Pillar Designs	Extraction Ratio (%)	In Situ Vertical Stress (psi)	Damage Potential	Average Pillar Effective Stress (psi)	Pillar Shortening Rate (in/yr)	Pillar Width Expansion Rate (in/yr)	Shortening Tunnel Life (Years)	Expansion Tunnel Life (Years)
140' x 178' Large Pillars	[redacted]%	1850	0.09	1091	0.05	0.33		
140' x 138' Large Pillars	[redacted]%	1850	0.10	1190	0.08	0.42		
120' x 120' Large Pillars	[redacted]%	1850	0.10	1354	0.13	0.62		
Yield Pillar to Large 120' x 140' Pillar Entry	[redacted]%	1850	0.10	1697	0.32	1.63		
East Mine 88' x' 88' Virgin Ground	[redacted]%	3010	0.11	2343	0.96	4.08		
East Mine 88' x 88' Under 4-Level	[redacted]%	2640	0.11	2055	0.57	2.41		
East Mine 88' x 88' Outside Footprint	[redacted]%	3190	0.11	2484	1.21	5.15		
East Mine Barrier Pillar Virgin Ground	[redacted]%	3010	0.09	3473	4.60	30.78		

Tunnel shortening and expansion life estimates based stand-up time of [redacted] years in East Mine under 4 Level.

- Tunnel life greater than [redacted] years for all 3 pillar designs based on pillar shortening.
- Tunnel life greater than [redacted] years for all 3 pillar designs based on pillar expansion.
- Tunnel life in transition area between yield-pillar panel and large pillar region ranges between [redacted] and [redacted] years

Results for Maximum Overburden Stress Assuming Post-Glacial Rebound (2590 psi)

Large Pillar Designs	Extraction Ratio (%)	In Situ Vertical Stress (psi)	Damage Potential	Average Pillar Effective Stress (psi)	Pillar Shortening Rate (in/yr)	Pillar Width Expansion Rate (in/yr)	Shortening Tunnel Life (Years)	Expansion Tunnel Life (Years)
140' x 178' Large Pillars	[redacted]%	2590	0.09	1528	0.21	1.28	[redacted]	[redacted]
140' x 138' Large Pillars	[redacted]%	2590	0.10	1666	0.30	1.61		
120' x 120' Large Pillars	[redacted]%	2590	0.10	1896	0.50	2.37		
Yield Pillar to Large 120' x 140' Pillar Entry	[redacted]%	2590	0.10	2376	1.24	6.28		
East Mine 88' x' 88' Virgin Ground	[redacted]%	3010	0.11	2343	0.96	4.08		
East Mine 88' x 88' Under 4-Level	[redacted]%	2640	0.11	2055	0.57	2.41		
East Mine 88' x 88' Outside Footprint	[redacted]%	3190	0.11	2484	1.21	5.15		
East Mine Barrier Pillar Virgin Ground	[redacted]%	3010	0.09	3473	4.60	30.78		

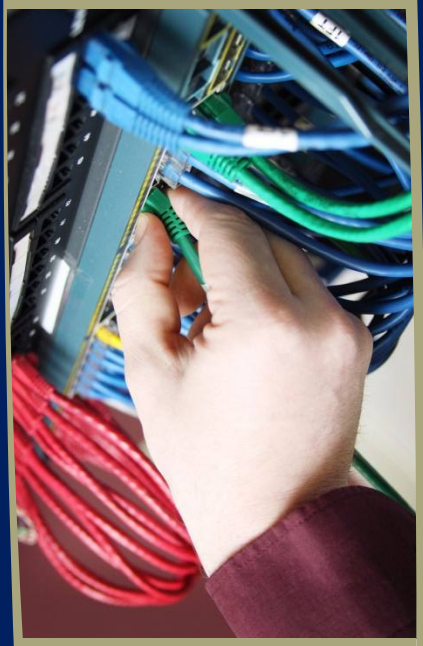
Tunnel shortening and expansion life estimates based stand-up time of [redacted] years in East Mine under 4 Level.

- Tunnel life greater than [redacted] years for all 3 pillar designs based on pillar shortening and pillar expansion.
- Tunnel life in transition area between yield-pillar panel and large pillar region ranges between [redacted] and [redacted] years

Summary

- Tunnel life expectancy is between [redacted] and [redacted] percent less for a criteria based on pillar expansion than shortening.
- Depending on the vertical stress, tunnel life based on pillar ***shortening*** magnitude is as follows:
  - 140' x 178' Pillars: [redacted] years ([redacted] yrs glacial stress)
  - 140' x 138' Pillars: [redacted] years ([redacted] yrs glacial stress)
  - 120' x 120' Pillars: [redacted] years ([redacted] yrs glacial stress)
- Depending on the vertical stress, tunnel life based on pillar ***expansion*** magnitude is as follows:
  - 140' x 178' Pillars: [redacted] years ([redacted] yrs glacial stress)
  - 140' x 138' Pillars: [redacted] years ([redacted] yrs glacial stress)
  - 120' x 120' Pillars: [redacted] years ([redacted] yrs glacial stress)
- Transition from yield-pillar panel to large pillar regions tunnel life varies from [redacted] to [redacted] years.
- Wasn't able to determine with certainty if post-glacial rebound increases vertical stress at Cayuga. Current opinion is not to consider impact of glacial rebound here but for the 120' sq pillars life would be reduced [redacted] years if considered.
- Pillars smaller than 120' square may be possible if less than [redacted]-year stand-up time acceptable.
- Bolting and scaling will be required to maintain rooms for extended durations.

RESPEC



RESPEC

QUESTIONS

STATE OF NEW YORK
SUPREME COURT : COUNTY OF TOMPKINS

In the Matter of the Application, CAYUGA LAKE ENVIRONMENTAL ACTION NOW (CLEAN), an Unincorporated Association by President JOHN V. DENNIS, and LOUISE BUCK, BURKE CARSON, JOHN V. DENNIS, WILLIAM HECHT, HILARY LAMBERT, ELIZABETH and ROBERT THOMAS, and KEN ZESERSON

Petitioners,

For a Judgment Pursuant to Article 78 of the New York Civil Practice Laws and Rules

vs.

THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, and CARGILL INCORPORATED

Respondents.

AFFIDAVIT OF RAYMOND C. VAUGHAN IN SUPPORT OF PETITION

Index No.

State of New York,
County of Erie, ss.:

RAYMOND C. VAUGHAN, being duly sworn, deposes and says:

1. I am a Professional Geologist (NY license no. 258) and Environmental Scientist with a Ph.D. in Geology from SUNY Buffalo. I am very familiar with the State Environmental Quality Review Act (SEQRA) as a result of my service on the Town of Hamburg Conservation Advisory Board (1980-1999) where I and other members regularly conducted SEQRA reviews of proposed projects referred to us by the Town Board and/or Planning Board. My familiarity with SEQRA was reinforced during the twelve years I was employed as an Environmental Scientist at the NYS Attorney General's Office (2000-2012). My knowledge of geology is a combination of education

and experience, including extensive work at the NYS Attorney General's Office on the evolving evidence of brine migration and associated long-term impacts from the 1994 salt mine collapse in Retsof, Livingston County, NY. My CV is attached as Exhibit A.

2. I have reviewed the Cayuga Salt Mine permit, Modification # 1, effective 2/12/2021, especially its § 9 which imposes a new condition that "No mining shall occur under the Frontenac Point Anomaly. No mining or mining activities shall be conducted within 1000 feet of the Frontenac Point Anomaly." I find that this requirement is ambiguous because *it fails to distinguish between two substantially different definitions of the Frontenac Point Anomaly* (FPA) that Respondents and their consultants have utilized within the past five years. Given the protective intent of this new requirement, and given my understanding of the need for applying such a protective requirement to the FPA, I find that the new requirement's ambiguity renders it unprotective.

3. According to DEC's Notice of Intent for the Cargill Salt Mine permit modification:

> New Condition 9 - Frontenac Point Anomaly [-] recognizes that Cargill performed additional investigations of the disturbed salt zone located near the west shore of the lake in the northern extended mineral lease area described in current permit condition 9.a. The disturbed salt area is now termed the Frontenac Point Anomaly (FPA). By letter, Cargill has agreed to not mine under the FPA and to maintain a minimum 1000-foot setback from the FPA for all mining activities. The new condition memorializes the letter and the commitment not to mine under the FPA and maintain the minimum 1000-foot setback as part of the permit.

DEC, *Notice of Intent to Modify*, July 29, 2020.

4. In fact, the new condition cannot "memorialize" either Cargill's letter or the commitment not to mine under the FPA and maintain the minimum 1000-foot setback. Cargill's letter is not listed in § 3 along with other approved plans, requiring

strict conformance, that have been submitted by the applicant or applicant's agent as part of the permit application. Thus, while new condition § 9 may not be entirely unenforceable, the phrases "under the FPA" and "1000-foot setback" have no clear meaning in the absence of a clear definition of the FPA and the 1000-foot setback line that encloses it.

5. In order to be protective, the modified permit would need to specify the applicable 1000-foot setback. Are *both* definitions of the FPA covered by § 9, meaning that the 1000-foot setback line encloses both versions of the FPA? Or does the setback line enclose only one version of the FPA – and, if so, what is the rational basis for applying the mining restrictions to only one and not both versions of the FPA?

Faulting: the FPA and its two conflicting definitions

6. The FPA is recognized by DEC, and by DEC's consultant Boyd, as a structural feature of concern for the Cayuga Salt Mine, particularly involving "the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake." Boyd 2018 letter at 2. The FPA is evidently a fault (id. at 1-6 and 9) and has been represented in two different ways on maps provided by Respondents. One version of the FPA depicts it as a generalized oval while another shows it as a slightly curving *line* that represents the FPA. The linear version is seen in Exhibits B and C; the generalized oval is seen in the Boyd 2018 letter, Exhibit D, at 4. (The map in the Boyd 2018 letter, as created by Boyd, is mostly a copy of a 2010 map but also includes the generalized FPA oval added by Boyd.)

7. Evidence that the FPA is a substantial fault includes information that Boyd provided to DEC in 2002. Boyd reported that the FPA, then called the "disturbed area," appeared to be "a graben-like structure with a vertical displacement of approximately 100

ft" (id. at 2). A few years later, based on seismic studies, RESPEC suggested "that the anomaly is a deep penetrating, nearly vertical, east-west-trending fault" (id. at 5).

8. Representing the FPA as a linear feature is more geologically plausible than representing it as a generalized oval because faults are generally linear features.

Relatively thin bedrock above the mine: Anomalies A, B, C, D, and E

9. A 2010 report by Willott – referenced in the Boyd 2018 letter but not released in its entirety under FOIL – is important because it identified the five areas of deep gouge known as Anomalies A through E. These "anomalies" of thin rock overburden are recognized as a concern (see Boyd 2018 letter at 1-10) because they are places where ancient glaciers gouged/scoured relatively deeply into the bedrock, creating what are now thin spots in the bedrock above the mine. In some of these thin spots, the layers of sturdy carbonate rock that provide crucial support for the mine roof are extremely thin or absent. Moreover, the places where ancient glaciers gouged/scoured relatively deeply are not entirely restricted to Anomalies A-E. In the 2010 Willott map shown in the Boyd 2018 letter, Exhibit D at 4, the elongated "Area where the rock overlying the limestone is very thin" encompasses not only Anomalies A-E but also the intervening areas beneath Cayuga Lake.

10. Comparison of the maps in Exhibits B, C, and D shows the linear configuration of the FPA skirting Anomaly D and passing through the thin-bedrock area between Anomalies D and E. Here, even if not elsewhere, mine integrity faces a combined risk from faulting and thin bedrock.

11. Expert evaluation on behalf of Respondents has reportedly led to a belief that "the anomalies represent erosion of bed rock that extends into the Helderberg limestone. The group could not discount faulting beneath the anomalies and confirmed

that the FPA represents a fracture in the limestones but there was no convincing evidence of lower limestones collapse due to salt solutioning." See Boyd 2018 letter at 5.

Source of the FPA maps in Exhibits B, C, and D

12. The Boyd 2018 letter, Exhibit D at 4, is the source for the oval version of the FPA. The basis for Boyd's use of an oval to represent the FPA, and his placement of the oval, remain unclear.

13. The linear version of the FPA, while less frequently shared with the public than the generalized oval version, is seen on the two maps – actually two versions of the same map – provided to CLEAN under FOIL and attached hereto as Exhibits B and C. CLEAN has given me no specific information on the source of this map, and in my best understanding no such information has been provided to CLEAN. Despite this lack of specific information, I can draw certain conclusions from the maps themselves.

14. The black-and-white version of the map in Exhibit B is accompanied by emails transmitting the map among DEC and Boyd staff in 2016; these provide limited context. The color version of the map in Exhibit C has no such evidence of how/when it was created or transmitted but includes a page number (2), a caption ("Figure 1-1. Mine Map of the Cayuga Mine Northern Reserves") and markings (RSI- 2099-15-006 and RSI-2099-15-053) that suggest that the map is from a report.

15. See also the subject line ("RESPEC update") of the emails in Exhibit B. RESPEC is a well-known geologic consulting company in South Dakota that has performed work for Cargill relating to the Cayuga Mine. The aforementioned markings on the map (RSI- 2099-15-006 and RSI-2099-15-053) are of the same general format as markings that RESPEC typically attaches to figures and illustrations in its reports. Based on the foregoing, including the word "update" in the subject line, the map is likely from a

RESPEC report that was prepared for Cargill and completed in 2016. I cannot be more specific because CLEAN has given me no additional information on the map source(s) beyond what's shown in Exhibits B and C. Furthermore, as noted above, it is my understanding that no specific information on the source(s) has been released under FOIL or otherwise provided to CLEAN.

Possible evolution of Respondents' understanding of the configuration of the FPA

2010 DEC letter

16. In a 2010 letter not released under FOIL in its entirety, Steve Army of DEC "affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable." This quote from Steve Army's letter is known from the Boyd 2018 letter at 3. Steve Army's letter should be made available in full so that the reasoned basis for DEC's agreement with the 1000-foot FPA standoff or setback can be independently evaluated, especially in relation to DEC and Cargill's then-current understanding of the FPA and its configuration.

17. Note that Respondents' recognition or understanding of the linear configuration of the FPA is several years later than Steve Army's 2010 letter. See especially the emails dated October 2016 in Exhibit B that forwarded the linear-configuration map with "update" in the subject line and "FYI" ("For Your Information") in the body of one of the emails. Information forwarded as an "update," and accompanied by an "FYI" tag, is normally understood to be new information not already known to the recipient(s). On this basis, Respondents' recognition or understanding of the linear configuration of the FPA dates from 2016, several years after the above-quoted DEC letter from Steve Army that "affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable." No explanation has been provided why a 1000-foot standoff or setback, already recognized

as protective, would not have been applied to the linear configuration of the FPA when it came to be recognized in 2016.

2013 RESPEC report

18. As additional geologic background, consider the following overview from a 2013 report prepared by Cargill's consultant RESPEC:

> Bedrock structures at the Cayuga Mine include folds, faults, and joints. The most prominent feature is the Fir Tree Point Anticline, which is the major east-west trending fold whose axis crosses Cayuga Lake between Myers Point and Portland Point. The smaller-scale structures observed in the mine at the #1 Salt, the #4 Salt, and the #6 Salt levels are related to regionally extensive tectonic deformation that produced the Fir Tree Point Anticline and even larger folds to the south.
>
> Smaller-scale folds and faults occur on the limbs and in the core of the Fir Tree Point Anticline. The extreme relief on the #4 salt bed is related to buckling in the core of the larger fold. The well-known thrust fault in the Tully Limestone in the quarry above the mine occurs along the crest of the fold. Faults are also known to occur on the limbs of the fold at the Onondaga Limestone level based on well control and can also be clearly observed in seismic data….
>
> *Salt Structure*. No evidence of faulting was noted in the seismic reflection data north of the Frontenac Point Anomaly. In addition, structural contour maps in Figures 3-4 through 3-8, for the #6 Salt, the base of the #4 Salt (Salina E), the top of the salt sequence (Salina F), the top of the Camillus shale, and the top of the overlying carbonates all appear relatively simple.
>
> In Corehole #18, the banding in the #6 salt is near-horizontal. There is some inclination of bedding in the #4 and #3 Salts. Dips as high as 60 degrees are noted but do not appear to be representative of large intervals within the sequence. Compressional deformation of the salt beds by internal shortening (i.e., thickening) appears to be responsible for the inclined strata in the #4 and #3 salt beds.
>
> Log sections for the F1 Salt (#4 Salt) in the Zeifle #1, Dunkle, and Campion wells also suggest some tectonic deformation in the region surrounding the Northern Reserves. The typical bedding sequence for the F salts is disrupted, the interval appears thicker, and the F1 Salt is less pure (see Figure 3-6).

RESPEC, Cargill Icing Technology Lansing Mine, Corehole #18 Stratigraphic Test Hole Installation and Data Collection, Topical Report RSI-2381 (November 2013), at 26-27.

19. The above-quoted overview by RESPEC acknowledges folds, faults, and joints at the mine, with "No evidence of faulting…noted in the seismic reflection data north of the Frontenac Point Anomaly" – but the geographic reach of this latter conclusion remains vague as long as the FPA remains poorly bounded. Note particularly that RESPEC's November 2013 interpretation should be regarded as a work in progress, as indicated by Respondents' recognition or understanding of the linear configuration of the FPA being a few years later than this RESPEC report. See especially the aforementioned emails dated October 2016 in Exhibit B that forwarded the linear-configuration map with "update" in the subject line and "FYI" in the body of one of the emails. On this basis, Respondents' recognition or understanding of the linear configuration of the FPA dates from 2016, a few years after the above-quoted 2013 RESPEC interpretation. No explanation has been provided why a 1000-foot standoff or setback, already recognized as protective, would not have been applied to the linear configuration of the FPA when it came to be recognized in 2016.

2018 Boyd letter

20. The Boyd 2018 letter, Exhibit D, is two years later than the 2016 recognition of the linear configuration of the FPA but shows only the generalized oval, not the linear version. While this might suggest that the linear configuration had been superseded or refuted by new investigation between 2016 and 2018, no such evidence has been presented or mentioned. Boyd's silence on this matter in the otherwise informative 2018 letter is not convincing evidence that the linear configuration has been ruled out. Boyd's statement that "Faulting was not detected" (id. at 10) is in the context of a drilling investigation of Anomaly C, not the FPA.

21. Partway through the Boyd 2018 letter, it pivots away from the purely mechanical strength of thinned bedrock at the scour anomalies to the question of whether

bedrock strength is further compromised by water penetration. The Boyd letter (op. cit. at 7-9) discusses a drilling investigation of Anomaly C, reporting generally positive results but with minimal emphasis on the limitations of the drilling investigation and without providing a clear line of reasoning on the original bedrock-strength issue. The issue continues to need independent evaluation. For example, the Boyd letter fails to mention any analysis being conducted on the salt crystallography of salt cores produced during the drilling investigation.

22. In summary, protective measures are needed for the FPA, and such measures need to be applied to the best-demonstrated location of the FPA. If different tests or expert interpretations point to different locations for the FPA, such protective measures need to be applied to each such location. The importance of this can be traced to the known risks posed by *thinning bedrock* and *faulting*. These are two individually important risk factors, both of which are known to be associated with the FPA, and *each* of which poses a risk to mine stability and integrity. The existence of these risk factors is not in dispute. The associated level of risk cannot be established precisely, yet there is general agreement that protective measures such as a 1000-foot setback or standoff are warranted. The need for such protective measures is based partly on lessons learned from the 1994 roof collapse, and the subsequent complete flooding and abandonment, of the Akzo salt mine in Retsof, Livingston County, NY. At the time of its collapse, the Akzo mine had been in operation for about a century and was the largest salt mine in North America.

This affidavit is based on information available to me at this time. Should additional information become available, I reserve the right to determine the impact, if any, of the new information on my opinions and conclusions and to modify or supplement this affidavit if necessary.

Sworn to before me this 7 day of June 2021.

Notary Public, State of New York

DEBRA A. McDONALD
NOTARY PUBLIC, STATE OF NEW YORK
REG. No. 01MC5030288
QUALIFIED IN ERIE COUNTY
My Commission Expires July 11, 2022

EXHIBIT A

RAYMOND C. VAUGHAN, Ph.D., P.G.
534 Delaware Avenue • Buffalo, NY 14202 • (716) 332-7113
rcvaughan9@gmail.com

Professional Geologist/Environmental Scientist/Consultant with specialties in geology, hydrogeology, physical chemistry, thermodynamics, public policy, technical communication, numerical methods and programming, environmental testing, site remediation, development of soil cleanup standards, chemical fate and transport, Great Lakes protection, aquatic invasive species policy and ballast water management technology, wetlands protection, climate change and carbon sequestration, bioassay and analytical methods, nuclear waste policy and technology, and research and development. Eight U.S. patents.

PROFESSIONAL EXPERIENCE

Consultant to Sierra Club Atlantic Chapter, 2017-2020
Geologist/Environmental Consultant, 2017-2020
- Review and interpretation of radiological test results from Hakes and Chemung landfills

Consultant to Cayuga Lake Environmental Action Now (CLEAN), 2017-present
Geologist/Environmental Consultant, 2017-present
- Reviewing Finger Lakes salt mining issues as part of geological support team

Consultant to Environmental Protection Dept. of Seneca Nation of Indians, 2016
Geologist/Environmental Consultant, 2016
- Report on large data set of radiological test results for several sets of soil samples

University at Buffalo, Department of Geology, 2015
Adjunct Assistant Professor, Fall 2015
- Created and taught graduate course, GLY 606, Environmental and Legal Issues in Geology

Consultant to Seneca Lake Pure Waters Association, 2014-2018
Geologist/Environmental Consultant, 2014-2018
- Report preparation and participation in Issues Conference on LPG storage proposal
- Ongoing support and consultation with scientific/legal team for preparation of legal briefs

New York State Attorney General's Office, Environmental Protection Bureau, Buffalo, NY, 1999-2012
Environmental Scientist, 2000-2012
Environmental Intern, 1999-2000
- Investigation and assessment of environmental issues
- Case preparation and other scientific consultation with experts
- Litigation support and interagency scientific consultation on mercury emission standards
- Affiant in mercury emissions case, *New Jersey v. EPA*, 517 F.3d 574 (D.C. Cir. 2008)
- Litigation support and interagency scientific consultation on aquatic invasive species
- Site characterization and remediation support for sites in New York State
- Design and execution of groundwater testing

- Head measurement and potentiometric surface mapping
- Groundwater modeling
- Design and execution of soil and sediment testing
- Integration of stratigraphic & structural data w/test results (esp. for assessing contaminant migration)
- Monitoring of well drilling and logging
- Pumping-test interpretation
- Interpretation of other testing and modeling results
- Development and application of soil contamination standards
- Review and interpretation of various reports submitted to Attorney General's Office
- Geologic characterization and interpretation of a major salt mine collapse
- Assessment of groundwater contamination from manure spreading
- Assessment of groundwater impacts from mining
- Assessment of potential impacts from oil & gas exploration
- Field investigation, record review, and interagency consultation on wetlands protection
- Consultation with environmental organizations on issues of mutual interest
- Participation in Great Lakes Binational Toxics Strategy

Graphic Controls Corporation, Buffalo, NY, 1976-1998
Senior Research Technician, 1981-1998
Research Technician, 1976-1981

- Development of electrode products including Quikset, Q-Trace, and Meditrace
- Development of silver/silver chloride and graphite inks and conductive substrates
- Development of hydrogels and conductive adhesives
- Design and construction of prototype equipment for coating, curing, and printing
- Product and component testing; development of test methods

Carborundum Company, Niagara Falls, NY, 1965-1975
Research Technician

- Development of boron nitride ceramic fibers and high-temperature polymer fibers
- Development of processes for converting fibers to various textile forms

EDUCATION/AFFILIATIONS

NYS Professional Geologist License No. 258
Ph.D., Geology, University at Buffalo, 2008
B.S., Math and Astronomy, Empire State College, 1975
Massachusetts Institute of Technology, 1962-1964
Member, Buffalo Association of Professional Geologists
Member, Clean Air Coalition of Western New York
Steering Committee, Coalition on West Valley Nuclear Wastes, 1978-2006
Member, West Valley Citizen Task Force, 1997-present
Member, Town of Hamburg Conservation Advisory Board, 1980-1999
Board of Directors, Western New York Land Conservancy, 1991-2002
Board of Managers, Buffalo Society of Natural Sciences, 2011-2020 and 2021-present
Board of Directors, Nature Sanctuary Society of Western New York, 2013-present

SELECTED PUBLICATIONS/PRESENTATIONS

R.C. Vaughan (editor and coauthor), *'Low-Level' Radioactive Waste: The Siting Process in New York State*, 3rd ed., Norwich, NY, 1990.

R.C. Vaughan, K. McGoldrick, C. Kent, J. Rauch, B. Cain, G. Mathe, and B. Stephan, *Geology Reports of the Coalition on West Valley Nuclear Wastes*, East Concord, NY, 1994.

R.C. Vaughan, "Fending Off Orthodoxy with Ink and Umbrage: Church and State Controversy in Western New York, 1815-1837," presented at Conference on New York State History, Buffalo, 1998.

R.C. Vaughan, "State Options for Controlling Aquatic Invasive Species in the Great Lakes," *National Environmental Enforcement Journal* **18**, 3 (2003).

R.C. Vaughan, "Ranking the Bioassay TEFs and REPs," poster presented at Dioxin 2003 conference, Boston; published in *Organohalogen Compounds* **60**, 165 (2003).

R.C. Vaughan, T.D. Wood, D.J. Higbee, J.R. Olson, and Y. Tondeur, "Chromatographic Separation Strategy for Isolating and Characterizing Compounds with High Bioassay Response," presented at Dioxin 2005 conference, Toronto; published in *Organohalogen Compounds* **67**, 208 (2005).

R.C. Vaughan, "The West Valley Nuclear Site within the Cattaraugus Creek watershed," Cattaraugus Creek Watershed Summit, Concord Town Hall, Springville, NY, October 3, 2006.

R.C. Vaughan, testimony on site decommissioning on behalf of West Valley Citizen Task Force, before U.S. Nuclear Regulatory Commission, Rockville, MD, 2006, available at www.nrc.gov/reading-rm/doc-collections/commission/tr/2006/20061211.pdf.

R.C. Vaughan, "Applying an Effect-Directed Strategy to the Search for Unrecognized Toxic Chemicals," presented at Great Lakes Binational Toxics Strategy Integration Workgroup meeting, Windsor, Ontario, February 2007; presentation slides available at http://archive.epa.gov/bns/web/pdf/vaughan022107.pdf.

R.C. Vaughan, "Due Process, Morgan's Disappearance, and American Antimasonry in Historical Context," presented at International Conference on the History of Freemasonry, Edinburgh, Scotland, 2007.

R.C. Vaughan, *Methods and Programs for Inverse Modeling of Underdetermined Sets of Gravity Data*, Ph.D. thesis, Department of Geology, University at Buffalo, 2007.

F. Zagorski and R.C. Vaughan, "New York's 401 Certification of EPA's Vessel General Permit (VGP)," presented at Great Lakes Aquatic Nuisance Species Panel Meeting, Grand Island, NY, 2009.

R.C. Vaughan, "Zoar Valley geology, uncertain timing of gorge incision, and comparison to the Niagara Gorge," presented at Nature Sanctuary Society of Western New York annual banquet, Buffalo, 2010.

R.C. Vaughan, "Stemming the Tide of Aquatic Invasive Species: Efforts of the Office of the New York State Attorney General," presented at SUNY ESF, Syracuse, 2010.

R.C. Vaughan, "Nuclear Power: Can it help solve the problem of climate change?", presented at University of Pittsburgh at Bradford's Nuclear Forum, Bradford, PA, 2011.

R.C. Vaughan, "NRC's recent and ongoing activities to authorize nuclear waste reprocessing," presented at West Valley Citizen Task Force meeting, West Valley, NY, 2011; presentation slides available at http://www.westvalleyctf.org/2011_Materials/09/2011-09-28_Vaughan_reprocessing_presentation.pdf.

R.C. Vaughan, "The Unfinished West Valley Experience at the Back End of the Nuclear Fuel Cycle, 1960-present," presented at Council of State Governments/Blue Ribbon Commission public meeting, Boston, 2011.

R.C. Vaughan and R. Newberry, "Is There a Distinctive Form of Great Lakes Humor? The Western New York Perspective," presented at Conference on New York State History, Niagara University, Lewiston, NY, 2012.

R.C. Vaughan, "The Nuclear Dilemma: No Good Place to Put the Waste," presented at St. Bonaventure University, St. Bonaventure, NY, 2013.

R.C. Vaughan, J. Sullivan, and C. Osterhoudt, "The Geology of Zoar Valley and the Cattaraugus Creek Watershed," *Nature Sanctuary Society of WNY Monograph in the Natural Sciences*, Vol. I, January 2013.

R.C. Vaughan, "West Valley site history, cleanup status, and role of the West Valley Citizen Task Force," presented at National Transportation Stakeholders Forum (U.S. Department of Energy/Council of State Governments), Buffalo, 2013.

R.C. Vaughan, "Henry J. Raymond & His Family," presented at Burnett Family Reunion, Southboro, MA, 2013.

R.C. Vaughan, "NFBS [Niagara Frontier Botanical Society] Leaders Speak at Spring Meeting," *Nature Preserves* **14**, no. 2 (April 2014), 2-3.

R.C. Vaughan, "Geologic History of the Niagara Escarpment," Appendix G of Western New York Land Conservancy, *Niagara Escarpment Legacy Project* (2014), available at pp. 83-93 of http://wnylc.org/site/wp-content/uploads/2014/05/Appendices-Niagara-Escarpment-Legacy-Project-May-2014.pdf.

R.C. Vaughan, "The Buffalo Skyway: Can CNU's Bad Boy Become a Beautiful Elevated Linear Park?", presented at 22nd Congress for the New Urbanism, Buffalo, 2014; available at https://www.youtube.com/watch?v=2_PRoEQLbIk.

R.C. Vaughan, "Tom Diggins on the Ecology of the Zoar Valley Gorge," *Nature Preserves* **14**, no. 3 (August 2014), 7-8.

R.C. Vaughan, "Departure of the Fair Train (Strates Shows) from Hamburg, NY, August 2014, after the Erie County Fair," video (length 8:40), 2014, available at https://www.youtube.com/watch?v=kYOVA0tI-Pc.

R.C. Vaughan, "Split-sample testing strategy to assess risk from dioxin/furan deposition," poster presented at Air Pollution Workshop, UB Department of Epidemiology and Environmental Health, Buffalo, 2014.

R.C. Vaughan, "West Valley site history, cleanup status, and role of the West Valley Citizen Task Force," presented to BSA Troop 652, Ellicottville, NY, 2014.

R.C. Vaughan, "NSSWNY Fall Membership Meeting: Ken Roblee on Western New York's Herptiles," *Nature Preserves* **14**, no. 4 (November 2014), 4-5.

R.C. Vaughan, "Industrial stack testing principles and methods," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "Mercury deposition from coal-fired power plant emissions, and the use of a simple computer model to predict downwind deposition," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "An air pollution episode involving residential exposure to a poorly characterized chemical," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "The Hemlock Woolly Adelgid: How You Can Become Part of the Solution," *Nature Preserves* **15**, no. 1 (February 2015), 4-5.

R.C. Vaughan, "Identity and Fate of Capt. John Dalzell and His Sons," *The Scottish Genealogist* **62**, 4-22 (March 2015).

R.C. Vaughan, "Geologic Issues for LP Gas Storage in Seneca Lake Salt Caverns," presented at Rochester Committee for Scientific Information public meeting, Rochester, NY, April 7, 2015.

R.C. Vaughan, "The Big Impact of a Tiny Product: Sam Mason's Work against Microbeads / Local, State Governments Issue Bans," *Nature Preserves* **15**, no. 3 (August 2015), 1-3.

R.C. Vaughan, "The History of Zoar Valley: NSSWNY Fall Lecture Explores the Rich Past of a Local Treasure," *Nature Preserves* **15**, no. 4 (December 2015), 1-3.

R.C. Vaughan, "Several prominent and representative residents of 331 Franklin Street, Buffalo, NY," 7-page report presented/summarized at public hearing on three City of Buffalo Landmark applications, Common Council Chambers, Buffalo City Hall, April 14, 2016.

R.C. Vaughan, "Biology: A Short Overview of Radiation, Radioactive Contamination, and Effects," presented at SNI Cattaraugus Community Wellness Center, Irving, NY, April 22, 2016.

R.C. Vaughan, "Cattaraugus Creek: A Story of Flowing Water and the Geology of the Channel It Flows Through," presented at SNI Cattaraugus Community Wellness Center, Irving, NY, April 22, 2016.

R.C. Vaughan, "NSSWNY Spring Membership Lecture: Dr. Wayne Gall on Lyme Disease and Other Tick-Borne Diseases," *Nature Preserves* **16**, no. 2 (April 2016), 4-5.

R.C. Vaughan, "Cattaraugus Creek: A Story of Flowing Water and the Geology of the Channel It Flows Through," presented at West Valley Citizen Task Force meeting, West Valley, NY, April 27, 2016.

S. Parwulski, D. Bauer, and R.C. Vaughan, "Renewing Our Connections to Nature: Dave Bauer's Call to Engage Children in Nature," *Nature Preserves* **16**, no. 4 (November 2016), 1-3.

R.C. Vaughan, "Messinger Woods: WNY's Emergency Room for Wildlife," *Nature Preserves* **17**, no. 2 (April 2017), 4-5.

R.C. Vaughan, "Endangered: The Rusty Patched Bumble Bee (*Bombus affinis*)," *Nature Preserves* **17**, no. 2 (April 2017), 10-11.

R.C. Vaughan, "Unresolved geologic questions for salt mining under Cayuga Lake," presented at Cayuga Lake Environmental Action Now (CLEAN) public meeting, Ithaca, NY, June 13, 2017.

R.C. Vaughan, "Climate & intense rainfall events: Can they be predicted well enough to support cleanup decisions for the West Valley nuclear waste site?", presented at American Meteorological Society, Western New York Chapter meeting, Buffalo State College, June 20, 2017.

R.C. Vaughan, "Erosion Modeling Issues that Need Attention and Sensitivity Analyses," presented at West Valley Citizen Task Force meeting, West Valley, NY, June 28, 2017.

R.C. Vaughan, "Ken Parker on Landscaping with Local Native Plants," *Nature Preserves* **17**, no. 3 (August 2017), 4-5.

R.C. Vaughan, "Jay Burney on the Buffalo Outer Harbor and Times Beach Nature Preserve," *Nature Preserves* **17**, no. 4 (November 2017), 1-2.

R.C. Vaughan, "Unresolved Issues for Disposal of Radium-bearing Wastes at Hakes Landfill," presented at Sierra Club/CCAC Public Meeting, Campbell, NY, February 10, 2018, available at https://www.youtube.com/watch?v=8YuC6cHWd3A.

R.C. Vaughan, "Controlling Aquatic Invasive Species in Ships' Ballast Water: A New York State perspective," presented at Nature Sanctuary Society of Western New York Spring membership meeting, Amherst, NY, March 4, 2018.

R.C. Vaughan, "Scoping: An important early step in the environmental review process that will guide cleanup decisions for buried waste at the West Valley nuclear waste site," presented at public meeting on scoping issues, Springville Center for the Arts, Springville, NY, March 11, 2018.

R.C. Vaughan, "Geology of the Cattaraugus Creek watershed and West Valley nuclear waste site," presented at public meeting on scoping issues, Crane Branch Library, Buffalo, March 15, 2018.

R.C. Vaughan, "A Likely Story: The Niagara Escarpment and Gorge," presented at Buffalo Geological Society meeting, April 6, 2018.

R.C. Vaughan, "Restoring the Niagara Gorge: Dave Spiering's Firsthand Look at the Transformation Process of One of Western New York's Most Significant Natural Areas," *Nature Preserves* **18**, no. 3 (August 2018), 1-3.

R.C. Vaughan, "Two Presentations on Invasive Species at the March Membership Meeting," *Nature Preserves* **18**, no. 3 (August 2018), 8-10.

R.C. Vaughan, "Paddling the Thelon: Ellen Gendreau's Northern Adventure," *Nature Preserves* **18**, no. 4 (November 2018), 1-4.

R.C. Vaughan, C. Konieczny, M.P. Wilson, and J.C. Swift, "Exploring the Geologic History of Zoar Valley through Research at Alexander Preserve," *Nature Preserves* **19**, no. 1 (February 2019), 17-22.

R.C. Vaughan, "Expert overview of poorly characterized impacts from salt mining under Cayuga Lake," presented (as part of joint presentation by R. Lippes, S. McCloud, and R.C. Vaughan) at Water Law II symposium, Cornell Law School, Ithaca, NY, March 22, 2019.

R.C. Vaughan, "Robbyn Drake: Exploring New Funding Options for the Society," *Nature Preserves* **19**, no. 2 (April 2019), 3.

R.C. Vaughan, "Tales to Be Told around a Campfire: Gerry Rising Looks Back at His Many Years Afield," *Nature Preserves* **19**, no. 3 (August 2019), 1-3.

R.C. Vaughan and A.O. James, *Vision for Skyway Corridor and relocated NY Route 5 highway*, Part 2 Technical Submission to the Competition to Re-Imagine the Buffalo Skyway Corridor, August 16, 2019 (61-page report and four presentation boards; one of nine finalist entries in the Competition sponsored and administered by New York State/Empire State Development).

R.C. Vaughan, "Conservationist in Chief: Judi Geer on Theodore Roosevelt and his Conservation Legacy," *Nature Preserves* **19**, no. 4 (November 2019), 1-3.

R.C. Vaughan and M.P. Wilson, "An Update on Geology Research at the William P. Alexander Preserve," *Nature Preserves* **19**, no. 4 (November 2019), 3.

R.C. Vaughan, "Evidence of High Levels of Radium and Radon in Hakes and Chemung Landfills," Sierra Club/CCAC webinar (part of joint presentation by D.O. Carpenter and R.C. Vaughan), March 28, 2020, available at https://youtu.be/vhY48XfvwQI.

R.C. Vaughan, "Algonquin Wildlife Research: Patrick Moldowan Delivers Spring Membership Lecture," *Nature Preserves* **20**, no. 2 (April 2020), 1-3.

EXHIBIT B

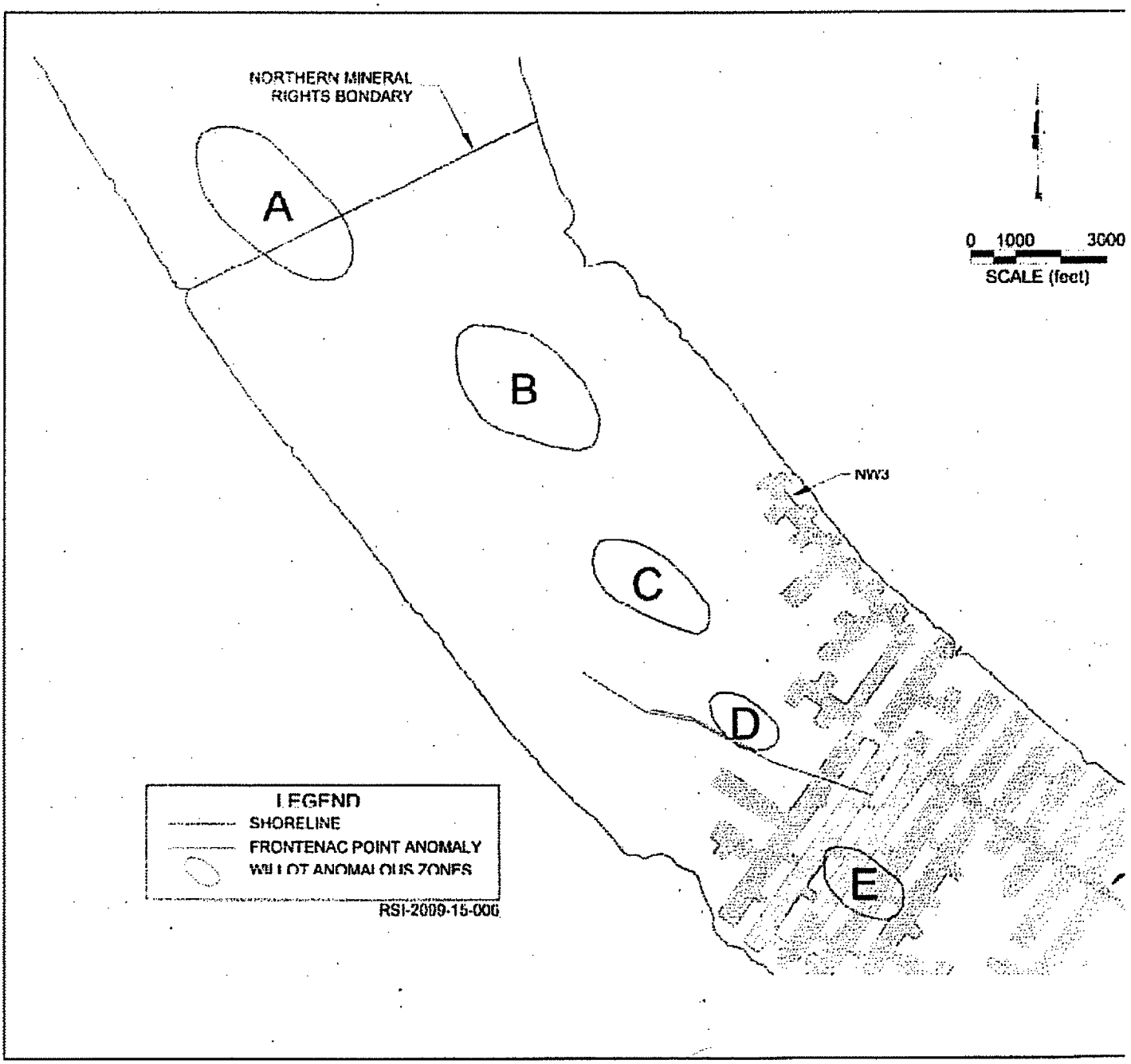
Lucidi, Christopher M (DEC)

From: Army, Steve (DEC)
Sent: Monday, October 24, 2016 11:24 AM
To: Podniesinski, Matthew J (DEC); Rodriguez, Simone S (DEC); Lucidi, Christopher M (DEC); McKelvey, Christopher J (DEC)
Subject: Fw: RESPEC update

FYI.

Steven M. Army
Region 8 Mining Program Supervisor
Office: 585-226-5372
Cell: 585-319-1012
Fax: 585-226-6323

From: [BOYD COMPANY]Vincent A. Scovazzo <v-scovaz@jtboyd.com>
Sent: Thursday, October 20, 2016 12:53 PM
To: Army, Steve (DEC)
Subject: RE: RESPEC update



Vincent A. Scovazzo PhD, PE, PG
Director of Geotechnical Services
John T. Boyd Company
307 Riverwood Street
Richland, WA 99352

509 627 1190

From: Army, Steve (DEC) [mailto:steve.army@dec.ny.gov]
Sent: Thursday, October 20, 2016 9:02 AM
To: [BOYD COMPANY]Vincent A. Scovazzo
Subject: RE: RESPEC update

EXHIBIT C

RSI-2099-15-053

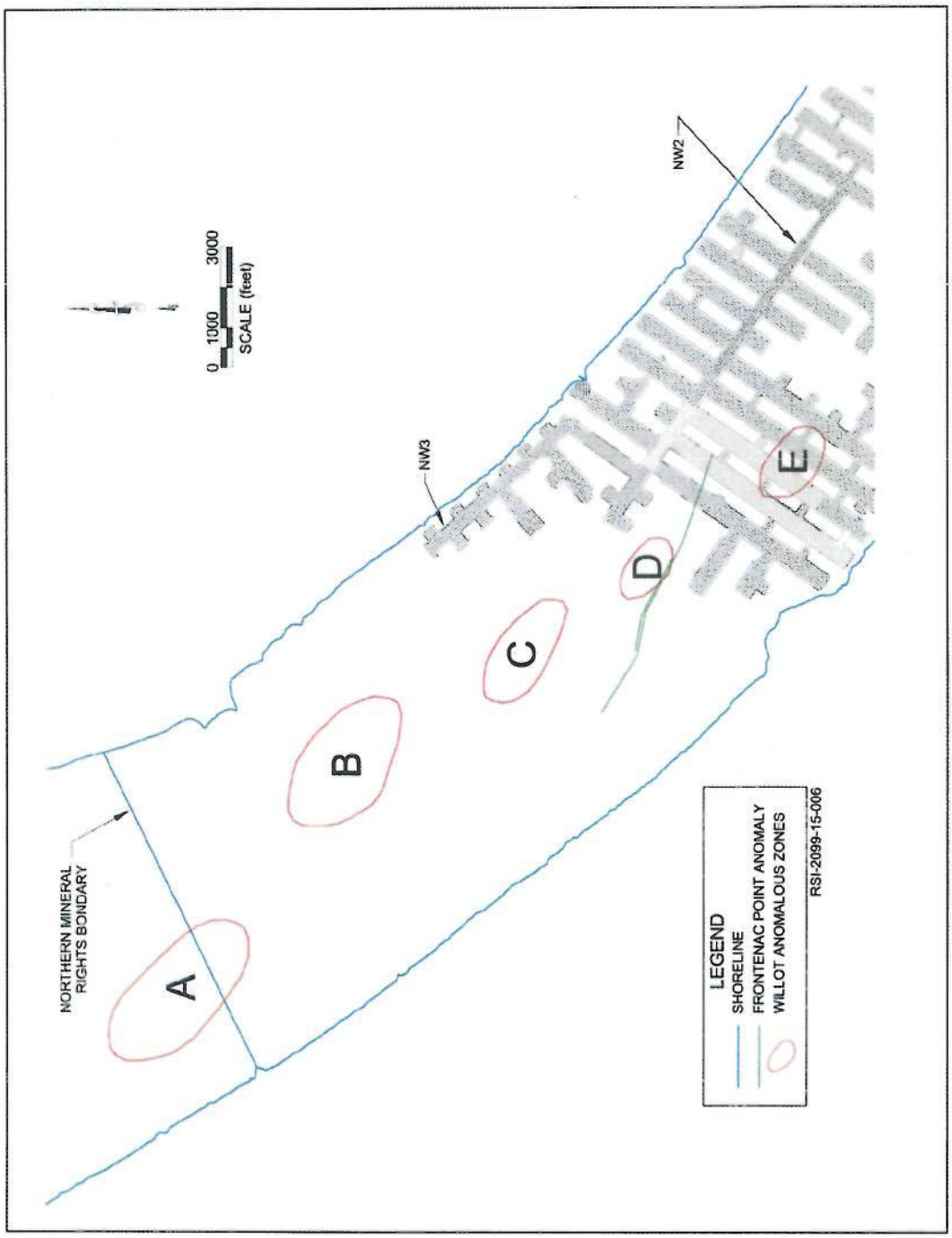


Figure 1-1. Mine Map of the Cayuga Mine Northern Reserves.

EXHIBIT D

John T. Boyd Company

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February 22, 2018
File: 2499.004

New York State Department of Environmental Conservation
Bureau of Resource Management & Development
Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500

Attention: Mr. Matthew Podniesinski
Director, Bureau of Resource Development
and Reclamation

Subject: Scour and Frontenac Point Anomalies
Cayuga Mine, Cargill Deicing Technology, Inc.
Seneca and Tompkins Counties, New York

Gentlemen:

At the request of the New York State Department of Environmental Conservation (NYSDEC), John T. Boyd Company (BOYD) has summarized the progress of research and engineering design in reference to overburden anomalies in the northern reserves of the Cayuga Mine of Cargill Deicing Technology.

BOYD became aware of what was then called the “disturbed salt area” and now known as the Frontenac Point Anomaly (FPA) during meetings with the staff at the Cayuga Mine who expressed a concern about mining north. During one of the initial meetings David Plumeau forwarded a report by Stearns & Wheler and Syracuse University[1] which reported on a seismic study of Cayuga Lake. This paper is the first to present a seismic survey of the lake and noted that the deepest glacial scour of the bed rock occurred one third of the way up the lake from Ithaca where the bedrock is eroded to 1,175 ft below lake level. They note that the scouring is likely controlled by the Onondaga Limestone.

[1] Hinchley, Edward J., H.T. Mullins, and A. Hine, 1991, Seismic Stratigraphy and Depositional History of Cayuga Lake, Geologic Society of America Special Paper - The Origin and Evolution of the New York Finger Lakes.

After the review of this paper, BOYD noted that the FPA is located at the intersection of two defined linears that corresponds to joint swarms identified by Engelder and Geiser[2]; joint swarm Ia that strikes north-south and joint swarm II that strikes east-west and parallels the regional folding. The lake bottom generally parallels joint swarm Ib. This location is just north of the kimberlite dykes swarm (Ithaca Kimberlites[3]) that parallels joint swarm Ia and may be a contributing factor to poor mining conditions in the southern extent of the Cayuga Mine.

In 1998, BOYD[4] wrote a letter to the NYSDEC about the FPA and both the NYSDEC and BOYD became mindful of this disturbed zone. Concerns focused on the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake. Cargill agreed to avoid the disturbed area until further study was completed.

After further study of the FPA, BOYD[5] reported in 2002 to NYSDEC that the disturbed area appeared to be a graben-like structure with a vertical displacement of approximately 100 ft and that further investigations are needed before mining could proceed into this zone.

NYSDEC Response

The NYSDEC added the following conditions to the 2003 mine permit:

- Special Conditions 18 – Cargill shall conduct further investigations of the disturbed salt zone, identified by seismic survey and shown on No.6 Salt structure contours (top of salt), which may exist near the west shore of the lake in the northern extended mineral lease area. Mine projections show that present plans are to extract this area sometime between 2016 and 2020. Further investigation of this disturbance needs to be completed and submitted to the Department for review before mining proceeds in this area.
- Special Conditions 19 – Cargill shall conduct further investigations and report on the adequacy of the thin rock overburden at the northern extent of the mineral lease area

[2] Engelder, Terry and Peter Geiser, 1980, On the use of regional joint sets as trajectories of paleostress fields during the development of the Appalachian Plateau, New York, Journal of Geophysical Research, Volume 85, Issue B11, Pages 6319–6341, 10 November.

[3] Mahlburg Kay, Suzanne, William T. Snedden, Brayton P. Foster, and Robert W. Kay, 1983, Upper Mantle and Crustal Fragments in the Ithaca Kimberlites, The Journal of Geology, Volume 91, Number 3, May.

[4] Scovazzo, Vincent A., 1998, Meeting of December 19, 1997, Cayuga Mine, Cargill Salt, letter to C. B. McGranahan, New York State Department of Environmental Conservation, John T Boyd Company project number 2499.2, January 5.

[5] Scovazzo, Vincent A. and Russell P. Moran, 2002, Review of the Mined Land Use Plan, Cayugs Mine, Cargill, Inc., prepared for New York Department of Environmental Conservation, John T. Boyd Company Report No. 2499.4, February.

where the solid rock overburden becomes thinner where the glacial till and lake sediment thickens and lake depth increases and where mining is proposed for this area after 2030. This condition must be thoroughly analyzed for stability by Cargill and reviewed by the Department before mining proceeds in this area.

These conditions are repeated in the presently enforced permit as 9.a. and 9.b.

In 2009, Boyd / PetroSearch[6] further defined the lake scour and identified five areas of deep gouge that were labeled as anomalies A through E within the continuous scour. One of these anomalies (Anomaly E) had already been undermined without affecting the mine's global stability. Since the anomalies are located in the northern mine reserve, Anomalies A through D would then require additional study before mining below these anomalies would be permitted. If these studies determined that mining will not adversely affect global stability or adversely affect Cayuga Lake, it would follow that mining between these anomalies will also have no adverse effects.

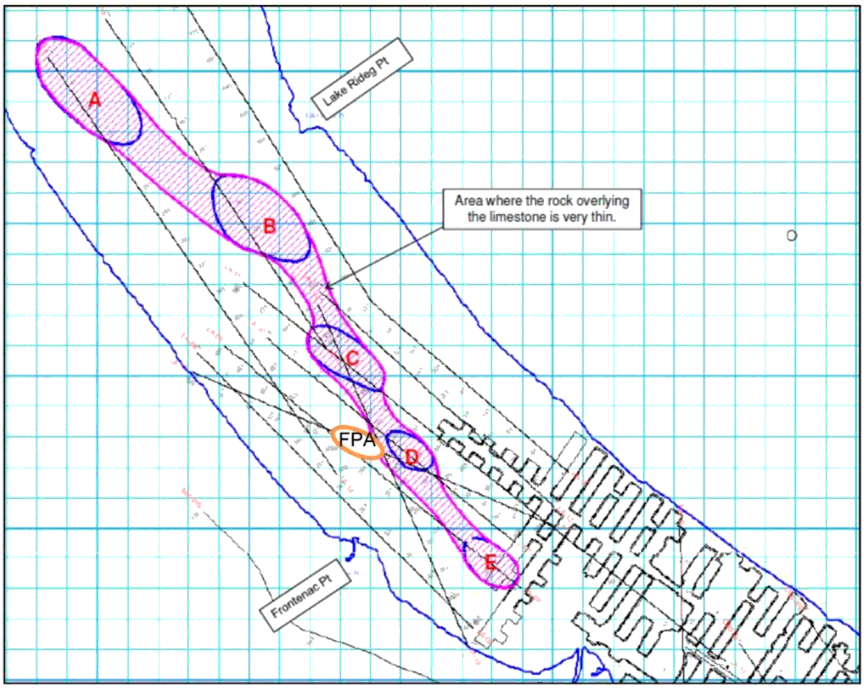
On December 24, 2010, NYSDEC[7] affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable. NYSDEC noted that if further consideration is to be given to this distance, additional information will need to be submitted to the Department for review and approval.

On March 13, 2015, BOYD and the NYSDEC recognized that mining options at the Cayuga Mine were becoming limited and would cause Cargill to develop northward and possibly require mining under the scour anomalies (A through E). It was decided that

[6] Willott, Richard, 2010, Geophysical Progress Report, Analysis of the Frontenac Point Anomoly, Cayuga Mine, for Cargill Salt Division, Boyd / PetroSearch Project #20101017, August 3, 2010.

[7] Army, Steven M., 2010, Cayuga Salt Mine MF#70052, New York State Department of Environmental Conservation letter to Russell S. Givens, Cayuga Mine, December 24.

BOYD and the NYSDEC would emphasize in discussions with Cargill that investigations of the FPA and all scour anomalies should quickly move forward.



Scour Anomalies A through E as Identified by Willott[6], the FPA Placed on Figure by BOYD

Further Seismic Studies by Cargill

In 1994, Cargill purchased a 1984 commercially available seismic survey from GeoData Corporation to further understand the geologic setting of the Cayuga Mine. GeoData reprocess the data and the interpretation was completed by Sear-Brown Group. In 1995, Cargill hired Bay Geophysical to complete extensive seismic surveys of the southern half of the Cayuga Lake. These data were processed by GeoData and interpreted by Sear-Brown Group. The results of the 1995 survey were considered good to poor but adequate to identify the mine location. In 1996, Cargill hired Duncan Exploration, Inc. to complete a land based survey. These data were processed by GeoData and interpreted by Sear-Brown Group. These studies showed the FPA and a lake scour.

Two additional lake seismic studies were completed in 2009 and 2016 to define the depth, location, and geology of the anomalies. In addition, the 1995 and 1997 data were reanalyzed because of advancement in software. In 2009, Cargill hired Walker Marine Seismic for a lake seismic survey; these data were processed by CGG Veritas and interpreted by Boyd / PetroSearch and RESPEC, which further defined possible limestone fracturing and the extent of the FPA.

In 2016, Bay Geophysical was again hired to complete a cross lake survey; these data were processed by Sterling Seismic Services and interpreted by Corona Consulting and RESPEC, which further defined the anomalies.

These seismic studies have been evaluated by Dr. William Goodman (RESPEC and Sear-Brown), John Clark (Corona Consulting), Richard Willott (Boyd / PetroSearch), and John Schneider (RESPEC). It was reported[8] that this group believes that the anomalies represent erosion of bed rock that extends into the Helderberg limestone. The group could not discount faulting beneath the anomalies and confirmed that the FPA represents a fracture in the limestones but there was no convincing evidence of lower limestones collapse due to salt solutioning.

Boyd / PetroSearch reported on the 2009 study defining the five scour anomalies (A through E) noting that the C and D anomalies show a "… maximum disturbance, where the upper salts may be leached, and the overlying carbonates broken and discontinuous."

Cargill Engineering Studies of the Anomalies

Cargill, in their letter to BOYD[9] notes. "…work has begun on re-evaluating the geologic anomaly previously identified on seismic lines north of Frontenac Point. At this time, development mining has stopped in the NW-2 mains…"

In 2007, RESPEC addressed the FPA[10] calling it a "suspected geological structure" and this anomaly was identified by a seismic study located approximately 2,400 ft north of Frontenac Point. Based on seismic studies, RESPEC suggested that the anomaly is a deep penetrating, nearly vertical, east-west-trending fault.

Of interest to RESPEC was Seismic Line 7, located on the west side of the lake that may show that the anomaly likely penetrates the Syracuse Formation. There is a down warping of the strata on both sides of the anomaly extending up through the lower half of the glacial till and is reminiscent of a collapse due to salt-dissolution.

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[8] Plumeau, David, 2017, Memorandum, Assessment of the Feasibility of Mining Beneath the "C" Anomaly, Cargill Deicing Technology, Cayuga Mine, to Vince Scovazzo, John T. Boyd Company, October.

[9] Plumeau, David, 2007, untitled letter to Vincent A. Scovazzo, John T. Boyd Company, February 20.

[10] DeVries, Kerry L., Paul E. Nelson, Leo L. Van Sambeek, William M. Goodman, 2007, Mine Stability Assessment, Cargill Deicing Technology, Cayuga Mine, Lansing, New York, RESPEC Topical Report RSI-1913, prepared for Cargill Deicing Technology, January.

RESPEC recommended that Cargill complete a floor elevation survey of NW2 and surrounding production panels that may indicate if a fault is near and possibly represents the FPA. Also, a face-drilling program was recommended to characterize the anomaly before mining the salt below the anomaly.

RESPEC cautioned that brine may be associated with the FPA and that as the anomaly is approached, the vertical distance between the salt and the base of the groundwater-saturated rock is likely to decrease. RESPEC notes that the NW2 mains at the time were close to the valley axis where the overlying carbonates will thin to less than 130 ft and recommended that the mains be shifted to the east. This shift has been completed by Cargill.

In 2014 RESPEC[11] noted "Well data in the northern part of the Cayuga Lake Valley have determined that brine is present on top of and in between beds in the Salina Group. The Frontenac Point Anomaly may reflect the southern extent of water infiltration." RESPEC opined that the planned 1,000 ft buffer around the FPA should prevent a hydraulic connection with the mine. Further, "As the mine progresses north, micro-seismic monitoring to detect anomalies and drilling in advance of the faces to detect an increase in moisture or presence of water is recommended as a precaution."

In 2016 RESPEC[12] designed large pillars for the C Anomaly that would reduce shear in the overlying salts and reduce shear to insignificant levels in the limestones.

Mr. Petersen[13] noted that due to the theory "... that the abnormal closure in U12, U40B and perhaps U24 could be due to hydraulic pressure within the de-stressed zone of the yield pillar panel design, it was wisely decided not to use the YPP (yield pillar panel) design to mine the northern reserves where the potential for high pressure/high volume aquiferic water in conjunction with large geological anomalies could bring water too close to the mining horizon. The concern being that the YPP design creates a low stress (destressed) zone above that panel that attracts higher pressure fluids in the rock strata, which given a geological conduit will flow into the de-stressed zone resulting in abnormal panel closure."

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[11] DeVries, Kerry L., William M. Goodman, and Cody A. Vining, 2014, Mine Stability Assessment, Cargill Deicing Technology, Cayuga Mine, Lansing, New York, RESPEC Topical Report RSI-2371, prepared for Cargill Deicing Technology, April.

[12] Devries, Kerry, 2016, Large Pillar Design, RESPEC, September 15. As Large Pillar Design 9-19-16 V2.pdf last modified on September 20, 2016.

[13] Petersen, Gary, 2016, Cayuga Mine, Thoughts on Mining the Northern Reserves, prepared for David Plumeau, Cargill Deicing Technology, RockTec Solutions, August 27.

In addressing the big pillar design of RESPEC to undermine C Anomaly, Petersen continues "The big pillar design doesn't create a de-stressed zone above the panel, making it a much better design for potential water pressure situations." Thus "... the potential for developing a leak is much lower ..." and "We know from experience that the big pillar design is prone to shear the roof along the roof/pillar contact out over the room and in some cases results in a rather large roof fall."

In reference to a set of yield pillars that will result in the three entry access to the large pillar area Mr. Petersen notes "The load transfer from the YPP initially goes to the edge of the adjacent big pillar and creates a relatively high peak load along the edge of the pillar ... which can cause roof shears to develop rather quickly."

Large roof falls at pillar edge and roof shear at the YPP – big pillar transition, as discussed by Mr. Petersen, are local events and not a factor in, or represent, global instability.

Drilling Investigation of Anomaly C

Several Investigators, including BOYD, RESPEC, and the group that evaluated the 2009 and 2016 seismic studies, had recommended drilling Anomaly C to verify assumptions and to clarify conditions. BOYD noted to Cargill that some of the questions about the anomalies could be clarified including:

- Whether or not a brine layer existed within the 4 Salt and the immediate roof.
- If water or brine exists, whether or not it is under pressure suggesting a connection to the lake or groundwater.
- Determine if a fault exists.
- Verify the thickness of the salt to show that solutioning did not occur or was minimal.
- Determine if down warping exists.

This planned drilling program was developed by Cargill and presented to NYSDEC and BOYD.

Mr. Plumeau[8] presented the results of this drilling program to BOYD in 2017. In his words "Although the computer modeling suggests there is no risk of large pillar mining under the C anomaly, Cargill chose to do advanced drilling to verify that there was no water present at a level 260' above the mine horizon in the footprint of the C anomaly. The drill hole was angled up into the #4 salt bed then deflected horizontally. That region is well above the expected de-stressed strata created by large pillar mining. The drill

hole and side tracks covered the length and width of the C anomaly as defined by lake seismic work."

Before drilling commenced into the 4 Salt, the holes were shut-in and the wellhead and the casing was successfully tested to 1,500 psi and held at 1,200 psi.

After each drilling day, the drill hole was allowed to drain for about 25 to 30 minutes and then sealed. When checked in the morning, the hydraulic head would be about 75 ft (32.5 psi). At day's end, the hole was allowed to drain for 45 minutes, and the following morning pressure rise was noted to be insignificant.

After drilling was completed, the holes were shut in (i.e., sealed) and the pressure checked every week. Mr. Plumeau noted that "There has been zero pressure increase when shut-in." "Opening the valve at the collar results in zero discharge of gas or brine– it is a dry hole."

"... drilling totaled over 8,000 lineal feet and has undulations and side tracks vertically up and down, and horizontally." For long-term monitoring, Cargill plans to install micro-seismic geophones in the hole and leave it open. Cargill will place a barrel under the collar of the hole and a conductivity meter will be placed in the barrel to monitor water discharge. If water enters the barrel, the meter will alert Cargill that the hole is draining water.

The hole was developed by REI Drilling Inc.[14] during March and September 2017 and "... installed one (1) multi-lateral directionally drilled borehole for exploration of the projected C Anomaly. REI drilled an exploratory borehole laterally within the 4 Salt seam to verify continuity of salt and the presence or lack of water in the formation. The borehole originated from H2 crosscut within U72 in the Number 6 Salt Bed and directionally drilled up to the 4 Salt seam. Five (5) roof tags and two (2) floor tags were drilled within the main borehole. Additionally, three (3) branches were drilled to the C Anomaly estimated extent."

[14] Schumacher, Forrest, 2017, Report of Directional Drilling for Exploration of the C Anomaly at Cargill's Cayuga Mine, to Alex Greenblatt, Cargill Deicing Technology, REI Drilling Inc., October 16.

Drilling description:

	Diameter (inches)		
Depth (ft)	Hole	Casing	Notes
162	12.75	8	Centralizers, grouted
540	6.75	4	
8,494	3.8	open hole	

The total depths achieved in each branch of the drilling program were:

Branch Name	Total Depth (ft)
Main Branch	3,570
Branch #1	3,875
Branch #2	3,894
Branch #3	3,364

Drilling hole direction and hole location was maintained by a non-magnetic directional drilling motor and a DDMS survey tool that measures orientation.

"Drilling did not encounter any anomalous conditions within the 4 Salt, which was verified by monitoring drill cuttings, gamma counts from the survey tool, and measuring shut-in pressures at the wellhead."

"The 4 Seam thickness was estimated by drilling corresponding roof and floor tags (side-tracks) at boreholes depths of 3,166 ft (roof), 3,228 ft (floor), 3,530 ft (floor), and 3,549 ft (roof). REI estimates salt thickness of 48 ft and 32 ft at depths of 3,020 ft DT and 3,370 ft DT respectively. Gamma counts … show continuity of salt in all lateral portions of the borehole." BOYD notes that at the nearby Borehole 18, the 4 Salt was 48 ft thick.

Conclusions

After reviewing the data presented to BOYD by Cargill, BOYD recommended that Cargill be permitted to mine under the C Anomaly using RESPEC's large pillar design, but not under the other scour anomalies or the FPA. It is BOYD's opinion that the 1,000 ft no-mining buffer should remain around the FPA and that mining under the Anomaly D and the FPA not be permitted because of the close proximity of these two anomalies. Mining under the A and B anomalies will require additional investigation specific to those anomalies and be reviewed and evaluated by BOYD and the NYSDEC before progressing.

BOYD arrived at this conclusion because the seismic surveys defined the extent of the C Anomaly, RESPEC designed a large pillar configuration to reduce stress in the 4 Salt and carbonates, and the drilling program showed:

- No brine or water was under pressure in the 4 Salt.
- Brine in the 4 Salt and its roof was not present in any significant quantities.
- Faulting was not detected.
- The 4 Salt was of expected thickness thus salt solutioning was minimal or did not occur.
- Down warping was either not present or minimal.

BOYD and the NYSDEC will monitor mining progress and the global stability under the C Anomaly by review and analysis of:

- Water/brine discharge from the C Anomaly exploration hole which may indicate if a connection develops between the 4 Salt or roof to groundwater or lake.
- Closure stations which will allow insight into opening behavior.
- Visual observation of mine conditions.
- Results from the Cayuga Mine micro-seismic monitoring system which will show activities within the overburden above the 6 Salt.

Please contact us if you require additional information or if we may be of further service.

Respectfully submitted,

JOHN T. BOYD COMPANY
By:

Vincent A. Scovazzo
Director of Geotechnical Services

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