2022 ANNUAL REPORT REVIEW
CAYUGA MINE, CARGILL, INC.

Seneca and Tompkins Counties, New York

Prepared For

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

By

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New York State Department of Environmental Conservation
Bureau of Resource Management & Development
Division of Mineral Resources
625 Broadway, Third Floor
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Attention: Mr. Matthew Podniesinski
Chief, Resource Development Section
Bureau of Resource
Management & Development

Subject: 2022 Annual Report Review
Cayuga Mine, Cargill, Inc.
Seneca and Tompkins Counties, New York

Ladies and Gentlemen:

At the request of the New York State Department of Environmental Conservation (NYSDEC), Dr. Vincent Scovazzo, Executive Consultant – Geotechnical, of John T. Boyd Company (BOYD) reviewed the Annual Report for the Cayuga Mine signed by Shawn G. Wilczynski. The signed report[1] file, was received by Matthew Podniesinski, New York State Department of Environmental Conservation via email on February 23, 2023. Supporting data was received by BOYD in March and April 2023 via encrypted and password protected USB memory sticks.

On February 15, 2006, Mr. Steven M. Potter, then the Director, Bureau of Resource Management & Development, NYSDEC, requested that BOYD review all documents, digital data, and annual reports received by BOYD starting with the 2006 Annual Report.

[1] Wilczynski, Shawn G.,2023, Annual Report for Mine File #709-3-29-0052; Cayuga Salt Mine, Permit ID#0-9999-00075-00001, Towns of Lansing and Ulysses, County of Tompkins, Town of Covert, County of Seneca, File: Cargill DEC annual report for Jan - Dec 2021 (3).docx,

The received documents were reviewed for their adherence to conditions of the revised Permit[2]. Condition 16 of the permit notes, “Consultant Services - Cargill is responsible for retaining and funding Consultant Services to be provided by a qualified, independent mining engineering geotechnical consultant.” BOYD is providing the Consulting Services for this annual review.

Discussion of Annual Report

The Permit has several conditions that affect the Annual Report and its review including:

Condition 9

Condition 9 of the Permit notes, “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.”

Condition 10

Condition 10 of the Permit notes, “Further Investigations - Cargill shall conduct further investigations and report on the adequacy of the thin rock overburden at the northern extent of the mineral lease area where the solid rock overburden becomes thinner where the glacial till and lake sediments thicken, and lake depth increases.

Additionally, further investigation and reporting shall be conducted for areas identified as anomalies A and B (and any other anomalous areas identified through additional investigations) if Cargill proposes to mine under these areas, or up to these areas without an established standoff. The aforementioned conditions must be thoroughly analyzed for stability by Cargill and reviewed by the Department before mining proceeds in these areas.”

Previously noted in past BOYD’s annual reports:

- Based upon the additional seismic survey and consultant reports, Cargill will maintain the planned 1,000 ft setback around the Frontenac Point Anomaly. Further

Cargill Salt letter to Matthew Podniesinski, New York State Department of Environmental Conservation, February 23.

[2] New York State Department of Environmental Conservation, 2021, Permit, Under the Environmental Conservation Law,” permit Issued to: Cargill Incorporated, for facility: Cayuga Salt Mine, DEC ID 0-9999-00075, effective date with modifications February 12, 2021, expiration date April 23, 2024, Permit Administrator Elizabeth A. Tracy, February 12.

investigation is to be completed and submitted to the Department for review and approval prior to mining within this 1,000 ft buffer.

The required additional investigations and reports have been performed for Anomaly C. Undermining of Anomaly C will be completed using a large pillar configuration rather than the more yielding production pillar typically used at the Cayuga Mine. Cargill has agreed that no additional mining will occur under Anomaly E and no mining will occur under Anomaly D and the Frontenac Point Anomaly. Additional investigations and reports will need to be undertaken for Anomalies A and B, and mining in these areas should be avoided until reviewed and approved by the NYSDEC.

Condition 17.a

Condition 17.a. requires “For each year the mine is in operation, Cargill shall submit to the Department an Annual Report. The report shall be due on or before each anniversary date of the issuance of the permit.”

Condition 17.a.(1)

Condition 17.a.(1) requires “Certification signed by the Cargill Lansing Mine Manager that all mining related activities, to the best of his knowledge, conducted during the reporting year were in conformance with this permit and the approved plans, or that variances have been reported and managed.”

- A certification was included on page 2 and the certification was signed by Mr. Shawn G. Wilczynski, Mine Manager, on February 23, 2023. This certification notes “…, to the best of my knowledge, conducted during the reporting period from January 1st of 2022 through December 31st of 2022 were in conformance with the DEC Permit # 0-9999-00075/00001 and the approved plans. No variances occurred and none were reported.”

Condition 17.a.(2)

Condition 17.a.(2) requires “A summary of non-routine mining incidents as defined in Special Condition 19 of this permit and any action taken by Cargill in response thereto or resolution thereof.” And Special Condition 19 states regarding Non-Routine Incidents - “Cargill shall immediately notify the Department's Region 7 Mined Land Reclamation Specialist of any non-routine mining incidents both surface and subsurface associated with activities related to this permit. Non-routine mining incidents shall mean incidents during mining, processing, or other mine related activities that may adversely affect mine stability, ground and surface water and other natural resources, or the health, safety, welfare or property of the general public. The Department shall require Cargill to record any data the Department believes may be of future value for adequate evaluation of a non-routine mining incident.”

On Page 2 of the Annual Report, it is noted “The Cayuga Mine is not aware of any non-routine incidents associated with the mining, processing, or other mine related activities that would have adversely affected any of the following:

- Mine stability
- Ground and surface water
- Natural resources
- Health, safety, welfare or property of the general public.”

Condition 17.a.(3)

Condition 17.a.(3) requires: An updated Mining Plan Map depicting the current extent of mining activities, and the proposed advancement of the working faces for the subsequent three years.

Included with the Annual Report data was a map depicting the northern workings of the Cargill mine, the planned mining for each of the next three fiscal years, and shorelines of Cayuga Lake.

- Cargill, Inc., 2023, Cayuga Mine, 3 Yr Mine Plan, New Basemap-planning-3yr mine plan2023-Model.pdf, January 10.

The Annual Report notes “The Cayuga Mine is currently operating in the northern region of the mine. Active mining is located in panels U-78, U-84, U-86, and U-88.”

The following maps were included in the data sent to BOYD and support this note:

- “New Basemap-royalty map2020bind.dwg”, containing map entitled Cargill Deicing Technology, Cayuga Mine, 6 Level Workings, showing mine advance per month over the last three years.
- “New Basemap-planning-3yr mine plan2023.dwg,” containing 2023, Cayuga Mine, 3 YR Mine Plan, January 10, showing planned mining by fiscal year from 2022-2023 through 2024-2025. Also shows the location of anomalies A and B. Note that this map shows that Panel U88 will mine under the edge of Anomaly B in this fiscal year.

Condition 17.a.(4)

Condition 17.a.(4) requires “The summary of in situ measurements of rock mechanics required by Special Condition 18.b. of this permit. Special Condition 18.b. states: “In situ measurements of rock mechanics shall be collected in accordance with the approved Mined Land Use Plan. A summary of the data collected shall be submitted to the Department as part of the Annual Report. Exceptions to anticipated trends in rock

behavior shad be noted and explained to the Department after these data are collected and exceptions to the anticipated behavior are identified. If closure rates are higher than anticipated, Cargill shall increase the frequency of measurement in the affected area and submit for review and approved by the Department a plan and implementation schedule for corrective action."

Closure Measurements

On Page 2 of the Annual Report Cargill noted "Currently, there are over 300 convergence stations being monitored." And "Evaluations of the convergence data indicate that overall no unusual trends have been identified and the mine is behaving as expected."

Cargill provided closure data, including raw and processed data, graphs, and, on occasion, explanations of any inconsistencies and anomalous readings including reasons for abandonment, along with observation in the vicinity of the instrument, in Excel spreadsheets. The location of closures and extensometers were shown on the following map:

- Convergence Map 2023 bind.dwg" containing Cargill Deicing Technology, Cayuga Mine, 6 Level Workings, Conversion Stations.

Closure measurements can be evaluated to indicate possible instability in three ways:

1. By studying the graphs of the rate of closure over time. The shape of these graphs indicates areas of instability, areas of concern, and areas of stability. Mr. Petersen of Rocktec Solutions (Cargill geotechnical consultant) has evaluated the closure in this manner in the past.
2. By establishing trigger values for total closure. This method is applicable in harder, less viscous rock, but is not applicable for the Cayuga Mine, as stable closure in salt will continue until the openings are closed.
3. By establishing trigger values for long-term closure rates. Since this is not being completed by the other investigators, BOYD applied such trigger rates in its evaluation of the closure readings.

Table 1 lists the top 6 measured closure rates in 2022 for areas of recent mining, defined as areas within 1,000 ft of the active mining that occurred since October 1, 2021. Reported here is the station's highest rate measured during this reporting period.

Table 1: 6 Closure Rates in Areas of Recent Mining

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
NW2PIN#56	0.392	5,886	16.62	0.359	74.8F,64%Humidity to 75.5F,65%Humidity
U82PIN#5	0.326	1,210	1.72	0.326	Final Rate, 5th Rate
NW2PIN#62	0.239	6,041	12.78	0.239	Final Rate
NW2PIN#65	0.178	5,667	10.59	0.171	
U82PIN#4	0.160	1,210	1.07	0.160	Final Rate, 5th Rate
NW2PIN#68	0.138	5,600	8.81	0.130	

Three of the stations' highest rate was the last rate reported (Final Rate) all other rates slowed over the reporting period. Two of the stations' highest rates were the 5th reading since installation.

Table 2 provides the top 10 closure rates away from recent mining activity. These results do not include data from panel U-12, as this panel's closure rates are analyzed separately and shown in Table 3.

Table 2: Top 10 Closure Rates Away from Recent Mining (Excluding Panel U-12)

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
W1PIN#4	0.680	14,068	23.046	0.680	Final Rate
U78PIN#3	0.566	1,407	2.314	0.566	Final Rate
NW2PIN#44	0.521	6,138	20.735	0.407	76.2F, 60%Humidity to 75.7 F, 63%Humidity
U78PIN#1	0.503	2,421	8.42	0.266	Yield pillar area
U59PIN#2	0.490	6,181	17.965	0.354	Reset rod and pole
U44PIN#2	0.484	7,175	20.658	0.396	Reset rod
U80PIN#2	0.459	2,625	8.354	0.459	Yield pillar area, Final Rate
U80PIN#5	0.449	1,911	5.845	0.449	Yield pillar area, Final Rate
NW2PIN#38	0.423	6,278	19.301	0.341	Reset rod
NW2PIN#50	0.405	6,006	18.917	0.390	Gauge was rusted, reset rod

Four of the stations' highest rate was the last rate reported (Final Rate) all other rates slowed over the reporting period. Three of these readings occurred in the yield pillar area where closures rates should be higher than the rest of the mine.

Table 3: Top 10 Closure Rates in Panel U-12

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U12PIN#61	0.626	12,678	15.665	0.339	
U12PIN#61A	0.548	1,045	1.540	0.417	
U12PIN#100A	0.521	412	0.464	0.345	
U12PIN#102	0.521	7,402	25.370	0.411	71.9F, 55%
U12PIN#103	0.495	7,402	13.482	0.378	
U12PIN#14	0.443	12,254	21.527	0.358	71.6F, 56%
U12PIN#101	0.417	7,402	14.129	0.326	70.3F, 58%
U12PIN#49A	0.391	1,020	23.071	0.202	72.3F, 39%
U12PIN#16	0.365	12,240	19.447	0.293	
U12PIN#90	0.365	998	4.240	0.267	

A zone of concentrated high closure rates is in panel U-12, that has experienced anomalous mine closure rates since 2018.

BOYD reviewed all the reported closure results for the period starting in October 2021 to February 2023. A total of 289 closure stations results were reported for the 6th Level and four for the 4th Level. This is 17 fewer 6th Level closure station results than last year and 14 fewer than two years ago. No 4th Level readings were reported last year.

The higher reported 4th Level closure rates for each of the four closure stations varied from 0.115 to 0.319 in./year.

Closure rate data are significant because they offer insight into the collapses and the inundation of the Retsof Mine. Sustained closure rates of 15 in./year or less were measured in stable areas of the Retsof Mine, while in the failure areas, closure was regularly measured with sustained rates over 230 in./year with onset of failure around 600 in./year. Although Retsof and Cayuga mines have different overburden and material properties, in the general sense, a comparison seems warranted for a relative indicator of stability. In comparison, the highest closure rate reported in this annual report was 0.680 in./year for the closure station W1PIN#4. This rate is 4.5% of the Retsof Mine stable area sustained rate, 0.3% of Resof Mine's stained rate, and 0.1% for Retsof onset of failure rate.

None of these 289 closure stations showed readings that exceeded 230 in./year.

Cargill, in addressing their extensometer program on page two of the Annual Report, notes “This data indicates the mine is behaving as expected.”

The annual report, on pages two and three, also addresses Cayuga Mine’s micro-seismic network, noting the network “… now has over 120 geophones and covers over 6 square miles of mine workings.” And “This data indicates the mine is behaving as expected and global stability continues to be maintained.”

Extensometer Measurements

Cargill included a statement in the Annual Report on page 3, Section 17.a.(iv) that “Roof sag and wall expansion, measured with extensometers, is also monitored as conditions warrant, and is reviewed internally and externally as well. This data indicates the mine is behaving as expected.”

Seven extensometers were read at least once in the 2022 reporting period. Extensometers were installed in various manners including at low angle (near horizontal) in the roof and horizontally into pillars. All installed and reviewed extensometers have 3 points, that is, three rods that are anchored in the rock at different depths. This results in three bay lengths that are the length difference between rods except for the first bay which is the length of the shortest rod.

Like previous reviews, BOYD evaluated the rate measured as strain per year. Using RESPEC’s 1995 Cargill salts values:

Dilation Limit	$J_2^{0.5}/I_1 = 0.36$
Creep Rate	$\dot{\varepsilon}^c = 8.3 \times 10^{-30}(\Delta\sigma)^{5.9}$

BOYD assessed the stress state to estimate that a strain rate greater than 8×10^{-3} (-/yr) is needed for destructive dilation. No calculated strain rate exceeded this standard.

Micro-seismic Measurements

The 2022 Annual Report Data included reports by ESG Solutions.

ESG Solutions, “Seismic Data Processing Results and Health Analysis Report for Cayuga Monitoring System,” prepared for Cargill Salt Division, January, February, March, April, May, June, July, August, September, October, November, December of 2022. Cargill notes in the annual report that “The Cayuga Mine operates a micro-seismic monitoring network which now has over 120 geophones and covers over 6 square miles of mine workings. The data from this system is reviewed daily in-house, by Engineering

Seismology Group (ESG), and is reviewed weekly by RESPEC. This data indicates the mine is behaving as expected and global stability continues to be maintained."

Consultant Reports
No consultant reports, other than those of ESG Solutions, were included in the Annual Report data.

Condition 17.a.(5)
Condition 17.a.(5) requires "The summary of subsidence monitoring data required by Special Condition 18.a. of this permit." Special Condition 18.a. states "Subsidence monitoring shall be conducted in accordance with the approved subsidence monitoring plan contained in the approved Mined Land Use Plan. Summaries of data collected shall be submitted to the Department as part of the Annual Report. Exceptions to anticipated trends shall be noted and explained to the Department after the data are collected and exceptions to anticipated behavior are established."

Discussions at a meeting among Cargill, BOYD, and the NYDEC on June 16, 2022, addressed the LiDAR reporting. LiDAR represents an advance over land surveys as the LiDAR coverage is over an area as opposed to along established lines. The data points tend to be at a greater density. Such an advance in subsidence monitoring was embraced by the meeting attendees who agreed on the following suggested changes to Condition 17.a.(5):

- A LiDAR survey will be completed every two years of mine affected land, including land survey of control points. Suggested reporting requirements are:
    - An AutoCAD map contoured (color coded) for total movement since the initial LiDAR survey.
    - An AutoCAD map contoured (color coded) for rate movement over last two-year period.
    - A spreadsheet showing control point survey results. and
    - Text discussing the results.
- The agreed upon survey interval will be revisited at the next annual meeting.

Cargill included a statement in the Annual Report, Page 3, that "Surface subsidence measurements continue to be performed in accordance with the Mined Land Use Plan. A traditional survey was completed in 2020 for the west shoreline, east shoreline, Town of Lansing, and #4 Shaft area and a baseline LiDAR survey of was completed in

November 2021. All results were well within expected ranges. The next surface subsidence LiDAR is planned for fall 2024."

BOYD expected to receive LiDAR subsidence maps and other subsidence survey data. No subsidence survey file was included in the data.

Condition 17.a.(6)
Condition 17.a.(6) requires "Information regarding the source and volume of any water inflow into the mine, and the disposition of such water."

Page three of the Annual Report notes that "Most the water is directed to a settling pond located on the 4-level of the mine. The water is then pumped from the settling pond to abandoned areas at the far west end of 4-level as well as to various areas of the active mine for dust control. Water labeled as Other Inflows is fully saturated brine and is stored in various abandoned areas on the 6 Level of the mine."

Cargill lists the following water flows in the Annual Report:

- Production Shaft (#1 shaft) – 29 gallons per minute (gpm)
- Ventilation Shaft (#2 shaft) – Less than 1 gpm
- Service Shaft (#3 shaft) – 1 gpm
- ED Plant Concentrate discharge – Less than 1 gpm
- Other inflows – 4 gpm
- Total Water Inflow = 35 gpm

Condition 17.a.(7)
Condition 17.a.(7) requires "A summary of all other monitoring data required under the terms of this permit or Department SPDES permit issued to Cargill."

Discussions on December 2, 2021 limited SPDES data given to BOYD to summary type. The Cargill Annual Report or data did not include any SPDES data or summary.

Condition 17.b
Condition 17.b. requires "Upon transmittal or receipt, Cargill shall submit to the Department copies of all correspondence with the Mine Safety and Health Administration involving non-routine mining incidents as described below."

Cargill notes on Page 3 of the Annual Report, "The Cayuga Mine has not received any citations or correspondence from MSHA regarding non-routine mining incidents as identified in section 19."

Condition 17.c
Condition 17.c. requires “Prior to undertaking any material change in the approved mining methods or techniques described in the documents listed in Special Conditions #3 & 4, Cargill shall submit to the Department a description of such modification in accordance with all applicable laws including the Uniform Procedures Act and State Environmental Quality Review Act.”

Cargill notes on Page 3 of the Annual Report, “The mining methods used at the Cayuga Mine have not been changed in the last year.”

Condition 17.d
Condition 17.d. requires “Cargill must maintain a written record, and make it available to the Department upon request, of all written citizen complaints received by Cargill and any responses by Cargill thereto.”

Cargill notes on Page 3 of the Annual Report, “Cargill maintains a written record of citizen complaints that is available to the Department upon request.” No list of complaints was received.

Condition 18.a
Condition 18.a. requires “Subsidence monitoring shall be conducted in accordance with the approved subsidence monitoring plan contained in the approved Mined Land Use Plan. Summaries of data collected shall be submitted to the Department as part of the Annual Report. Exceptions to anticipated trends shall be noted and explained to the Department after the data are collected and exceptions to anticipated behavior are established.”

Condition 18.b
And Condition 18.b. requires “In situ measurements of rock mechanics shall be collected in accordance with the approved Mined Land Use Plan. A summary of the data collected shall be submitted to the Department as part of the Annual Report. Exceptions to anticipated trends in rock behavior shad be noted and explained to the Department after these data are collected and exceptions to the anticipated behavior are identified. If closure rates are higher than anticipated, Cargill shall increase the frequency of measurement in the affected area and submit for review and approved by the Department a plan and implementation schedule for corrective action.”

Cargill notes on Page 3 of the Annual Report, “All monitoring of subsidence and in situ measurements of rock mechanics have continued as outlined in 17.a.(4) and 17.a.(5)”.

Site Visit

BOYD recommends the following topics be addressed during the next site visit:

- The planned undermining of the edge of Anomaly B in this fiscal year.
- Reporting of LiDAR subsidence data.
- S-3 Sump.

BOYD suggests that in-mine observations be completed for portions of the U-12 panel and S-3 Mains, and any ongoing construction of the planned S-3 Sump.

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, Ph.D., P.E.
Executive Consultant – Geotechnical

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