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Mining and Geological Consultants

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June 17 , 2020
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New York State Department of Environmental Conservation
Bureau of Resource Management & Development
Division of Mineral Resources
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Attention: Mr. Matthew Podniesinski
Chief, Resource Development Section
Bureau of Resource
Management & Development

Subject: Revised 2019 Annual Report Review
Cayuga Mine, Cargill, Inc.
Seneca and Tompkins Counties, New York

Ladies and Gentlemen:

The 2019 Annual Report Review completed by John T. Boyd Company (BOYD) and submitted to Mr. Matthew Podniesinski on May 15, 2020 has been revised. On May 28, 2020, Mr. Mark Theisinger, Senior Engineer of Cargill's Cayuga Mine notified BOYD that Cargill's original data set contained some irregularities and calculation issues. The data and calculation changes were made and a final data set was provided via the secured Intralinks website on June 02, 2020.

Initially, Dr. Vincent Scovazzo, Director of Geotechnical Services, and Dr. María Jaime, Senior Geotechnical Engineer, of BOYD, received an email message on March 10, 2020 from Steven Army, Region 8 Mining Program Supervisor, New York State Department of Environmental Conservation (NYSDEC) with the attached Annual Report¹ signed by Shawn G. Wilczynski as file [DOC031020-03102020105346.pdf](#) last modified March 10, 2020.

¹ Wilczynski, Shawn G. of Cargill Deicing Technology, 2020, "Annual Report for Mine File #709-3-29-0052; Cayuga Salt Mine, Permit ID#0-9999-00075-00001" to Matthew Podniesinski of New York State Department of Environmental Conservation, March 4.

Dr. Scovazzo received an email message on April 06, 2020 from Mr. Theisinger advising that the 2019 Annual Report data set could be accessed on Intralinks. This data set contained:

- Maps as Adobe Acrobat® files.
- Extensometer and closure readings as Adobe Acrobat® and Excel® files.
- Seismicity consultant reports from Engineering Seismology Group (ESG).

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.

The received documents were reviewed for their adherence to conditions of the revised Permit². Section 12.8 of the revised permit limits cost for review of annual reports by Consulting Services to \$15,000. BOYD is providing the Consulting Services for this annual review. It is noted that “Funding relating to permit modifications or alterations requiring consultant review shall not be capped due to the varying nature of potential future applications. Cargill shall fund the cost of the annual meeting/underground inspections, and will share the cost of joint inspections with American Rock Salt Co., LLC.”

The Cargill 2019 Annual Report contained ESG reports but no other consultant reports. Previously, active mining location and mine progress over the last three years were determined from the royalty map. Upon the request from BOYD, Mark Theisinger made the royalty map available on Intralinks on April 28, 2020 as part of the report data set. The file, [9.3 Royalty map2020.pdf](#), contained the mine advance information required for the 2019 Annual Report review.

Discussion of Annual Report

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

Condition 9

Condition 9.a.

Condition 9.a. requires investigation into the disturbed salt zone and this investigation to be completed and submitted before mining proceeds into the area. Based upon the additional seismic survey and consultant reports, Cargill will maintain the planned 1,000 ft setback around the Frontenac Point Anomaly. Further investigation is to be

² New York State Department of Environmental Conservation, Region 7, 2007, “Permit” DEC ID 0-9999-00075, expiration December 31, 2012, December 31, Modification # I Effective Date: November 8, 2013.

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

Condition 9.b.

Condition 9.b. requires investigations and reports on the adequacy of the thin rock overburden where the solid rock overburden is thinner, the glacial till and lake sediments thicken, and lake depth increases. The thin rock overburden and Frontenac Point Anomaly may overlap.

The required additional investigations and reports have been performed for Anomaly C. Undermining of Anomaly C will be completed using a large pillar configuration and not 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.

The 2019 Annual Report notes the inclusion of reports by ESG Canada Inc. which were in the Intralinks data set as documents 7.1 through 7.14:

- ESG Solutions, “Seismic Data Processing Results and Health Analysis Report for Cayuga Monitoring System,” prepared for Cargill Salt Division, covering 14 months from November 2018 to December 2019.

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 ESG, and is reviewed weekly by RESPEC. This data indicates the mine is behaving as expected and is stable.”

Condition 15.a.

Condition 15.a. requires an Annual Report to be submitted by Cargill in response to 15.a. sub-conditions (1) through (8) and Condition 15.b. through g. These conditions and Cargill’s responses are summarized below.

Condition 15.a.(1)

Condition 15.a.(1) requires the inclusion of the Mine Manager’s signed certification that “all mining related activities...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, Section 15.a.(1) and the certification was signed by Mr. Shawn G. Wilczynski, Mine Manager, on March 4, 2020. This certification notes "...that all mining activities, to the best of my knowledge, conducted during the reporting period from October 1, 2018 through December 31st of 2019 were in conformance with the DEC Permit # 0-9999-00075/00001 and the approved plans. No variances occurred and none were reported."

Condition 15.a.(2)

Condition 15.a.(2) requires "A summary of all non-routine mining incidents as defined in Special Conditions Part b. ..." Condition 15.b. defines non-routine as "incidents during mining, processing, or other mine related activities that may adversely affect mine stability, ground and surface water or other natural resources, or the health, safety, welfare or property of the general public." During a meeting held on August 17, 2004, among Cargill, NYSDEC, and BOYD, it was agreed that statements will be included in the Annual Report "to point out known, encountered, or discovered geologic and geotechnical anomalies and mine action to address such anomalies."

Cargill included a statement in the Annual Report page 2, Section 15.a.(2) that "[t]he 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 15.a.(3)

Condition 15.a.(3) requires "[a]n updated Mining Plan Map depicting the current extent of mining activities, and the proposed advancement of the working face for the subsequent three years." At the August 2004 meeting, it was agreed that in addition "[a] mine map showing instrumentation location and type and shore line..." will be included in the Annual Report.

Cargill included a statement in the Annual Report, page 2, Section 15.a.(3) that "[t]he Cayuga Mine is currently operating in the northern region of the mine. Active mining is located in panels U-78, U-80, U-82 U-84, and NW-3." Mine maps as electronic files were supplied by Cargill to fulfill this condition. Included maps were:

- Adobe Acrobat® file [9.2 3yr mine plan.pdf](#) downloaded from Intralinks on April 28, 2020, containing MBD, 2020, "Cayuga Mine, 3 Yr Mine Plan" January 22. The

high-resolution map shows the planned extent of mining through 2023 with pillar configurations.

- Adobe Acrobat® file [6.7 Convergence2020.pdf](#), downloaded from Intralinks on April 28, 2020, containing the high-resolution map Cargill Deicing Technology, undated, “Cayuga Mine, 6 Level Workings, Convergence Stations” showing the locations of convergence stations.
- Word® document [6.2 Closure Dec-2019.docx](#) downloaded from Intralinks on April 6, 2020, containing two closure maps, undated, “Cayuga Mine Closure (Inches) Dec-2019” and “Cayuga Mine Closure Rate (Inches/Year) Dec-2019.” The maps show contours of total closure ranging from 0 in. to 27 in., and contours of closure rates ranging from 0 in. to 4.5 in./year, respectively.

The supplied maps show the extent of mining, proposed mine plan, shorelines of Cayuga Lake, total closure, closure rate, and instrument locations.

Condition 15.a.(4)

Condition 15.a.(4) requires the annual report to include a “summary of in situ measurements of rock mechanics required by Part f. of this Special Condition.”

Condition 15.f. requires the measurement and collection of in situ rock mechanics data “in accordance with the approved Mined Land Use Plan.” The data are to include “plots of relevant graphs. ...” Furthermore, “[e]xceptions to anticipated trends in rock behavior shall be noted and explained. ...”

At the August 2004 meeting, it was agreed that “[a]ll rock mechanics data” would be incorporated in the Annual Report, “including, but not limited to, all instrumentation readings and observations from the initial readings to present. Data for subsidence, closure, and extensometers are to be provided electronically. These electronic files are to include raw and processed data, graphs, and explanations of any inconsistencies and anomalous readings including reasons for abandonment, reinstallation, etc., along with applicable observation in the vicinity of the instrument such as floor heave, water inflow, etc. Future reports are to contain comment on whether, in the opinion of Cargill, the instrument readings support or conflict with prior stability models especially in areas employing new mine, panel, or main configurations.”

Closure Measurements

Cargill included a statement in the Annual Report on page 2, Section 15.a.(4) that “Evaluations of the convergence data indicate that overall, no unusual trends have been identified and the mine is behaving as expected. There continues to be a few slight anomalies, which while showing elevated closure rates, are not elevated enough to be of a concern to global stability. These areas are being monitored more closely and areas are being outfitted with additional electronic instrumentation to help gather more data.”

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.

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.

BOYD reviewed the 306 closure stations read during the reporting period (7 more than last year; 300 in Level 6, 4 in Level 4A, and 2 in Level 4) Levels 4 and 4A readings show an overall trend of steady constant closure rates.

None of these 306 closure stations showed readings that exceeded 230 in./year. Table 1 lists the top 10 measured closure rates in 2019 for areas of recent mining, defined as areas within 1,000 ft of the advance face that occurred since October of 2018.

Table 1. Top 10 Closure Rates in Areas of Recent Mining

Station	Closure Rate (in./yr)	Time from Mining to Reading (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U78PIN#1	17.8120	1320	7.190	1.4294	^{1,2} 2nd after mining resumed in August 2018
NW3PIN#75	17.7155	28	2.308	2.8157	^{1,2} First reading
NW3PIN#68	13.9542	145	6.403	3.8207	²
U78PIN#4	6.9524	63	1.200	6.9524	¹ Only reading reported
NW3PIN#62	3.0170	322	8.145	0.9684	^{1,2}
NW3PIN#56	2.2270	537	7.261	0.5328	^{1,2} Approx. 1,300 ft away from active face
U76PIN#16	1.3849	67	1.285	0.1941	^{1,2}
U78PIN#3	1.3383	63	0.231	1.3383	¹ Only reading reported
U78PIN#2	1.1935	63	0.206	1.1935	¹ Only reading reported
U76PIN#2	0.7682	1296	8.847	0.4718	U78 mining?

¹ First reading in reporting period (October 2018 through December 2019).

² Closure rate trend consistently decreasing.

These rates are substantially lower than the comparable rates for 2018. All of these rates substantially decreased over time showing that the ground is stable or stabilizing.

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 from Mining to Reading (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U72PIN#12	0.9751	1729	6.580	0.9751	^{1,2} Only reading reported
NW3PIN#44	0.9006	1365	8.748	0.9006	^{2,3} Only reading reported
U40BPIN#8	0.8948	6435	30.427	0.7883	³ 71.9°F 67%H, maxed, rod reset on 10/7/19
NW2PIN#44	0.7535	5036	19.878	0.5309	³ 76.2F, 52%H, rod reset on 12/13/19
U40BPIN#14	0.7182	6295	28.670	0.6286	³ Rod reset on 10/7/19
W1PIN#4	0.6930	13139	21.341	0.6930	² Only reading reported
NW2PIN#50	0.6594	4904	18.012	0.5254	³
NW3PIN#50	0.6584	699	7.204	0.4459	¹ Slight decrease of closure rates over time.
NW2PIN#56	0.6387	4934	15.878	0.4356	Rod reset on 11/4/19
U40BPIN#2	0.6123	6546	28.670	0.6286	^{2,3} Rod reset on 10/7/19

¹ Erratic closure rates over time.

² Closure rates not decreasing over time.

³ First reading of reporting period.

These top 10 rates away from recent mining are lower than the comparable rates for 2018, and they are staggered throughout the mine.

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

Station	Closure Rate (in./yr)	Time from Installation to Reading (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U12PIN#49A	989.880	6	22.186	0.0730	^{1,2} 2 nd Highest is 10.585 in./yr @195 days
U12PIN#94	34.2188	4	0.666	2.4507	^{1,2} 2 nd Highest is 6.4483 in./yr @18 days
U12PIN#91	12.7750	12	2.616	0.5736	^{1,3}
U12PIN#93	10.2200	5	1.796	0.9386	^{1,3}
U12PIN#100.5	9.5421	106	1.063	0.6205	¹ Pole destroyed
U12PIN#92	9.2163	5	0.533	3.1286	^{1,3} 2 nd Reading
U12PIN#90	5.6741	130	2.897	3.7230	^{1,3}
U12PIN#61A	3.4675	2	0.637	0.2086	^{1,3} 69.4F, 40%H
U12PIN#32	2.6767	10825 ⁴	26.595	0.2738	¹
U12PIN#61	1.7033	11532 ⁴	15.410	0.3650	¹

¹ Erratic closure rates over time.

² First reading.

³ Slight decrease of closure rates over time.

⁴ Time from mining to reading (days).

Station U12PIN#61 shows its closure rate decreased throughout 2019 and is significantly lower than the last rate recorded in 2018. The top eight closure rates listed in Table 3 correspond to stations installed in 2019. With the exception of station U12PIN#49A, all closure rates are considered low and stable. The high rate from closure station U12PIN#49A was the result of the first reading taken, on January 29, 2019. One day later it had decreased by more than three orders of magnitude.

The contour map of closure rates in December 2019 depicts a clear zone of concentrated closure rates up to a maximum of 4.5 in. per year. This concentrated maximum rate is located within panel U-80 and is the result of mining the surrounding panels U-78 and U-82. Its magnitude is considered low and stable.

Another zone of high concentrated closure rates is located in panel U-12, which is a panel that experienced anomalous mine closure rates during 2018 and the first half of 2019. This led to the development of an investigative program focused on finding fluid under pressure within the overlying rock layers above #6 Salt. On November 14, 2019, brine was encountered in one of the investigation drill holes located near closure station U12PIN#49A, 133 ft above #6 Salt, in the Dolomite rock layer between #4A Salt and #5 Salt layers. After measures were implemented to relieve fluid pressure in the roof as anticipated by the program procedures, the closure rates significantly decreased by one order of magnitude.

Extensometers Results

Cargill included a statement in the Annual Report on page 2, Section 15.a.(4) 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."

Data from 19 extensometers that were read in 2019 were evaluated (four more than in 2018). Extensometers were installed in various manners including vertically into the roof; at low angle (near horizontal); at an angle that resulted in the extensometer being installed over the pillars; vertically into the roof, and horizontally into pillars. These data are further complicated by the varying rod and bay lengths. (Bay length is the length difference between rods except for the first bay which is the length of the shortest rod.) Nevertheless, BOYD attempted to ascertain anomalies within these data.

Similar to last year, BOYD evaluated the rate measure as strain per year. Using RESPEC's 1995 Cargill salts values:

$$\begin{array}{ll} \text{Dilation Limit} & J_2^{0.5}/I_1 = 0.36 \\ \text{Creep Rate} & \dot{\epsilon}^c = 8.3 \times 10^{-30}(\Delta\sigma)^{5.9} \end{array}$$

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.

Table 4 lists the five highest extension rates measured during 2019.

Table 4. Top 5 Estimated Strain Rates

Mine Area	Extensometer Label	Displacement Rate (in./yr)	Rod Length (ft)	Strain Rate (-/yr)
Screen Plant Pillar	I-Pillar B-Hole 3 Tun	0.437	10.0	3.64×10^{-3}
Surge Bin 4 Level	STA. #25	0.429	11.0	3.25×10^{-3}
Screen Plant Pillar	G-Pillar B-Hole 3 Tun	0.243	7.0	2.89×10^{-3}
Surge Bin Roof	#27 - Roof ext.	0.596	19.5	2.55×10^{-3}
Screen Plant Pillar	J-Pillar B-Hole 1 Tun	0.145	6.0	2.01×10^{-3}

These strain rates are acceptable.

Consultant Reports Concerning Conditions 15.a.(4).

No consultant reports were available on Intralinks, other than ESG Solutions monthly reports:

- ESG Solutions, 2018 and 2019, “Seismic Data Processing Results and Health Analysis Report for Cayuga Monitoring System,” prepared for Cargill Salt Division, covering 14 months from November 2018 to December 2019.

These reports are discussed in section Condition 9.b. above.

Condition 15.a.(5)

Condition 15.a.(5) requires the Annual Report include a “summary of subsidence monitoring data required by Part e. of this Special Condition.” Condition 12.e. requires “[s]ubsidence monitoring shall be conducted in accordance with the approved subsidence monitoring plan contained within the approved Mine Land Use Plan.” Furthermore, “[e]xceptions to the trends shall be noted and explained...” Points applicable to this condition were agreed upon at the August 2004 meeting and are noted above under Condition 15.a.(4).

Cargill included a statement in the Annual Report page 3, Section 15.a.(5) that “Surface subsidence measurements continue to be performed in accordance with the Mined Land Use Plan. The surface subsidence survey was completed in September of 2019, minor inconsistencies do exist and are being investigated.”

No subsidence data file was included in the data set on Intralinks. BOYD expects to review these data when they are provided.

Condition 15.a.(6)

Condition 15.a.(6) requires the inclusion of “[i]nformation regarding the source and volume of any water inflow into the mine, and the disposition of such water.” At the August 2004 meeting, it was agreed that a discussion about water disposal in Level 4 would be included in the Annual Report, noting: “Updates of Level 4 filling including data on shore line advance.” However, in 2012 it was noted that “Access to view the pond is not possible due to ground conditions.”

Section 15.a.(6) 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 east 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 and is stored in various areas on the 6 Level of the mine.”

A data file with water volume calculations was not included in the data set on Intralinks.

Cargill lists the following water flows in the Annual Report:

- Production Shaft (#1 shaft) - 25 gallons per minute (gpm).
- Ventilation Shaft (#2 shaft) - Less than 1 gpm.
- Service Shaft (#3 shaft) - 1 gpm.
- ED Plant Concentrate discharge - 3 gpm.
- Other Inflows - 2.5 gpm.
- Total Water Inflow = 32.5 gpm.

The total water inflow rate is 2.5 gpm more than reported in 2018.

Condition 15.a.(7)

Condition 15.a.(7) requires the inclusion of “[a] summary of all other monitoring data required under the terms of this permit or Department SPDES permit issued to Cargill.” Cargill included a statement in the Annual Report page 3, Section 15.a.(7) that “For the 2019 calendar year there was no exceedance of the SPDES limits for the storm water outfalls.”

Back up data to this statement were not provided on Intralinks. Typically, an Excel spreadsheet, which documents MLRP outfall and provides information on outfall water quality including cyanide, chloride, zinc, total dissolved solids, and cooling and treatment water, is provided.

SPDES data and a discussion of these data were not included in the Annual Report. These data are to be reviewed by NYSDEC. Discussion on June 6, 2019, suggests that direct reporting requirements of SPDES data to the State of New York renders this requirement moot.

Condition 15.b. and c.

Condition 15.b. and c. addresses Mine Safety and Health Administration (MSHA) reporting involving non-routine mining incidents as defined in Condition 15.b. Condition 15.c. requires Cargill to submit “all correspondence with the Mine Safety and Health Administration involving non-routine mining incidents...”

Cargill includes a statement in section 15.b. of the Annual Report that “[t]here were no incidents meeting the guidelines for notification as identified in section 15.a.(2)” and section 15.c. of the Annual Report that “[t]he Cayuga Mine has not received any citations or correspondence from MSHA regarding non-routine mining incidents as identified in section 15.a.(2).” The Annual Report does not note reports or letters from MSHA concerning any non-routine mining incidents.

Condition 15.d.

Condition 15.d. addresses reporting requirements “Prior to undertaking any material change in the approved mining methods or techniques ... Cargill shall submit to the Department a description of such modification ...” This condition does not require the reporting to occur in the Annual Report.

Cargill notes in section 15.d. that “[t]he mining methods used at the Cayuga Mine have not been changed in the last year.”

Condition 15.g.

Condition 15.g. addresses the reporting and recording of citizen complaints.

Cargill includes a statement in section 15.g. of the Annual Report that “[n]o written complaints from citizens were received since the last report (November 2019).”

Site Visit

A site visit to discuss these findings amongst NYSDEC, Cargill, and BOYD is scheduled to take place on August 6, 2020. During this visit the following should be discussed:

- 4 Level monitoring.
- ‘Other inflows’.
- Subsidence data.

- Panel U-12 behavior.
- Outside consultant review such as Mr. Petersen of Rocktec Solutions.

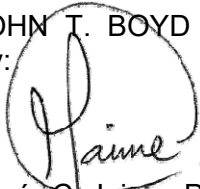
BOYD recommends visiting U-12 and U-78 panels.

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

Respectfully submitted,

JOHN T. BOYD COMPANY

By:



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