

CARGILL CAYUGA MINE MINED LAND USE PLAN

VOLUME I

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CARGILL CAYUGA MINE

VOLUME I

MINED LAND USE PLAN

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Location Map

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Columnar Sections 1999 Core Holes

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Cargill Salt, Inc. (Cargill) mines salt from a series of underground mining levels at their Cayuga Mine in the Town of Lansing, Tompkins County, New York. Mining is presently conducted beneath Cayuga Lake, within lands leased from the New York State Office of General Services (OGS). Cargill has historically also mined salt from lands it owns and leases east and west of Cayuga Lake. Cargill has also extended their existing lease hold rights with OGS to include additional lands under Cayuga Lake to both the north and south of previously authorized areas. Virtually all the salt mined from Cargill's Cayuga Mine is sold as road salt for de-icing highways and bridges in the Mid-Atlantic, Northeast and New England states.

Cargill has been authorized to mine salt at the Cayuga Mine under the Mined Land Reclamation Law (MLR) (MLF#7093-29-0052). Previously, the New York State Department of Environmental Conservation (NYSDEC) only regulated the surface features at the Cayuga Mine. Cargill submitted, for informational purposes only, the areas of underground activity. NYSDEC has sought to include the underground workings as part of the regulated activity on the site. Cargill has entered into a stipulation with NYSDEC to provide additional information under a reservation of all historic and legal rights as set forth in the stipulation. This Mining Plan for Cargill includes all lands either owned by Cargill or under lease from the OGS or others. The Plan, as outlined, increases the area to be mined within Cargill's current lease area under Cayuga Lake. Cargill owns approximately 260.04 acres of land on the surface at the Cayuga Mine. Of those 260.04 acres, approximately 67.67 acres of surface land have been affected by mining-related activities (storage, processing, bagging, etc.). To date, NYSDEC has reviewed

underground mining over approximately 8,361 acres in the eastern reserves area and beneath Cayuga Lake. This application includes an additional approximately 5,056 acres of reserves area located beneath Cayuga Lake. Mining is not prohibited at this site.

Cargill has engaged Spectra Environmental Group, Inc. (Spectra) to prepare this Mined Land Use Plan (MLUP). A series of consultants has previously been engaged to provide technical consulting services in support of mine planning and design. Most notable, The Sear-Brown Group (Sear Brown) has conducted geologic and hydrogeologic investigations and RESPEC has provided geotechnical and rock mechanics evaluations.

This MLUP, Volume I, and an Expanded Environmental Assessment, Volume II, are a summation of a continuing series of technical evaluations that have been conducted over the previous 30 years and are submitted under a reservation of rights as outlined in the stipulation with the DEC. Both Sear-Brown and RESPEC are primary contributing

authors to these volumes. Most figures and plates are derived from and appropriately credited to either Sear-Brown or RESPEC.

2.0 **MINING PLAN**

2.1 Introduction

The Cargill Salt, Inc. Cayuga Mine is an underground room-and-pillar rock salt mine accessed by three (3) vertical shafts from Cargill's surface complex located off of Portland Point Road. Salt has been mined from a series of salt layers within the Syracuse Formation of the Silurian-age Salina Group. All drilling, blasting and hauling of unprocessed rock/salt occurs underground. Additionally, all primary crushing and screening occurs underground, isolated from the surface environment and potential surface receptors.

This report, Volume I, provides a comprehensive discussion of the mining plan at Cargill's Cayuga Mine. The discussion includes information regarding surface and subsurface facilities in operation at the mine. Also included in the discussion are sections pertaining to the present operation of the mine, the history of mining at the site, an overview of facility layout, measures employed by Cargill for pollution control and the prevention of environmental damage, and a discussion of the planned reclamation at Cargill's Cayuga Mine. This submittal also includes a long form Environmental Assessment Form (EAF) and an Expanded Environmental Assessment included in Volume II. Volume II provides more detailed technical data regarding site and regional geology, geotechnical considerations, underground design and geomechanical modeling, rock mechanics monitoring, subsidence monitoring, microseismic monitoring and pollution control.

2.1.1 Regulatory Setting

The New York State Mined Land Reclamation Law was written for the regulation of surface mines. Specifically, 6 NYCRR Part 420 states:

“Affected land and land affected by mining means the sum of that surface area of land or land under water which: (i) has been disturbed by mining since April first, nineteen hundred seventy-five and not been reclaimed, and (ii) is to be disturbed by mining during the term of the permit to mine.”

Consequently, many of the components of the State Mined Land Reclamation Law are not applicable to Cargill's Cayuga Mine. Although the Cayuga Mine is constantly

expanding at depth, its surface extent is limited to the presently affected surface area. Aspects such as concurrent reclamation, grading, slope control, haul roads, etc. are not applicable to the Cayuga mine with the exception of the mine's surface features.

Cargill's Cayuga Mine is located in the Town of Lansing, Tompkins County, New York. The mine's surface facilities are located off Portland Point Road on the east side of Cayuga Lake, approximately as shown on the Location Map (Figure 2.1-1) on the following page. The mine itself is located beneath a portion of Cayuga Lake and the surrounding area (including lands owned by Cargill).

2.1.3 Adjacent Land-Use Features

The surface operations of Cargill's Cayuga Mine are located off a dead-end road (Portland Point Road). The predominant land uses in the immediate vicinity are industrial, and include the surface facilities of Cargill's Cayuga Mine and the Cayuga Crushed Stone Quarry, owned by Hanson Aggregates East, on the east side of Portland Point Road.

Land-use features adjacent to Cargill's surface operations include: 1) Cayuga Lake and the Norfolk-Southern Railroad to the west; 2) Portland Point Road and the lands of Cayuga Crushed Stone to the east; 3) Minnegar Brook and the lands of others to the north; and 4) Portland Point, the lands of others and Cayuga Lake to the south. Other lands along Portland Point Road are generally vacant brushland.

The vast majority of the current mining area is located under Cayuga Lake, as shown on the Location Plan Map (Figure 2.1-1). Land-uses in the vicinity, in addition to the lake, include the Norfolk-Southern Railroad (along the eastern shore of the lake), Taughannock Falls State Park (on the west side of Cayuga Lake adjacent to the northernmost workings of the mine), Lansing Park (on the east side of the lake northwesterly of the surface operations of the Cayuga Mine and easterly, southerly and northerly of the extraction areas).

Cargill's lease area from OGS extends under Cayuga Lake to the limits shown on the Site Location Map. The lease area extends easterly of the surface facilities to the area east of N.Y.S. Route 34. The majority of this area is occupied by open space, farmland, rural residential or commercial land uses. Cargill also leases lands to the west of the Cayuga Lake as also shown on the Site Location Map.

The surface lands at the Cargill Mine are occupied by operational features such as hoist houses, salt storage pads, conveyors, a salt storage building, a bagging facility, corporate offices, a railroad siding (complete with rail-bulk loading facilities), surface exposures of shafts, truck-loading facilities, etc. Specifically, the present condition of the land surface at the Cayuga Mine is shown on the Surface Mining Plan Map (Plate 2.2-1).

Portland Point Road, in the immediate vicinity of the Cayuga Mine, runs roughly north south through Cargill's surface operations. Cargill's office is located on the east side of Portland Point Road with the remaining surface features on the west side of the road. The salt storage facilities are concentrated in the northern portion of the property on the west side of the road. The southern portion of the property on the west side of Portland Point Road contains the shafts, hoists, rail bulk-loading facilities, shop and parking areas.

2.2.1 Mining History and Land Use

2.2.1.1 Brine Field

International Salt Co. (most recently AKZO Nobel Salt Co.) operated a salt refinery at Myer's Point about 1 mile northwest of the Cayuga Mine shafts until 1962. This refinery utilized brine (water was pumped into the salt beds to dissolve salt and the resulting brine pumped back to the surface) to manufacture refined salt. During the period of operation, the refinery obtained brine from three cavities. The largest cavity is in the No.1 Salt Layer of the Syracuse Formation, a smaller cavity is in the No.2 Salt Layer, and a third cavity, which was never fully developed for production use, is in the No.4 Salt Layer. The wells have been plugged and abandoned. Cargill plans to mine the area located to the west and south of the cavities developed at Myer's Point.

Information regarding the solution-mined caverns developed by International Salt Co. at the former Myer's Point plant site is sparse. Records were not retained about brine production from the various wells nor are specific data available concerning the original completion depths of the various wells. The refinery was closed before sonar survey technology for surveying caverns was well developed; therefore, no down-hole data on cavern sizes or shapes were ever obtained. Sevenker (1987 and 1992) assembled some information on the cavities and wells in reports prepared for Cargill. Additional information was obtained through discussions held with AKZO Nobel Salt.

Salt was produced primarily from the main cavity with some lesser production from the second cavity both located under Myer's Point. Very minor production came from a third

cavity, located north of Myer's Point under the valley wall. The main cavity was developed in the No.1 Salt (uppermost), the second cavity (well 10) in the No.2 salt, and the third cavity (gallery 1) in the No.4 Salt (the same salt as the original Cayuga Mine). The thickness of the No.1 Salt varies from about 80 feet in the southern portion of the former plant property to approximately 150 feet to the north. The No.2 salt is reportedly about 70 feet thick near the second cavity. The roof of the main cavity is at an elevation of about 1,100 feet bmsl (below mean sea level) or at a depth of approximately 1,500 feet. The well

10 cavity roof is about 1,290 feet bmsl (1,690-foot depth), and gallery 1 is located at about

1,500 feet bmsl (2,100-foot depth). The estimated roof depths do not account for possible roof stoping' into the overlying Camillus Shale that may have occurred.

The main cavity was used for brine production from the beginning of operations at the plant in 1894 until it shut down in 1962. The main cavity was entered by multiple wells. The early wells drilled for the refinery would have been operated individually for both water injection and brine production. Water would have been injected near the top of the salt and brine produced from near the bottom of the well. The effect of this method of solution mining would have been to create a "morning glory"² shaped cavern with a majority of the mining occurring within the top one-half of the cavern and little salt dissolution occurring at the bottom of the cavern.

The second cavity was initially developed in 1945 and operated until the plant shut down in 1962. This cavity was developed only through well 10. The cavity was operated in a similar fashion to that used for the main cavity, again likely producing a "morning glory" shaped cavity.

The third cavity (gallery 1, wells 20 and 21) was to be developed by hydrofracturing between the two wells drilled specifically for that purpose. Attempts to connect the two wells were largely unsuccessful. These attempts did establish a high-pressure connection between the wells and the main cavity. Well 20 may have been operated as a single well cavity for the last year of the plant's production.

The refinery was altered several times in its history to increase its capacity. Estimates of the plant capacity and corresponding brine requirements were used by Sevenker (1987) to develop estimates of the sizes of the cavities. Sevenker estimated the total production from the caverns to have been about 7,736,000 tons (4,275,000 +/- yd³) of salt. Internal memorandum reports from AKZO Nobel Salt estimate total plant production to have been between 6,000,000 and 9,186,000 tons (3,315,000 to 5,075,000 +/- yd³) of salt.

Stoping . the loosening and removal of ore in a mine either upward (overhead or overhand) or downward (underhand)

2 Morning Glory .the shape of the solution cavity is an inverted cone or ‘morning glory’

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Multi-seam room and pillar mining has been employed at Cargill's Cayuga mine. Access to the multiple salt layers within the Syracuse Formation of the Silurian-age Salina Group was afforded via a series of shafts sunk from the ground surface. Specifically, room-and-pillar mining has occurred in the Nos. 1, 4, 4a and 6 salt layers of the Syracuse Formation. These layers are shown in schematic section on Plates 2.2-2 through 2.2-6 and are discussed in detail in the accompanying Volume II.

The No. 1 shaft was sunk between 1915 and 1918. Mining began in the No. 1 Salt Level in January of 1923 and ended in January of 1924. The No. 1 shaft was deepened in 1924 to the No. 4 Salt Level where mining commenced in 1924. In the original mine design, mining of the No.4 Salt bed followed the thick rolls or northwest trending folds that deform the bed. Thus, both pillar widths and room (stope) widths varied greatly. Mining continued in the No. 4 level until about 1970. The current limits of mining on Level 4 are shown in Figure 2.2-1 on the following page. In 1968 some mining was done in the No. 4A salt bed. The limits of mining on Level 4A are shown in Figure 2.2-2 on page 9.

Mining began in the No. 6 salt level in 1968. From the opening of the No.6 level in 1968 until about 1976, production was approximately 3,300 tons per day with 3 operating shifts per day. Rooms 32 feet wide and 8—10 feet tall were mined on approximately 120-foot centers (between 88-foot-square pillars) with an extraction ratio of approximately 46 percent.

During the early years of mining on the No. 6 level, there were few ground control problems. Few rock falls occurred from the ceilings. It is theorized that this may have been because of a "protective cover" provided by the overlying No.4 level workings in the multi-seam excavation. The early workings in Level 6 took place under previously mined level 4 workings in the eastern portion of the mine. **By the mid- 1970s, however, as the mining moved farther eastward, stresses increased due to the increasing thickness of overlying strata. Active mining was no longer occurring beneath mined out portions of Level No. 4 and ground conditions worsened. It was theorized that the large, stiff pillars in the traditional room-and-pillar design caused the instability by punching through the roof strata around the mine openings. This can lead to roof falls and/or floor heave.**

The use of yield pillars has been explored industry-wide to resolve safety and operational concerns associated with large pillars in traditional room and pillar mining (Jeremic, 1994). In 1976, Cargill began to experiment with the use of yield pillars as a potential solution to the ground control problems that were plaguing the eastern workings of the No. 6 Level. While actively mining, Cargill initiated a sequence of testing between 1976 and 1984 on the east side of the Level No. 6 workings. The excavation sequences were carefully designed and instrumented. Cargill employed a systematic and methodical mining approach that included measured response, structural calculations, and industry experience. Extensive monitoring including stress, closure and extensometer measurements, and surface subsidence data were used to assess the performance of the developing mine layout over time. Subsequent layouts were developed, evaluated and adopted based on the specific conditions in existence at the Cayuga Mine.

In 1984, Cargill began working the west end of the Level No. 6 workings (i.e. within that portion of the lease area beneath Cayuga Lake), applying all the information, experience and knowledge gained from the mining of the east end. Small pillars within relatively wide panels separated by massive barrier pillars describe the mining layout currently being used at the Cayuga Mine. The layout has evolved since 1976, and represents an approximately 25-year systematic and scientific approach to the establishment of a safe and stable mine through the use of yield pillar panels and massive abutment pillars.

2.2.2 Topography and Physiography

Tompkins County is situated within the Appalachian Plateau physiographic province as shown in Figure 2.2-3. on the following page. The plateau is highly dissected by incising streams and is generally characterized by hill-valley topography with up to 1,000 feet of vertical relief within individual basins.

The county has been divided by Neely (1965) into three zones based upon elevation as indicated in Figure 2.2-4 on page 12. Large portions of the county occur at elevations in excess of 1,100 feet above mean sea level (amsl). Included within the high elevation zone is the southern part of the county, which consists of high plateau that ranges between 1500 and 2000 feet amsl and is separated from an intermediate elevation plateau (>1,100 feet) by the Portage Escarpment.

In Tompkins County, three major north-northwest trending valleys and one prominent northeast trending valley dissect the terrain. The westernmost of the northwest-trending valleys extends between Enfield in the north and West Danby in the south and is occupied by Enfield Creek and the Cayuga Inlet. Cayuga Lake and Sixmile

