



1942 VERMONT COPPER CO. INC. 1958

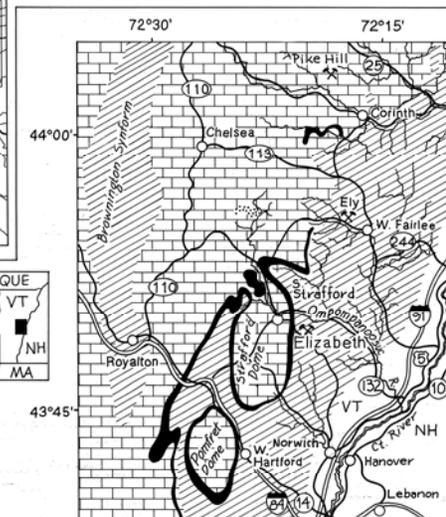
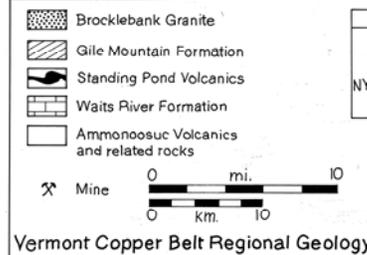
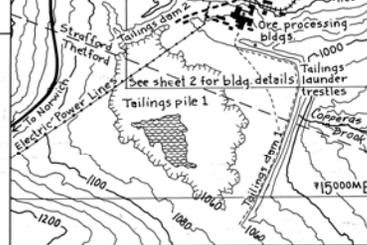
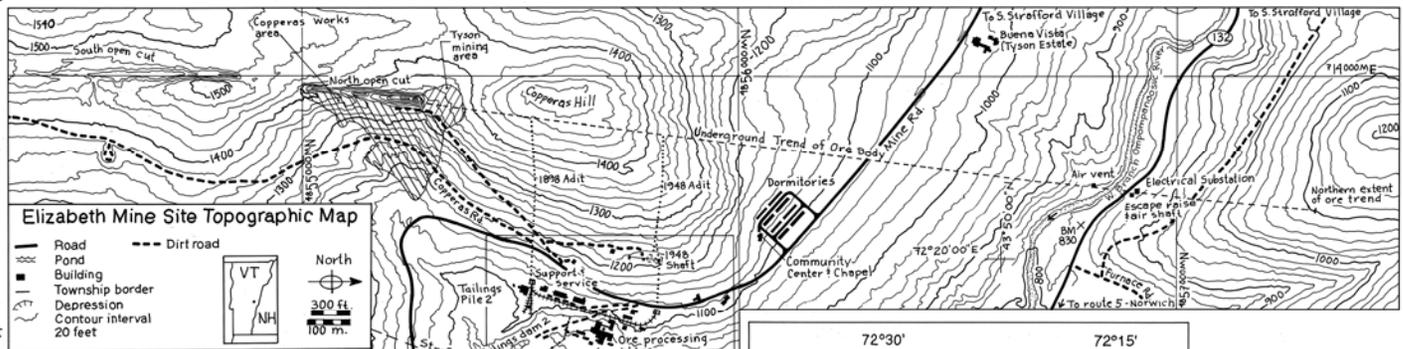
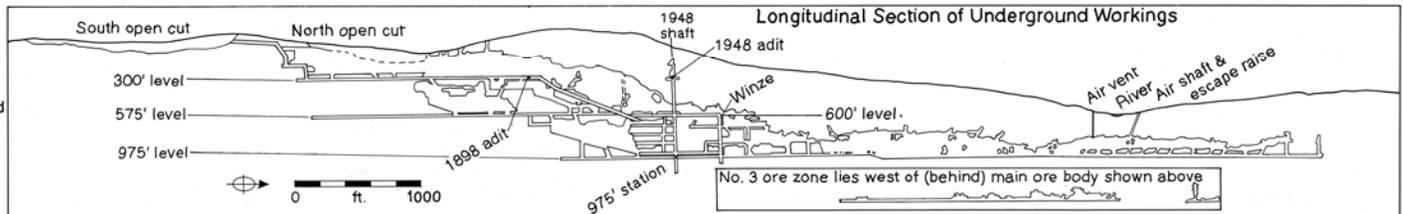
ELIZABETH MINE



The Elizabeth Mine is the southernmost mine in the 20-mile long Orange County, Vermont, Copper Belt, a series of copper-bearing Appalachian Sulfide-type ore deposits that includes the Ely Mine at Vershire and the Pike Hill mines at Corinth. The Elizabeth Mine ran almost continuously from 1809 to 1958, and produced the highest tonnage of copper of the three mines. It was also an important domestic source of copperas, an iron sulfate chemical, from 1809 to 1882. Copper was smelted on site in several brief campaigns between 1830 and 1919. The mine was most productive between 1943 and 1958 when it was revived using modern technology. After entry into World War II the U.S. government assisted development of the Elizabeth Mine as a strategic source of copper. The Vermont Copper Company, Inc., organized in April 1942, was awarded a contract with the Reconstruction Finance Corporation, and reopened the mine. The project included building a twelve-mile paved highway, miners' housing, and restoring an 1898 mine entrance. The Galigher Company of Salt Lake City, UT, built the core complex of ore processing and support buildings on Mine Road. Underground mining resumed in spring, 1943. The ore was concentrated on site, trucked to Norwich, VT, and sent from there by rail to a Phelps-Dodge Copper Co., smelter at Laurel Hill, Long Island, NY. After the war, productivity was hampered by low ore volume and technical problems, and the mine did not turn its first profit until 1949.

Underground mining methods were changed to increase output, and milling equipment was improved to handle more ore and extract more copper. Surface ore from the South Open Cut and old ore dumps supplemented underground ore. In 1950 the mine reached a production high of 7 million lbs., which coincided with a rise in price and demand for copper during the Korean War. Efforts to exploit other values in the ore took place in 1952, when sulfur shortages prompted installation of equipment to extract 25,000 tons per year of pyrrhotite (iron sulfide) from mill tailings. This material was purchased by the Brown Paper Company of Berlin, NH, which extracted sulfur for treating wood pulp. Ultimately matching and tuning of mining practices and processing equipment resulted in a production peak of 800 tons per day, and exploitation of the iron byproduct added to profits. Prices fell after the Korean War, but U.S. Government contracts kept the mine operating. In June 1954, the mine was purchased by Appalachian Sulphides, Inc., a Canadian mining company. The mid-1950s were highly productive years. Annual production exceeded 8.5 million lbs. in 1954 and 1955. Employment reached a high of 220 and sales exceeded \$3 million. However, by 1956, as underground workings progressed north of the Ompompanoosic River, the grade and quantity of ore diminished. Copper was in oversupply and prices fell from a 90-year peak. In February 1958, Appalachian Sulphides closed the Elizabeth Mine in favor of reopening a similar copper sulfide mine at Ore Knob, NC. When the Elizabeth Mine closed underground workings extended approximately 7,500 ft and included about 5 miles of tunnels. Between 1946 and 1956 the mine was among the top 25 copper producers in the U.S. The 1943-1958 mining campaign yielded approximately 91.5 million lbs. of copper, and total lifetime output for the Elizabeth Mine is estimated at over 100 million lbs.

Consult the Appendix for the Narrative Report for source credits for all 4 drawings



HISTORIC AMERICAN ENGINEERING RECORD
 SHEET #4
 VERMONT COPPER COMPANY, INC. ELIZABETH MINE 1942 - 1958
 STRAFFORD, THE FORD TOWNSHIPS, ORANGE COUNTY, VERMONT
 DATA COMPILED BY MATT KERPSTEAD, INDUSTRIAL HISTORIAN,
 PUBLIC ARCHAEOLOGY LABORATORY, PAWTUCKET, RI
 ILLUSTRATED BY DENNIS O'BRIEN, ILLUSTRATOR, MYSTIC, CT 03250
 ELIZABETH MINE RECORDING PROJECT
 UNDER THE AUSPICES OF THE VERMONT HISTORICAL SOCIETY
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ELIZABETH MINE

Mine Plant Buildings

The center of 1942-1958 operations was the complex of World War II-era buildings on Mine Road, constructed to wartime emergency standards and of functional design.

1898 and 1948 Adits: horizontal entrances for electrified underground mine cars for transporting miners and ore.

1948 Shaft: vertical shaft serving the 1948 Adit and descending to the 975 ft level. An electric hoist raised and lowered men, ore, and equipment in three separate shaft compartments.

Office/Warehouse Building: main administrative building for the mine. Housed the receptionist, secretary, geologists and mine engineers; also a warehouse for mine equipment.

Assay Laboratory: for analysis of ore from the mine and concentrating process to control mining and flotation chemistry to maximize efficiency and copper concentrate production.

Machine Shop/Workshop: equipment maintenance and repair shop for the mine. A mine car spur track led into the building, providing service for underground equipment. A blacksmith forge and machine tools made the mine self-sufficient for most needs.

Compressor Building: supplied compressed air for pneumatic rock drills and equipment.

Change House: where mine employees changed into waterproof clothing and steel-toed boots, picked up helmets with lamps, and showered at the end of their shifts.

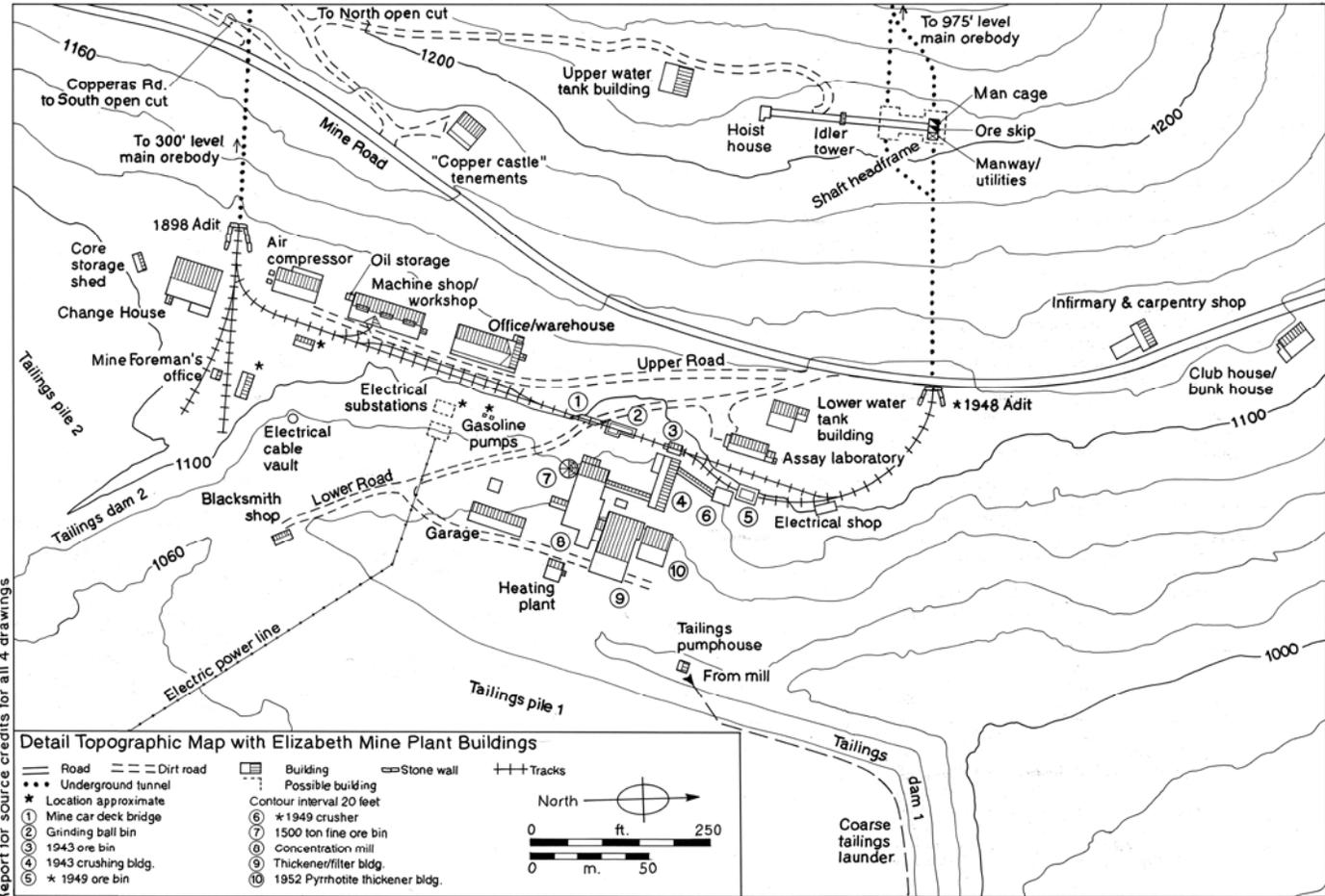
Crushers: for breaking ore into smaller pieces before it was conveyed to the ore storage bins.

Concentrating Mill: where crushed ore was finely ground and separated into concentrate and tailings by a flotation process. Copper tailings were pumped to Tailings Pile 1.

Thickener/Filter Building: contained equipment for removing water from ore concentrate and bins for storing it before shipment to the smelter.

Pyrrhotite Thickener Building: housed the thickener for pyrrhotite processing. Pyrrhotite tailings were pumped to Tailings Pile 2.

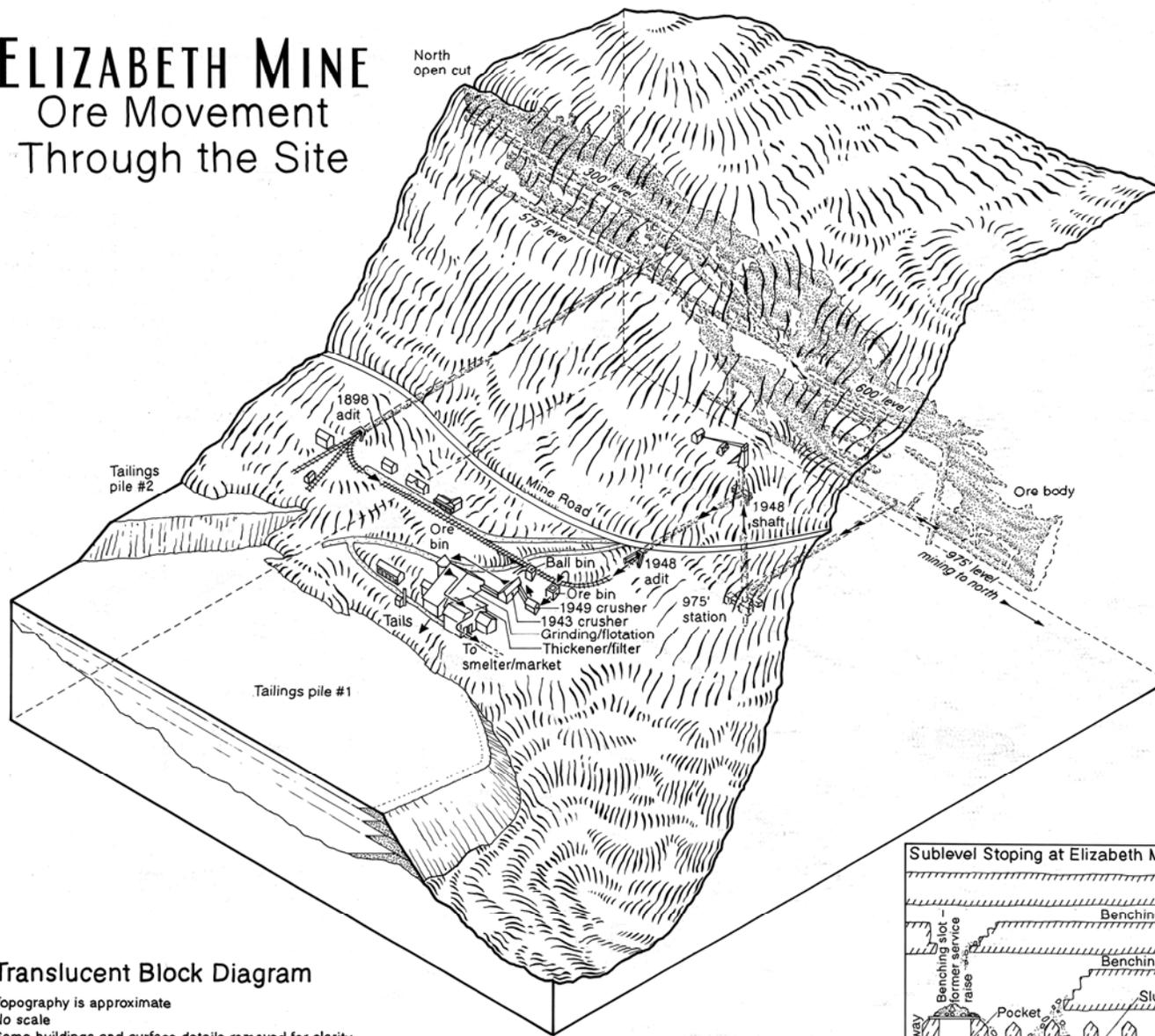
Water Tank Buildings: sheltered large heated tanks supplying water to the Concentrating Mill. A water level indicator board was located outside each building and was visible from the Mill.



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ELIZABETH MINE

Ore Movement Through the Site



The Elizabeth Mine orebody is a north-south trending deposit that plunges north and dips east. It was first surface mined from the North Open Cut, and then underground via a series of shafts and adits (tunnels) to the north. Mining progressed north and deeper along a series of longitudinal levels, numbered in feet of depth below the surface at the North Open Cut.

In 1943 underground access to the orebody was via the 1,360 ft long 1898 Adit, which met the ore at the 300 ft level. This adit was enlarged and a room blasted for a hoist to pull mine cars up an 830 ft long inclined tunnel from the 575 ft level. During the 1940s mining progressed north and south of the 1898 Adit. By 1948 hauling ore almost 2,000 ft to the 1898 Adit had become inefficient. Exploratory drilling revealed large quantities of ore extending to the north. In 1948 a new adit and shaft were constructed to efficiently reach this ore. The 1948 Shaft descended to the 300 ft level where it met the new adit and continued down to the 975 ft station, where a tunnel extended west to the orebody. At the 975 ft station mine cars dumped ore into a skip hoist for the trip up the shaft to the 300 ft level where it was transferred to mine cars bound for the crusher.

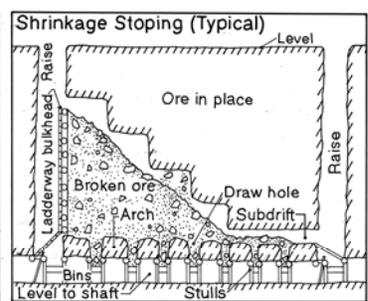
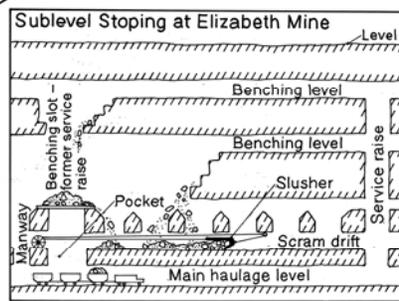
The new workings allowed major production increases. By 1954, mining had progressed south to the area under the North Open Cut, and north almost to the Ompompanoosuc River. A 3,000 ft long secondary ore zone was discovered west of the main orebody and mined via a 150 ft long crosscut. Secondary ore shoots in the zone west of the surface plant were mined from below via the 575 ft and 975 ft levels. By 1958, when the mine closed, underground mining extended to a point 1,600 ft north of the river, about 200 ft below the riverbed.

Mining was mechanized, using compressed air and electrically powered scrapers, loaders, locomotives, and ore cars. Mining followed two methods depending on configuration of the orebody. In sub-level stoping blocks of ore were mined in horizontal benches from the bottom up, supplying a constant flow of freshly broken ore. In shrinkage stoping mining progressed upward leaving broken ore to oxidize, which interfered with the milling process. Ventilation was provided by a fan in the 1948 shaft, and additional vent pipes and an air shaft were sunk near the river.

Translucent Block Diagram

Topography is approximate
 No scale
 Some buildings and surface details removed for clarity
 → Flow of ore
 ↖ North

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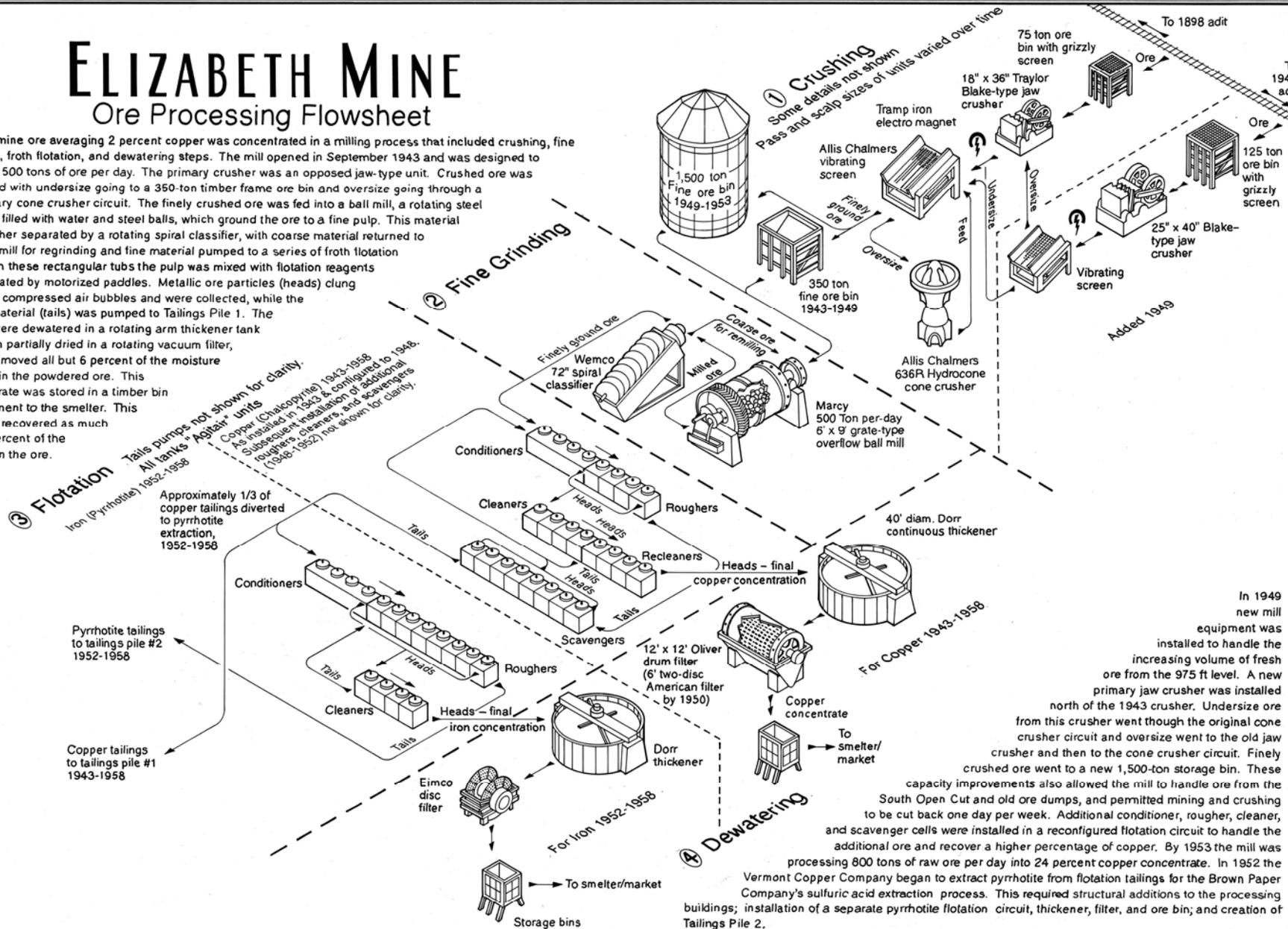


DRAWING BY: DENNIS O'BRIEN, ILLUSTRATOR, MYSTIC, CT. 12/2008. DATA COMPILED BY MATT KIERSTEAD, INDUSTRIAL HISTORIAN, PUBLIC ARCHAEOLOGICAL LABORATORY, PAWTUCKET, RI.
 ELIZABETH MINE RECORDING PROJECT
 SOUTH STRAFFORD - STRAFFORD/THE FORD TOWNSHIPS - ORANGE COUNTY - VERMONT
 SHEET 3-4
 HISTORIC AMERICAN ENGINEERING RECORD
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ELIZABETH MINE

Ore Processing Flowsheet

Run-of-mine ore averaging 2 percent copper was concentrated in a milling process that included crushing, fine grinding, froth flotation, and dewatering steps. The mill opened in September 1943 and was designed to process 500 tons of ore per day. The primary crusher was an opposed jaw-type unit. Crushed ore was screened with undersize going to a 350-ton timber frame ore bin and oversize going through a secondary cone crusher circuit. The finely crushed ore was fed into a ball mill, a rotating steel cylinder filled with water and steel balls, which ground the ore to a fine pulp. This material was further separated by a rotating spiral classifier, with coarse material returned to the ball mill for regrinding and fine material pumped to a series of froth flotation tanks. In these rectangular tubs the pulp was mixed with flotation reagents and agitated by motorized paddles. Metallic ore particles (heads) clung to rising compressed air bubbles and were collected, while the waste material (tails) was pumped to Tailings Pile 1. The heads were dewatered in a rotating arm thickener tank and then partially dried in a rotating vacuum filter, which removed all but 6 percent of the moisture content in the powdered ore. This concentrate was stored in a timber bin for shipment to the smelter. This process recovered as much as 95 percent of the copper in the ore.



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DATA COMPILED BY MATT KIERSTED, INDUSTRIAL HISTORIAN,
PUBLIC ARCHAEOLOGICAL LABORATORY, PAWTUCKET, RI

VERMONT COPPER COMPANY, INC. ELIZABETH MINE 1942 - 1968

SOUTH STRAFFORD STRAFFORD THE FORD TOWNSHIPS ORANGE COUNTY VERMONT

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DESIGNED BY DENNIS O'BRIEN, ILLUSTRATOR, MYSTIC, CT. 19 2003

ELIZABETH MINE RECORDING PROJECT

UNIVERSITY OF VERMONT DEPARTMENT OF THE ENVIRONMENT

HISTORIC AMERICAN ENGINEERING RECORD SHEET 4-4