MILESTONE HERITAGE CONSULTING

Technical Memorandum
Ely Copper Mine Site Remediation
Vershire, Vermont

Section 106 NHPA Compliance Support:
University of Vermont Archival Research
July 4, 2015
Milestone Report No. 0007

Submitted to:
Nobis Engineering, Inc.
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Concord, NH 03301

Introduction

Nobis Engineering, Inc. (Nobis) is assisting the U.S. Environmental Protection Agency (EPA) with environmental remediation (“cleanup”) at the historic Ely Copper Mine site (Site) in Vershire, Vermont. The Site includes mine entrance shafts and adits (tunnels), some of which drain water from the underground mine workings. Associated contaminated groundwater and surface water discharges pose unacceptable human health or environmental risks. Nobis has conducted investigations including drilling and sampling to determine the level and characteristics of the water that has filled the mine workings ("mine pool") as part of efforts to identify and evaluate appropriate remedial alternatives. Nobis requested that Milestone Heritage Consulting (Milestone) conduct focused background research in several potentially applicable archival collections held by the University of Vermont's Bailey-Howe Library, Special Collections in order to identify information that could potentially inform investigations, specifically information about historic water accumulation and/or pumping rates/capacities, equipment, etc. This Technical memorandum presents the results of that research.

Materials Consulted

Based on preliminary review of the finding aids available online and/or from Special Collections staff, Milestone conducted research in the following manuscript collections:

- Vermont Copper Company Collection (MSS.942): Cartons 4 & 5, bound volumes 1 through 4, and maps 1 through 3.

- Collamer Abbott Collection (MSS.191): Cartons 1, 5, 12 through 14.

- Copperfield Mine Records (no MSS#): Cartons 1 & 3, Sketch 1 (oversize)

Results

The research did not reveal any definitive "smoking gun" information stating specific water inflow or pumping rates. Several items in reports and correspondence indicate the mine was considered a dry one, that there was some minor inflow from the surface and fissures in the rock, that the mine flooded and was pumped out several times after periods of inactivity, and options for pumping methods were considered. This archival information may contain enough data to extrapolate some flow rate characteristics.

General indications are that the Ely Mine was a relatively dry one. According to George Perkins' 1901-1902 *Report of the State Geologist...*, at Ely: "Very little artificial support is required and the mine is free from the seepage of waters." According to F.M.F. Cazin's 1882 *Report on the Property and Business of the Vermont Copper Company*, "The mine may be virtually called a dry one, notwithstanding its depth of over 1,000 feet vertically, because no pumps are required, and a few cars of water every twenty-four hours exhaust the small seepage into the mine." That same report indicates that mine hoisting in the Main Shaft "is done by wire rope in iron cars carrying nearly two tons each." It is unknown if the cars indicated for hoisting water were the same ones used for hoisting ore or what the dimensions of those cars were.

A transcription of an *Annual Report of the Copperfield Mining & Smelting Co*. dated March 1891 authored by President and General manager Otto Krause indicates that a pumping plant was installed in 1890 but rotten timbers and rock falls inside the mine interfered with the pumping program. In 1891 the mine may have been idle without pumping as far back as July of 1883. The report states that "After thirteen months steady pumping with two Blake's Duplex plunger pumps, 12X4X12, the bottom was finally reached in July and the inclined shaft measured 2,450 feet on the dip from the main adit or landing [Main (1861) Adit]" [The shaft was sunk deeper during subsequent mining]. "There is hardly any water now collecting in the mine except some drippings from the surface and from crevices, all of which is easily checked by say, one-half day's pumping every three weeks. "

A November 24, 1899 "Memorandum in the Matter of Unwatering Mine at Copperfield, VT" includes discussion of options for again pumping out the Ely Mine, including cable hoisting water in a dedicated water hoisting tank, electric pumps, steam pumps, or compressed air pumps. At this time the mine may have been idled as far back as 1893. This memorandum includes discussion of various pumping capacities that may or may not reflect actual conditions or requirements. This letter includes a cross section sketch of the mine workings looking west showing a proposed electrical pumping system including 75 hp pumps at three underground pumping stations at 400 ft intervals. The sketch indicates that in November 1899 the mine pool water level was just above a point 400 vertical (not on the diagonal incline) feet below what can be inferred to be the Main Adit ("landing") level (see attached memo and sketch at end of this Technical Memorandum).

A January 13, 1900 letter from Westinghouse, Church, Kerr & Co., Engineers to William J. Knox indicates that installation of steam pumps of between 100 gallons per minute (gpm) and 200 gpm would have been satisfactory (see attached).

An undated "Mine Machinery" inventory from an *Inventory of Machines* for sale when the mine finally shut down in 1905 includes: "2 large Blake Mine Pumps [presumably serial numbers] 25279 +80 and 27298, one in mine and one at smelter machine shop. Both old pumps and worth about $250. ea[ch]." No cylinder dimensions or capacities were given. The different pump locations may indicate that only one pump was needed to pump water from the mine and the other was retained and stored as a spare.

Mine Openings Considerations

Review of Herman Rittler's 1859 *Report on the Mine and Property of the Vermont Copper Mining Company* and its plan and section figures indicates the potential presence of surface and subsurface mine workings now either buried by mine waste or not visible from the surface that may need to be considered in planning for mine waste removal by heavy equipment. Rittler indicates for the Deep Adit ("Adit h") a total length of 360 feet from the mouth, with a distance from the mouth to the Burleigh Shaft ("Shaft III") of 175 feet. At the Burleigh Shaft, Rittler's map and discussion indicate that "Near the north side of the shaft, the vein was stoped [removed from underground forming a cavity] by four stopes [presumably mined in four levels by overhand or underhand stoping] to the north for about seventy-five feet. The south corner of the shaft, on the surface, was also stoped." The latter stoping may be the surface depression visible immediately south of the shaft. Rittler's section diagram (and subsequent 1940s USBM illustrations) suggest the underground stoping north of the shaft came close to the surface. This area is now covered in mine waste. It is unknown whether the roof of this stoped out area has collapsed and filled with mine waste, or is still intact over the stopes. An area at least 75 feet north of the Burleigh Shaft entrance may need to be treated as an exclusion zone for heavy equipment.

According to Rittler, at the 1850s Pollard Adit (opening "e"), "an opening of sixty [or "fifty"] feet was driven, and Adit 2 is extended nineteen feet ["21 degrees northwest"] in length." This suggests that the current mine waste may be filling a 50-60 ft long bedrock trench with a 19 ft long adit extending northwest at its northern end.

Preliminary

MEMORANDUM IN THE MATTER OF

UNWATERING MINE AT COPPERFIELD, VT.

NOVEMBER 24th, 1899.

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TANK METHOD

1. If tank method employed, hoisting apparatus would not be available for handling ore, falls, track repair or other material, except by interruption of unwatering operations and then only at inconvenience and delay in changing from tanks to cars.

2. With more than one tank much difficulty would presumably be encountered from falls, condition of track under water, etc., thus greatly reducing capacity.

3. Average round trip, hoisting method, about 4200 feet, made in not less than 7 minutes, with no delays. Could not count on less than 14 minutes average trip, allowing for starts, stops and delays.

At Susquehanna mine, pair 26" x 60" engines hoisted five coal cars weighing 20 tons loaded, maximum incline being 20 degrees. Speed not stated. Bowden's paper (Transactions A.I.M.E. Oct.'91) indicates three tanks holding 22 1/2 tons water exclusive weights tanks, etc. Probable therefore that no more than three 2000 gallon tanks were used.

Engines at shaft house are pair 20" x 42" and ratio to Susquehanna engine equals 1 to 1.69. Therefore speed, maximum incline, etc., being equal Copperfield engines hoist $\frac{6000}{1.69}$ = 3550 gallons per trip by comparison.

This with 14 minutes average round trip equals 250 gallons per minute and would require two tanks of about the size used at Susquehanna mine. If found impossible to use more than one tank on account condition of mine, rate would probably not exceed 100 gallons per minute at most, allowing for delays, due to difficulties and other operations. One hundred gallons per minute equals approximately 4.3 millions per month.

4. Could probably begin unwatering somewhat sooner by tanks than other methods, though new boilers, stack and some piping required, also adequate provision for feed water supply at shaft house.

ELECTRIC PUMPING

1. Proposed to pump 400 gallons per minute using eventually three pumping stations, each under 400 feet head. Four hundred gallons, per minute equals 17.28 million gallons per month, and each pump would require about 75 H.P. motor.

2. Necessary on account of present water level to start with two pumps. Therefore not feasible to use smelter engine temporarily with low pressure steam to furnish power for initial pumping, although this was considered when level of water was understood to be higher.

3. Electric pumping permits mining operations and repairing to be undertaken without interfering with unwatering;- greatly increases the rate of pumping; will provide light in the shaft, and be available for various purposes after mine is unwatered.

4. Copper cost; 180 K.W. generator, 85% power factor, as follows

(a)	Generator at smelter, 1100 volt,	\$3287.	\$3287.
(b)	" 2000' nearer shaft, 1100 volt,	2272.	
(c)	" at smelter, 2200 volt,	____	1393.
	Difference =	\$1017.	\$1896.

One 180 K.W. generator, 1100 volt, on hand at W.E.& M.Co. This could be rewound for 2200 volts in about 35 days at cost of approximately \$200. Therefore it would pay to have this done. Above figures are for high tension copper only and ~~are~~ merely for comparison. Costs cover use of lead covered wire in shaft.

STEAM PUMPING

1. Except at reduced capacity as compared with electric pumping, steam pumps would require increased boiler capacity at shaft house and pumps of dimensions difficult to handle in mine. The large quantity of steam required would need to be condensed in order to make mine tenable and even then would be liable to be objectionable.

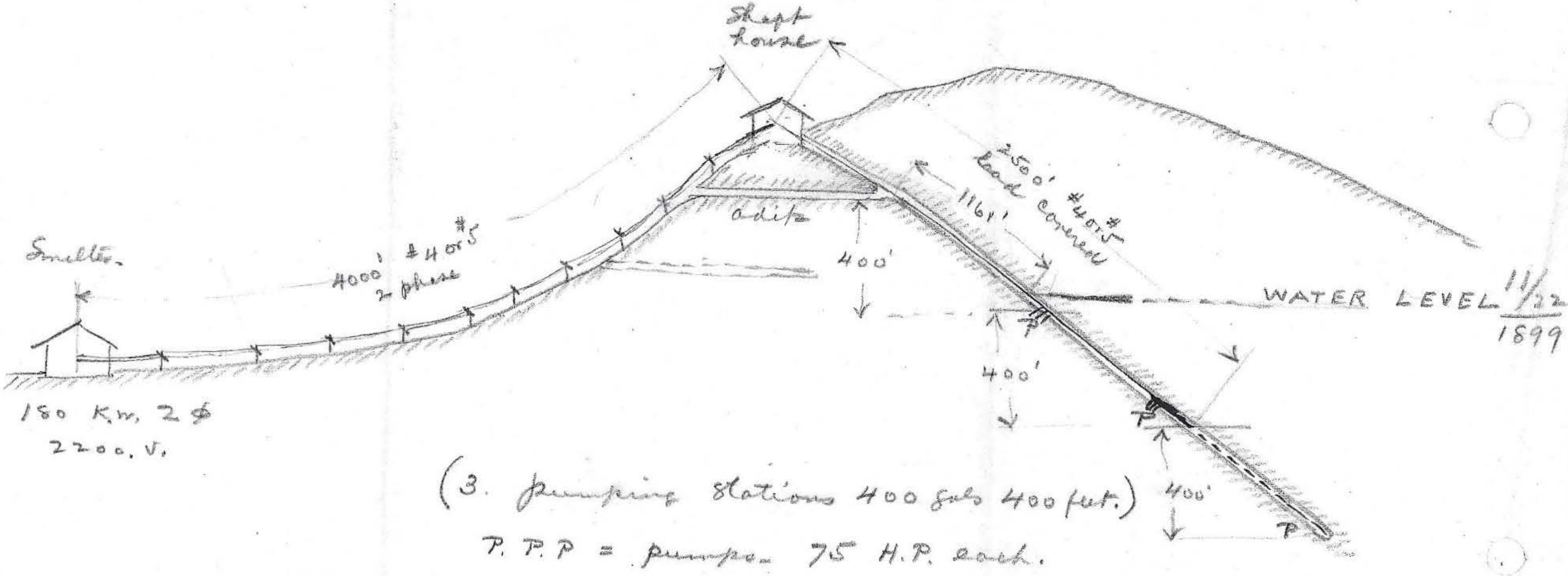
2. This method would involve considerable expense for pumps/ boilers, piping, etc., and was discarded in view of expectation that electricity will be largely used for general purposes on the property.

AIR PUMPING

1. Use of compressed air (reheated) instead of steam in pumps has been considered but discarded on account of reduced pumping

capacity possible with present compressor capacity, as compared with electric pumping.

2. Pöhle air lift not regarded as good for high lifts with inclined piping on account separation of air and water under these conditions.


Shaft house
Smelter
4000' #4 or 5
2 phase
adit
400'
2500' #4 or 5
lead covered
1164'
WATER LEVEL 11/22/1899
400'
400'
P
P
P
180 Kw, 2 φ
2200. V.
(3. pumping stations 400 gals 400 feet.)
P. P. P = pumps 75 H.P. each.

WESTINGHOUSE, CHURCH, KERR & CO.
INCORPORATED.
Engineers.

H. H. WESTINGHOUSE, PRESIDENT.
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WESTINGHOUSE B'LD'G, PITTSBURGH.
UNION TRUST B'LD'G, DETROIT.

Boston, U.S.A. Jan. 13, 1900.

Mr. Wm. J. Knox,

c/o George Westinghouse, Esq.

Pittsburg, Pa.

Dear Sir:-

Replying to your letter of the 11th would say that we are planning to install the induced draft plant in such a way that it may be permanent if desired. With reference to capacity of boiler plant would say by whatever pumping method the mine is unwatered the boiler capacity will be limited. If the three boilers are forced hard, say to double their rating they would generate sufficient steam to run the present air compressor on an average of about one half of its normal capacity; to operate compound steam pumps for pumping 100 gallons per minute against a vertical head of 1200 feet and to operate the hoisting engines at roughly 60% of their capacity.

The above is not however a complete statement of the case for the reason that much of the service varies, that of the hoisting plant particularly being intermittent. At the outset the work of hoisting will be relatively light owing to present condition of the track and slope and to the delays incident to the necessary repairs and improvements. Steam will therefore be released for pumping purposes to such extent as hoisting capacity cannot be utilized, but on the other hand pumping will be done against comparatively low heads during the earlier stages, thus permitting an increase in the rate of pumping, with a given boiler capacity, that would not be possible during the later stages when the water will have to be pumped against greater heads and when the condition of the track may be assumed to be such that hoisting work can be carried on to a much larger extent than at first.

This statement will obviously hold true of whatever method of pumping is employed. If the present air compressor is operated to its full capacity for air drills only, about 2/3 of the forced boiler capacity would be available for hoisting and pumping. The extent to which delays and down trips will cause the boiler H. P. required to "average" below the power required for hoisting will depend so largely upon conditions of service that it can only be a matter for conjecture.

From present indications the chances are that if present air compressor is used entirely for drill work that the limitations in hoisting would allow pumping to be carried on at a minimum of 100 galls. per minute. This rate would be increased to such extent as steam might not be required for other purposes, and our expectation has been to provide pumping apparatus having a capacity of about 200 galls. per minute in order that advantage might be taken at times of surplus steam and during the earlier stages of pumping to increase the flow.

We had not expected that the entire capacity of the present compressor would be required for operating drills, but if so, we assume that it would furnish sufficient air for mine ventilation and remove this factor from consideration in connection with the pumping. If so there is a question whether an additional air compressor could be installed at the present time to advantage. If used in connection with the pumping it would involve additional transformations of energy of a doubtful value, and if installed now in anticipation of future needs might unnecessarily prejudice permanent improvements in the direction of doing more work at the shaft house than we have felt was wise.

We have therefore made no estimate of cost or installing additional air compressor, but this would probably be in the neighborhood of $3000. Unless therefore it was of immediate need in connection with mining operations or manifestly desirable for unwatering the mine we would be inclined to defer installation until other plans which we understand to be still in abeyance can be perfected.

The cost of pumps, piping, etc. in the shaft would not vary so much either method, but what the entire cost of installaing a new compressor would be extra, and provided the old compressor, supplying air to drills or otherwise, will adequately ventilate the mine and provided also that a rate of pumping varying from 100 to 200 galls. per minute will be satisfactory, ~~that~~ the use of direct acting steam pumps will probably be the simplest and best method of unwatering the mine.

If however it is your intention to at once install another compressor, use could doubtless be made of it in connection with a portion of the pumping operations, but the extent to which water could be thus handled would depend so largely upon combination of circumstances that we do not feel that the subject is susceptible of a more exact statement than the general one above indicated, namely, about 100 to 200 galls, per minute according to circumstances.

We note what you say with reference to straightening and re-laying track, also about unwatering of mine. We are doing nothing about either and await your further advices.

Yours truly,

Westinghouse, Church, Kerr & Co.

M-

Henry J. Cossant

I expect to be in N.Y.
next week H.J.C.