

BONANZAS & BORRASCAS – A COMSTOCK MINING HISTORY

[I]

The Business Of Mining:

Types of Mills, Economics of Milling, Mills Owners & Operations

Scores of mills were built and rebuilt in Story County and adjacent counties to process the 7 to 10 million tons of extracted ores from the Lode between 1865 and 1885. In the early 1860s so-called custom or independent millers set up shop on the Comstock. Mine owners being preoccupied with establishing their underground operations often lacked both the capital to build their own refineries and the skill to operate them. Millers found themselves in the envious position of being able to dictate the terms of the contracts even though milling capacity soon exceeded demand. Over time, as mining companies became better established, they had reason to try to bypass the custom mills and to construct their own mills. The mills became an extension of the mining operations, and in the annual statements of the mining companies the cost of refining ore was treated, like extraction or transportation or administration as another cost of doing business. The problem for mining companies with their own mills was that they had a shortage of milling capacity when their mines entered a highly productive period and conversely they had an excess of milling capacity when expansion in output turned to contraction. Both could be costly in that inadequate capacity could lead to investment in plant and equipment that may not be justified over the long term and idle capacity could lead to higher fixed costs and lower returns on capital. Both theoretically could dilute profits and threaten dividends. Since mining companies could not predict with certainty how much refining capacity that they would need a year or two later they constantly ran the risk of having too much or too little milling capacity. One strategy to moderate the risk was for mining to create stand-alone milling companies that were not strictly dependent on the output of their own mines. Ideally an independent milling company set up by a mining company could offer in-house milling services for all the mines that the company owned and custom milling for those companies that lacked mills with the hope of smoothing out fluctuations in production that even the best mining operations could not avoid. But there is a somewhat more nefarious reason was behind these undertakings. The mining companies had discovered that by divorcing milling from mining operations they stood to profit from both businesses. (Railroads, of course, followed a similar tack in creating railroad construction companies separate from the railroads themselves.) Milling companies were usually organized as partnerships among the founders or principals or as corporations with the founders as the major stockholders and a few other associates or friends as minor stockholders. If milling-company stocks traded on the San Francisco Exchange they attracted little attention. Even though they could be profitable, they depended for their financial success on the state or health of the mining industry and more particularly on the mines in which their principals had a role. As stand-alone companies they probably had little appeal at the stock traders. Moreover it is not clear that the founders of the milling companies really wanted to share milling profits with an investor public or needed an investor class to finance their operations. Despite the rationale that independent mills could secure their financial footing by shopping around for business from all mining companies, the best performing milling companies were associated with highly productive mining operations. When the mines were on the

upswing, the mills made money, and conversely when the mines in contraction, the mills were sold or abandoned. In the end milling remained tightly linked to the health or state of mining. What the creation of large quasi-independent milling companies succeeded in doing was pushing down milling costs without destroying their potential profitability. Truly independent mills in the mold of the original custom mills did not disappear but were moved to the periphery of the milling business.

It would be useful to present a modest discussion of milling technology, as it had evolved by the second half of the nineteenth century, before tackling the financial issues involved in the mill operations. Spanish colonial miners soon discovered that much of the silver ore that they extracted from underground could not be smelted economically. Smelting worked best when silver ore contained a base metal like lead. The lead acted as a flux. Under high temperatures the lead and silver particles fused, and then again since lead had a lower melting point intense heat would be applied to separate the silver and the lead. These were often referred to as high-grade silver ores because the natural presence of the lead flux made “cooking” the ore economical and efficient and resulted in silver of high quality (fineness and purity). The great discoveries at Zacatecas and Potosí contained silver ores in combination with other minerals that did not readily lend themselves to smelting because of the cost of purchasing flux, firewood or charcoal and other ingredients. These less smeltable ores came to predominate, and without a different technology for recovering the silver the grand camps of Zacatecas and Potosí would have had a much-diminished mining history. As unsmeltable ores piled up around the entrances to the mines and near the smelting facilities the search for alternate refining techniques became intense. The prize went to Bartolomé de Medina, a Spaniard who was working in Mexico. He developed an ore-reduction technology based upon amalgamating the ore with mercury or quicksilver rather than smelting it. Although used since ancient times amalgamation had few practitioners. In the method that Medina fashioned the ore after being pulverized and washed was incorporated with mercury in an open, walled space that resembled a patio. In Spanish America Medina’s technology became known as the patio process. Over a period of many weeks or several months of stirring the soup silver (and gold) amalgamated with the mercury. The amalgamated ingredients were removed from the patio and transferred to a small furnace where the heat would evaporate the mercury and leave the silver. Over time other minerals were added to the mixture to speed up amalgamation along with adaptations to the furnaces to try to capture the evaporating mercury, but the basic technology remained unchanged into the nineteenth century. Spanish colonial miners and millers proved to be resistant to major innovations that some mining professionals recommended in part because of the cost to alter their plant and equipment and in part because of the familiarity and predictability with the existing techniques. As would be true of refiners on the Comstock and in other Western mining camps some refiners in Spanish America proved to be more skilled than others in pulverizing the ores, incorporating the mercury and insolating the silver. It was also true that the quality of the mercury mattered (imported Spanish mercury was superior to local Andean mercury) as well as the type of ore (Mexican ores tended to be richer than Peruvian ores). When western mining established itself miners and millers embraced

amalgamation but chafed at the inefficiencies that the Spanish-American system entailed.¹

Since mining was new to Western United State, the opportunity existed for miners and millers to be more innovative. Milling operations were frequently discussed in local newspapers and scientific journals, but documents concerning operations seldom show up in company archives. Part of the explanation for the absence of documentary evidence is that, as more and more milling operations were spun off into private companies, mining companies were under no statutory requirement to report on milling operations except to report what they paid for milling their ores. In the early years there was considerable interest in the founding and building of the mills because it was less than clear how or where the Comstock's ores would be processed. Once the initial flurry of activity relating to the construction of the plant and the design of the equipment ended toward the middle of the 1860s many decisions about the most efficient methods for reducing the ores had become standardized. The Comstock would witness the erection of newer mills or the renovation of older mills with ever-increasing capacity into the middle of the 1870s with much less debate and experimentation concerning milling techniques because the procedures and protocols were fairly well understood. From the earliest days, as noted above, Comstock miners knew that their ores could not be efficiently smelted. They turned instead to reduction through the patio process, but they were dismayed at the time required to complete the operation. The search was for a way to speed up amalgamation of the silver and mercury. Eliot Lord correctly observed that colonial Mexican miners had developed techniques for shortening the time required to complete the amalgamation that involved grinding the ore as finely as possible, adding mercury, salt and water until it became a "pasty" mixture called pulp, transferring it to a copper kettle where it was boiled, stirred and tested for four hours or more and finally after amalgamation had been determined to have occurred removing it to large basins or vats of water that washed away the slime or residue and left the amalgam. While these and other techniques were known to late colonial miners, they were not widely accepted because of the cost of the equipment or the scarcity of the ingredients. By the nineteenth century, however, many Mexican mills had introduced these modifications.² What held back colonial Mexican millers was not relevant to late nineteenth century Comstock milling. Almost every aspect of the amalgamation process was open to modification and improvement. From the material and mechanization of the batteries and the stamps to the size and number of the amalgamating pans, from the addition of agitators to the collection of slimes every step was scrutinized to see how the processing of ore could save time and money. Both Lord and DeQuille consider the contributions of early millers like Almarin Paul, Israel Knox and Henry Brevoort and various superintendents who proved to be ingenious at

¹ Numerous sources could be cited relative to Spanish American mining and milling. A good overview is Peter Bakewell,, "Mining in Colonial Spanish America," in Leslie Bethell, ed., *The Cambridge History of Latin America, The Colonial Period*, 2 vols. (Cambridge: Cambridge University Press, 1984), 2: 113-119.

² See Lord's discussion of these improvements based upon his reading of Francisco Gamboa, *Comentarios a las Ordenanzas de Minas...* Eliot used the Heathfield translation. These references will found in vol. 2, pp. 200-203. There are several monographs on the history of ore reduction in colonial and modern Mexico. One of the most thorough (in Spanish) on the developments summarized by Eliot is Modesto Bargalló, *La minería y la metalurgia en la América española durante la época colonial* (Mexico, 1955).

applying and reworking the new ideas.³ What converged from the efforts of these tinkers and experimenters was something called (almost generically) the Washoe Process. In short it transformed the patio process of many weeks into a mechanized process of a few days. When Mackay and Fair through Pacific Mill and Mining built (and rebuilt) their new mills – Consolidated and California – in Virginia City between 1874 and 1876, they employed the Washoe Process only on a grander scale than any other miller had. It is worth noting that Eliot Lord's *Comstock Mining and Miners* included illustrations of mills, their interiors and their mechanics that are well worth studying. A set of 10 drawings of the interior of the Gould & Curry mill is especially noteworthy (between pp. 126 and 127). These illustrate the scope of the mill and the extent of mechanization that had infused the milling business only a few years after the discoveries. One can imagine that if drawings of the Mackay and Fair's mills had been rendered a decade later the result would even have been grander.

The Surveyor-General's 1866 report offered an extensive inventory of Comstock milling facilities and operations⁴. It included names of owners, locations of mills, construction costs, tax assessments and numerous details about capacity, equipment supplies, etc. In the four counties – Story, Lyon, Ormsby and Washoe – surrounding the Comstock there were total of 77 mills. Story had the most with 33 mills or 43 percent; Lyon was second with 27 or 35 percent; Washoe had 9 or 12 percent; and Ormsby had 8 or 10 percent. The total cost to build these 77 mills, based on data given to the Surveyor-General, was \$5 million for an average cost of about \$65,000 per mill. Story County accounted for \$2 million or 40 percent and Lyon for \$1.4 million or 28 percent. Story was the only county that reported tax assessments on mill properties, and they amounted to \$954,000, a figure that was not the tax collected but the proportion of the value of the property (about 48 percent) against which property taxes were levied. Gould & Curry's mill, located in Seven Mile Cañon about two miles from its mine under Virginia City, probably was the most expensive mill to have been built up to that time with a price tag of \$380,000. The least expensive was Monitor near Dayton in Lyon County at \$6,000. These 77 mills had 1,400 stamps for crushing ore for an average of 18 stamps per mill. Again Gould & Curry's mill headed the list with 80 stamps, and Monitor plus several other small mills had only five stamps. The cost of construction per stamp was comparable in the largest and smallest mills: \$4,750 at Gould & Curry versus \$5,000 at Monitor. The 77 mills could process about 65,000 tons of ore monthly or 750,000 tons

³ Lord, *Comstock Mining and Miners*, 82-89; DeQuille, *A History of the Comstock Lode and Mines...* (Virginia, NV: F. Boegle, 1889), 74-79.

⁴ "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), Tables are inserts between p. 21 and p. 25 with notes about the mills on pp. 25-26. The following discussion is based on data and calculations from these Tables. In addition to his survey of plant and equipment Surveyor-General Marlette asked a few mining companies to provide him with financial data on milling operations. When mining companies used outside millers or organized their own independent milling companies to reduce their ores, their own mining accounts revealed very little about the cost of reduction. Except for small quantities of ore sold each year by miners to millers the amalgamated or refined ore remained the possession of the mining companies. Mining-company accounts normally showed how much the reduction cost per ton and not much else. Few milling accounts have survived if they ever existed, even when mining companies, whose records do survive, built and managed the mills themselves. Thus, inquiries such as those conducted by the Surveyor-General in 1866 offer a glimpse into a less well-understood economic sphere.

yearly. That was between two and three times more than the output of ore to be milled in 1866. The zeal to build milling facilities derived from the same economic fantasy that fed the drive to claim and exploit every acre of the Comstock.

One of the most grandly publicized of the early mills was constructed for Gould & Curry. In 1861 Gould & Curry undertook the construction of a small mill in the vicinity of Seven Mile Cañon, but then over the next two years as output from the mine grew it enlarged and refurbished the mill at a cost (allegedly) of nearly \$900,000. The reduction process that had been installed proved to be so inefficient that the new superintendent, Charles Bonner, in 1864 discarded it. Then another reconstruction was ordered at a cost of more than a half million dollars.⁵ By 1865 when Louis Janin jr. had replaced Bonner as superintendent Gould & Curry had spent more than \$1.5 million on the construction and reconstruction of this mill. In the 1866 survey the mill was estimated to have cost \$385,000, a figure that does not match up with any of the figures just cited. In any event after the second remodeling to install a “more traditional patio” process and under Janin’s leadership the efficiency of the mill improved. In 1865 the Gould & Curry mill reduced nearly 32,000 tons at \$12.93 per ton. This was a spectacular turnaround that began in November 1864. Before that it was alleged to have cost up to \$50 per ton to refine Gould & Curry’s ore in its own mill, and because of the high cost most of its ore was sent to custom mills, which charged on average \$26 per ton. Gould & Curry could no longer afford the extravagance in outlays for mill construction and ore reduction because the per-ton yields of its ores had dropped from extraordinarily high levels of \$70 to \$100 to \$30.⁶

In the same report with his survey the Surveyor-General published detailed financial data provided to him by Janin. He wrote that the “admirable system of accounts of expenditures adapted in the Gould & Curry and Savage office, is worthy of all commendation, and it is to be hoped, will be adopted by other companies.”⁷ Unfortunately while the efforts of Superintendent Janin and his staff represented an improvement over some earlier financial reporting, the excerpts that appeared in the Survey-General’s report have figures that do not always add up. Still Janin’s statement can be a useful point to start the analysis of milling operations. Gould & Curry finances showed that the mine produced 62,425 tons of ore with an average yield of \$28.64 per ton.⁸ Although he did not provide a total-dollar value, a simple calculation - tonnage x yield – would result in a bullion value of \$1.8 million. Even with expanded milling capacity, perhaps the largest of any Comstock mill, Gould & Curry assigned some ores to custom mills. Sixty-five percent or 40,432 tons were “worked” at the company’s new mill and 28 percent or 17,680 tons at custom mills. A portion of the total, 4,313 tons or 7

⁵ Lord, *Comstock Mining and Miners*, 125. Lord cited Annual Reports from 1861 through 1864 plus newspaper reports. Smith, *The Comstock Lode*, 85.

⁶ Lord, *Comstock Mining and Miners*, 128-129.

⁷ “Annual Report of the Surveyor-General...1866” in *State Journal and Appendix*, 3rd Legislative Session (1867), 30.

⁸ It was described as 3rd class ore without any further details. Ores could be classified in terms of their chemistry and purity but seldom were as just noted in superintendents’ reports. It would appear based on yields per ton that a 3rd-class ore had an average of slightly above average yield compared to all Comstock ores.

percent was unaccounted for. Janin made no reference to the disposition of the missing ore, whether it was set aside for later processing, was sold to other millers or was simply too inferior to be milled and had been scrapped. If per-ton yield were calculated more strictly on the basis of 58,000 tons rather than 63,000 tons, it would rise to \$33. Unfortunately the excerpted version of the Janin report contained no figures that would detail the cost to Gould & Curry of having ores reduced at customs mills. Of the 40,432 tons crushed at Gould & Curry's mill 36,001 tons or 88 percent were actually amalgamated. The remaining 12 percent or about 6,000 tons were lost in what were called "slimes and moisture in the ore". The slimes were not necessarily lost permanently, although a different process was required to unlock the minerals in them. It was an accepted practice to assay the ore in its "wet" or crushed form and then to assay it again in its "dry" or amalgamated form. For Gould & Curry the wet assays came in at nearly \$44 per ton and the dry assays at \$33 per ton. The \$33-per-ton figure matched up the figure above, although the bases for the calculations are actually different. The "so-called "loss" of about 75 percent from the wet to the dry was about average for the Comstock. But the breakdown between gold at 30 percent (\$364,000) and silver 70 percent (\$825,000) was somewhat below what other mines were reporting. This ratio will fluctuate from mine to mine and from area to area.⁹

The matter of "slimes" was a continuing concern to Comstock millers. As the ore was pulverized either by breakers or crushers, it was mixed with water into what Mark Twain called a "creamy paste". As this paste moved from the stamps into the amalgamation pans the water was drained off as slimes into wooden troughs and eventually into nearby pools or ravines. The slimes contained mud, rock, other metals and nuggets of gold and silver. Procedures for screening out the nuggets with course blankets, fine screens and other such gadgets did not totally succeed, and at the end of the trough slimes hardened into tailings. Tailings could be reworked to extract their minerals, although the reworking could be expensive and usually required the construction of special milling equipment. Working the slimes was not ennobling work, according to Twain. "Of all the recreations in the world, screening tailings on a hot day, with a long-handled shovel, is the most undesirable." Twain asserted that about a third of the ore containing gold and silver floated away in the slimes, and that was in fact the same figure that miners and miller used when estimating how much would be lost between the wet and dry assay. Since the dry assay was taken from the cake of metal that emerged from the amalgamation, whatever metal was recovered from slimes was considered to be a bonus. Some mining companies in addition to their reduction mills built tailings mills, and some independent millers specialized in processing tailings. Janin did not recount how the tailings were handled, and the accounts, which he presented, made no reference to them. It was certain, though, that the tailings from the operations at Gould & Curry's were not ignored. Piles of tailings all over the Comstock region served legitimate business enterprises such as tailings mills and, as Twain reminded his readers, inspired hucksters (even today): "I have seen men hunt over a pile of nearly worthless quartz for an hour, and at last find a little piece as large as a filbert, which was rich in gold and silver – and this was reserved for a fire-assay! Of course the fire-assay would

⁹ "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), 33.

demonstrate that a ton of rock would yield hundreds of dollars—and on such assay many an utterly worthless mine was sold.” Although as much as a third of the ore may have ended up in tailings dumps, the quantity of tailings actually recovered and registered (for tax purposes) remained a fraction of the gold and silver amalgamated from the ore and presented to the mint.¹⁰

Based on Janin’s figures the cost for the Gould & Curry mill to reduce more than 40,000 tons of ore was \$12.27 per ton.¹¹ Janin stated that milling costs both at the company mill and at the custom mills averaged \$13.30 per ton. It appears that the company milling was slightly less costly than custom milling. Beginning in the second half of the 1860s many of the local mills came under the ownership or the control of William Sharon. His plan was to break the stranglehold of the independent millers and yet to make money milling ores from mines that he owned or controlled as well as from other mines. Although precise data on milling rates at custom mills in the early 1860s is seldom revealed in the surviving sources, the data after Sharon invoked his plan indicate that rates had fallen to about \$15 per ton. Once Sharon’s plan proved successful other entrepreneurs began to emulate it, and that put rates under additional downward pressure. It would appear that both Gould & Curry’s mill as well as the custom millers came in at the low range of milling rates. At Gould & Curry’s mill of the nearly \$500,000 in milling costs, 61 percent was for supplies and materials, 32 percent for labor and 7 percent for hauling. In a more detailed schedule Janin broke down refining costs into seven categories and then further divided each category into seven subsections, as shown in Figure 1 by dollars and cents per ton (functions in left-most column arranged by percentage):

FIGURE 1
MILLING COSTS PER TON BY CATEGORY, GOULD & CURRY, 1867

Category	Labor	Wood	Castings	Copper	Salt	Mercury	Sundries	Total
Power	\$0.5888	\$3.9784					\$0.1249	\$4.6121(38%)
Amalgamation	\$0.7681	\$0.0465	\$0.5936	\$0.4350	\$0.2706	\$0.8659	\$0.1096	\$3.0896(25%)
Repairs	\$0.8410						\$0.6941	\$1.5341(12%)
Batteries	\$0.6598		\$0.2085				\$0.1096	\$0.0896(8%)
Hauling							\$0.9000	\$0.9000(7%)
Foreman, etc.	\$0.7133							\$0.7133(6%)
Breakers	\$0.4132						\$0.333	\$0.4465(4%)
Totals	\$3.9042	\$4.0249	\$0.8021	\$0.4350	\$0.2706	\$0.8659	\$1.9648	\$12.2678
	32%	33%	07%	04%	02%	07%	16%	

Note: batteries were stamps for crushing ores; foreman plus watchman and laborers – not clear how laborers in this column different from other laborers; breakers assigned to break up ore chunks in amalgamation pans; copper actually sulphate of copper; bottom row of percentages does not add up to 100% because of rounding up. There is a tiny mistake in the summing of items across for the function amalgamation - \$3.0893 instead of \$3.0896.]

¹⁰ Mark Twain [Samuel Clemens], *Roughing It* (New York: Penguin Books, 1981 [Reprint of 1872 edition]), 36. Almost no information on how the tailings were constructed or operated has shown up in the original sources that I have consulted.

¹¹ “Annual Report of the Surveyor-General...1866” in *State Journal and Appendix*, 3rd Legislative Session (1867), 34. The Table in the text is a rearrangement of Janin’s data as given in his report. The percentages are mine.

The arrangement of milling expenses is not in and of itself surprising. Power, typically a major operating cost, consumed \$4.61 per ton or 38 percent of the total. The major component of power was the purchase of wood (\$3.99 of the \$4.61.) and the remainder, slightly more than 60 cents per ton, was spent on labor and supplies. Since wood powered nearly all the machinery used in Comstock mining, it was in constant demand. In the mills firewood was needed primarily to drive the breakers and stamps that crushed the ore before it was mixed with the mercury and other chemicals to begin amalgamation. Some firewood was needed during the amalgamation itself, but it was accounted for separately. If the cost of firewood for amalgamating were combined with the cost of firewood for crushing (and a few other minor tasks) firewood purchases comprised a third of milling-component costs. Timber was harvested as far away as Lake Tahoe and then hauled (or “floated”) to the Comstock. In the Surveyor-General’s mill survey Gould & Curry stated that it averaged 20 cords of wood per day (several times the average for all mills), and while Gould & Curry did not report the cost per cord, other mills reported that they paid between \$13 and \$16 a cord. Despite some discrepancies between the Surveyor-General’s survey and Janin’s accounts, it is possible to estimate timber purchases cost Gould & Curry between \$100,000 and \$150,000 per year. The mill under normal operations may have used between 7,000 and 8,000 cords of wood to power the crushers, mixers, steamers and other machines in reducing the ore. Electrification did not arrive until late in the nineteenth century, long after the zenith in Comstock mining and milling, and as the figures from Gould & Curry timber was one of those ancillary industries that required mining and milling entrepreneurs to find resourceful ways to insure a continuous and cost-effective supply. In some cases, although this was not the case with Gould & Curry, principals in mining companies also became principals in timber operations.

The next most costly item behind power was amalgamation at \$3.09 or 25 percent of the total. This was the actual process of incorporating the quicksilver or mercury with the ore so that the minerals would separate from the residue by uniting with the quicksilver. The individual components ranked as follows: mercury (28 percent), labor (25 percent), castings (19 percent), sulphate of copper (14 percent), salt (9 percent), sundries (4 percent) and wood (2 percent). Not surprising mercury was the most costly item. Amalgamation was less efficient without salt and copper so that if these three ingredients were summed they would constitute more than half (51 percent) of the total costs. Labor represented about a quarter of the total and purchases of replacements for castings on machines about a fifth. Miscellaneous supplies came in at 4 percent and firewood at 2 percent. This did not include the preparation of the ore – “breakers” and “batteries” for crushing and pulverizing the ore – and if preparation and amalgamation were combined they would add up to \$3.63 per ton, which was still less than the overall power costs. The cost of the central ingredient, mercury, was only 87 cents per ton or 7 percent of the total component cost at Gould & Curry. Since mercury could be recovered from batch to batch and was seldom totally lost (unlike firewood) a far smaller portion of the component costs was tied up in mercury than wood. Indeed labor, just behind firewood, was a much bigger component cost than mercury. Of course how much mercury could be recovered varied from mill to mill, and where efficiencies were rare or modest mercury could become a much larger expense.

After accounting for power, amalgamation and preparation the remaining costs concerned repairs (12 percent), transportation (7 percent) and salaried personnel like foremen and watchmen (6 percent). With respect to repairs the major component was labor, which was billed at 84 cents per ton or 55 percent of total repairs. Hauling was simply listed at 90 cents per ton for “sundries”, and the personnel item was an expense that could not be included under any other category. Although one might wish for greater specificity in each category or component, one comes away from the report with a fairly clear understanding of how costs were spread across a milling operation. As important as mercury was, and in the opinion of some as costly as mercury was, it did not rank at the top of the list. Rather the cost of firewood to power the machines consumed \$4.03 per ton and the cost of labor, a smaller component in milling than in mining, nonetheless ranked behind cost of power at \$3.90 per ton or 32 percent. In a nation that was quickly industrializing and in an industry that was the beneficiary of that industrializing the role of power to drive more and increasingly complex machinery and the role of labor will loom large in how the Comstock industry confronted the cost structure. If the milling costs reported by Janin to Surveyor-General in the second half of the 1860s, they were, it would appear, as much as half the milling rates of the custom mills in the first half of the 1860s according to undocumented estimates.

On the basis of Janin’s figures for ore extracted and then processed in Gould & Curry’s mill the results appear to be positive. Of the 40,432 tons crushed at the mill 36,001 tons (11 percent loss) were actually submitted to amalgamation to yield \$1.2 million in bullion, \$825,000 in silver and \$364,000 in gold. To extract the total crushed tonnage cost an estimated \$7.86 per ton or \$318,000.¹² As noted above, to refine that tonnage cost \$12.27 per ton or \$496,005. Janin did break it down into three categories: \$301,751 or 61 percent for on materials, \$157,865 or 32 percent on labor and \$36,389 or 7 percent for transportation. The ratio of mining to refining costs of \$1 to \$1.50 per ton was not out of line with what other companies reported in the second half for the 1860s and later. Even without considering the ore processed at custom mills the company had a gross profit of nearly \$400,000. Obviously some costs that modern accounting rules would require have not been included but that figure did indicate gross operating profits. The company paid a dividend of \$250,000, substantial but not spectacular in mining lore.¹³

At the time of the survey most of the large mining companies owned and operated their own mills, and like Gould & Curry they also used independent millers. In addition to Gould & Curry Savage reported that to mill 9,700 tons in the two mills (Atchison and Minnesota) that it owned in Washoe County cost \$12.04 per ton. The third leg in the milling complex in addition to custom mills and company mills was a separate milling

¹² Janin’s extraction costs were based on 62,425 tons, not just the 40,032 tons submitted to Gould & Curry’s mill, so it cannot be determined if \$7.86 was an appropriate estimate for extraction costs of the smaller volume. It is not possible to compute extraction costs except for total tonnage.

¹³ “Annual Report of the Surveyor-General...1866” in *State Journal and Appendix*, 3rd Legislative Session (1867), 31-34. Dividend figures from Grant Smith Notebooks, NC229, Binder 1, Special Collections, Library, University of Nevada at Reno.

business under the ownership of the principals of the mining companies, the so-called Sharon model. At the vanguard of the newly emerging mining and milling corporate structure was a major Comstock investor, the San Franciscan financier, William Ralston. He had invested in and made money from several large mining ventures: Gould & Curry, Ophir and Mexican to name a few. As the shafts reached the 500-foot level they began to flood out. In addition Ralston's own agents in Virginia City had mismanaged his properties to the extent that Ralston was the victim of theft. To protect his Comstock investments, which underwrote his other non-mining investment in San Francisco and across the West, he sent William Sharon to Virginia City in 1864. Sharon was frequently described in Napoleonic terms – a small, compact man who became such a towering figure. In the same year Ralston set up the Bank of California with Sharon as the chief cashier in Virginia City's branch.¹⁴ With Sharon's arrival to implement Ralston's strategy the business of mining underwent a fundamental change. After an impressively thorough investigation of the Comstock mining and milling operations Sharon concluded that the Comstock despite a huge volume of water at the bottom of many of the active mining shafts was not washed up. He approved loans to mining companies even though in 1864-1865, as ore production and stock valuations fell in tandem, the Comstock was experiencing its first financial panic. Sharon's approach was not to rely on one or a few assays but to order many assays in different mines. On the basis of these tests he became convinced that rich ores lay under the water.¹⁵ Sharon was also convinced that in both mining and milling extravagance rather than prudence governed the Comstock operations. Even Lord credited Sharon with a new outlook: "where organization was to triumph over anarchy and cool calculations of self-interest were to be the only basis of recognized action."¹⁶ And the search for order was no more apparent than in the milling sphere. In addition to lending to mine owners, Ralston and Sharon also made loans to millers. As a result of the Comstock's first major contraction borrowers easily fell behind on their bank payments (interest in some cases was 2 to 5 percent per month), and when they did, through foreclosure proceedings, the Bank of California ended up with the properties. Foreclosure was preferred to a forced sale because a forced sale could yield less than a loan's face value and a foreclosure presented the opportunity to try to preserve the investment in plant and equipment by operating the mill. But foreclosures that led to idle operations were a money-loser. Milling properties deteriorated quickly, according to Lord, because the dyes, pans and shoes, all made from iron, became corroded with rust when not in use.¹⁷ That would represent substantial capacity at a time when the Comstock was struggling to recover. By 1867 the Bank may have owned as many as 17 mills. Whatever the number Ralston and Sharon decided to create a milling company called Union Mill and Mining Company, incorporated in California with a capitalization of \$1.5 million in the form of 15,000 shares. Although the charter investors include seven

¹⁴ While description and analysis of the roles played by Ralston and Sharon were standard fare in most Comstock histories, some of the most illuminating details appear in works by the Progressive historian, George Lyman. See in particular *Ralston's Ring, California Plunders the Comstock Lode* (New York: Charles Scribner's Sons, 1937), 34-35, 38-39. For a typical characterization of Sharon see Lord, *Comstock Mining and Miners*, 244.

¹⁵ Lyman, *Ralston's Ring*, 38-39. Many assays were made as close to the water level as possible.

¹⁶ Lord, *Comstock Mining and Miners*, 245. This is a fine example of Lord's devotion to laissez-faire principles.

¹⁷ Lord, *Comstock Mining and Miners*, 246.

individuals, three of the seven – Ralston, Sharon and D. O. Mills (longtime colleague of Ralston) became the principals. Seventeen mills were far too many to operate economically, and once the company was in place consolidation became the order of the day. Concentrating the milling along the Carson River where waterpower was assured became the strategy that apparently was pursued relentlessly.¹⁸

How Ralston and Sharon carried out their strategy has not, to my knowledge, been examined in detail. There was no doubt that Union Mill and Mining became the dominant milling operation for Comstock and remained so well into the 1870s. Even before the 1867 incorporation according to the Surveyor-General's mill survey from 1866 Sharon was listed as owner or agent for eight mills. Ralston's name did not appear; nor did any of the names of the other investors in the soon-to-be-announced Union Mill and Mining. But the Ralston crowd owned mines that also owned mines. So surely the eight mills only represented a part of the total under the control of the Ralston, Sharon and their associates. Even with an incomplete list the mills directly connected to Sharon provide some illuminating details. It is worth noting that Sharon's name appeared in the survey in several different ways: Wm. Or W. Sharon Agt. (6), Sharon & Co. (1) and Williams & Sharon (1).¹⁹

FIGURE 2
MILLS LISTING WILLIAM SHARON AS OWNER OR AGENT, 1866

Mill Names	Location-County	Date	Cost	Power-HP	Stamps	Crush per Month
Empire State	7 Mile Canyon-Story	ND	\$35,000	Steam-?	15	700 tons
Pacific	Lower Gold Hill-Story	1863	\$75,000	Steam-80	30	1,300 tons
Franklin	Carson River-Dayton-Lyon	1861	\$50,000	Water-?	10	500 tons
Gold Cañon Reduction	Silver City-Lyon	1861	\$40,000	Steam-30	15	750 tons
Illinois	Carson River-Dayton-Lyon	1864	\$30,000	Steam-30	20	500 tons
Swansea	Johntown-Lyon	1862	\$60,000	Steam-40	12	600 tons
Brunswick	Empire-Ormsby	1863	\$50,000	Water-?	8	600 tons
Carson	Carson-Ormsby	1862	\$25,000	Water-?	10	?
Totals			\$365,000		120	4,950 tons

See footnote 13.

The mills were spread through three counties: two in Story near Virginia City; four in Lyon with two along the Carson River; and two in Ormsby with both along the Carson River. Waterpower drove three mills, and a fourth mill, Illinois, while located along the Carson River apparently used steam as did the other four. Statistical comparisons with Sharon-identified mills and the total survey would not be useful because some of the other mills were surely under the control of the Ralston/Sharon

¹⁸ Lyman, *Ralston's Ring*, 85-86.

¹⁹ The Williams of Williams & Sharon could not be identified. The thought occurs that this could be a typographical error in that Sharon's name was William and the entry perhaps should read William Sharon.

combine. The properties unmistakably linked to Sharon cost about \$365,000 to build or \$46,000 per mill. The most expensive was Pacific at \$75,000 and the least expensive was Carson at \$25,000. Pacific, built in 1863, had 30 stamps, two or three times the number at the other mills, and a capacity of 1,200 tons per ton, twice the capacity of other mills. It cost about \$2,500 per stamp to build Pacific. Being located in Gold Hill away from any river Pacific was power by 80 horsepower steam engine. In terms of cost per stamp Illinois was the cheapest. Built in 1864 at a cost of \$30,000, it had 20 stamps or \$1,500 per stamp. Although on the Carson River it used steam power rather than waterpower (30 horsepower engine) to operate 20 stamps (\$1,500 per stamp) with a monthly crushing capacity of 500 tons. The most expensive mill was Brunswick. It had the fewest stamps (8) at a cost of \$6,250 per stamp with total construction costs of \$50,000. It could crush 600 tons per month and was powered by water (from the Carson River). Other factors such as the number and size of the amalgamation pans, the number of settlers and agitators for combining the ores with the mercury and other chemicals and the weight of each stamp had to be considered with respect to a mill's cost and capacity. Still some of the figures cited above square with other information about the cost and capacity of Comstock mills.

Even though the 1866 survey had linked these eight mills directly to Sharon and his allies other mills owned by mining companies had also fallen under the control of the so-called Bank Crowd in the middle 1860s. They included Ophir, Gould & Curry and Yellow Jacket, all of whom had large mills. If the data assembled by the Surveyor-General on these three company mills were added to the foregoing mill data, then the growing concentration of the milling business in the hands of Ralston and Sharon was be far more pronounced. These three company mills with a total of 144 stamps and a crushing capacity per month of 7,000 tons cost at least \$600,000 to construct or about \$4,200 per stamp.²⁰ One can presume that at the time of the Surveyor-General's 1866 report as many as 11 mills with between 250 and 300 stamps, a crushing capacity per month of 12,000 tons and a price tag of at least \$1 million could have fallen under the control of Ralston, Sharon and their associated in the Bank of California. The total crushing capacity of all the mills in the four counties was about 60,000 tons per month, and the Bank Crowd may have controlled about a fifth of that capacity. Even though some very large mills were outside the control of Ralston and Sharon, they had a dominance that no other individual or combine had ever evidenced through the 1866 survey.²¹ As difficult as it is to pin down the exact number of mills owned or controlled by Ralston and Sharon in the years preceding the organization of the Union Mill and Mining Company in 1867, the trend toward what Grant Smith termed "private" milling had begun. Private milling existed along side of private mining, and while they had separate corporate identities, they were in fact set up by the mine owners who gleaned

²⁰ There was much conflicting information about the cost to build and rebuild the Ophir and Gould & Curry mills, and the figures cited by the Surveyor-General were very much on the low side. Without actual company records any resolution of these conflicts remains improbable.

²¹ O'Neale, Rule & Co controlled three or four mills with a total crushing capacity of between 2,000 and 2,500 tons per month. In addition Crown Point Mining Company, which would eventually come under the control of Ralston and Sharon, had at least two mills with a crushing capacity of less than 2,000 tons per month.

profits from both enterprises.²² The objective in creating Union Mill and Mining was to consolidate and concentrate milling operations. That meant that some of the 17 mills could be sold or abandoned because they were inefficient, and the remaining mills, which could set their own rates irrespective of the custom milling rates, would not only be fed ores from their own mines but could also solicit business from other mining companies. Custom mills, of course, had always been under private ownership, usually a single proprietor or several partners, and their independence from the mine owners was a source of friction. Although custom mills survived, private milling as envisioned by Ralston and Sharon became the standard on the Comstock.²³

The business of refining had changed noticeably by 1873 when the State Mineralogist presented his biennial report to the 6th Session of the State Legislature. The data that he collected was from 1871 and 1872, and in the half-dozen years since the Surveyor-General's survey the Sharon model had taken hold on the Comstock. The state had 162 mills with 1,904 stamps and the capacity of 5,183 tons per day. The four counties of Storey, Lyon, Ormsby and Washoe had a total of 64 mills (40 percent) with 981 stamps (52 percent) and a daily capacity of 3,043 tons (59 percent). A direct comparison with the 1866 survey requires some care because the Mineralogist's 1873 report included tailing mills and the 1866 survey did not. It is not known when independent tailings mills were first constructed. There is almost no discussion of tailings mills in standard published sources. Based on the 1873 Mineralogist's report at least a half-dozen tailings mills had been built in Storey and Lyon Counties by 1873. One of those mills, Occidental, was described as both a quartz mill and a tailings mill. If we exclude tailings mills from the 1873 report (excluding Occidental), we can then compare that report with the 1866 survey. The total number of quartz mills for the four counties in 1873 would fall from 64 to 57, a figure that was 26 percent below the total number of mills (77) in 1866. Along with the decline in the number of mills came a 33-percent decline in the number of stamps. A decrease in mills and stamps was counterbalanced to a degree by an increase of 13 percent in capacity (from 2,072 tons to 2,338 tons – tailings capacity not included). After the craze in mill building during the 1860s some mills had been abandoned, some may have been converted to tailings operations and some were remodeled and upgraded. New mill building did not cease in the 1870s. Several large, powerful and efficient mills were constructed in and around Virginia City, mainly in connection with mining bonanzas at Crown Point, Belcher, Consolidated Virginia and California. Since 1866 the number of mills in Storey and Lyon – the two counties most densely populated with mills - had declined from 60 to 46 or 12 percent and the number of stamps from 1031 to 687 or 33 percent. On the other hand daily capacity had grown from 1,484 to 1,704 tons or 15 percent. Even with a decline in the number of mills and stamps Lyon and Storey Counties still had a third or more of the milling facilities in Nevada.²⁴

²² Smith, *The Comstock Lode*, 50-51.

²³ The mill data from "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), insert after p. 21.

²⁴ "Biennial Report of the State Mineralogist...1871 and 1872" in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 147. The 1866 data from the footnote above.

Close scrutiny of the 1873 milling data reveals how the Comstock-related milling business had changed since 1866. Milling needed water, and the location of so many mills along rivers, especially the Carson River, was not an accident. Even though the ore had to be hauled 10 to 20 miles from the mines to the mills, that was initially cheaper than trying to bring water to the Comstock. The Washoe County mills being the most distance were the most vulnerable. In 1866 some of the largest mills yet built were in Washoe (City) and Franktown. The former town had two mills (Manhattan and New York & Washoe), owned by companies with similar names (New York & Nevada Co. and New York & Washoe Co.), each of which had 24 stamps with a daily capacity of 45 tons and cost an estimated \$100,000 to build in 1863. In nearby Franktown Ophir Mining had built its mill in 1862 with 72 stamps and a capacity of 33 tons per day at a cost of \$150,000, although in 1869 the Mineralogists declared that it cost over \$500,000.²⁵ Its grandeur did not escape Lord's attention: 12 miles (16 miles according to the Surveyor-General) from the mine and covering an acre of ground the costly complex boasted not only a mill but also "shops, stables, carriage-houses, quarters for workmen, offices, and superintendent's residence", all of which "constituted a miniature city".²⁶ With second highest number of stamps in the four counties (only Gould & Curry's mill, discussed earlier, had more) the capacity of the mill was only average for Washoe County mills and for mills in the four counties.²⁷ Meanwhile in 1864 the Ophir Mining built a second mill along the Carson River in Lyon County about half the size of the Washoe County facility. Not far from the first Ophir Mill in Franktown J. H. Dall had built Washoe Valley Reduction with 60 stamps and a capacity of 60 tons daily for \$140,000. By 1873, wrote the Mineralogist, all but one reduction mills in Washoe County were idle and most of those built in the decade before had been abandoned or dismantled. The Truckee Mill (not on the Surveyor-General list) was still reducing ores, and several tailings mills remained in business. The cause of their demise: the Virginia and Truckee Railroad that allowed miners to transport their ores more cheaply to the mills to the south of the Lode on the Carson River. Without specifying the names or types of mills or commenting on their operational status, the Mineralogist noted that Washoe County in 1873 had 5 mills (down from 9 or 45 percent in 1866), 84 stamps (down from 261 or 68 percent) and 124-ton per-day capacity (down from 308 or 60 percent). For all intents and purposes refining ceased to be a major business. Washoe County now had to depend on Reno and Wadsworth, both important rail centers, and farming and grazing outside the cities for its economic prosperity.²⁸

Ormsby County, which included mainly Carson City, the State Capital, but was later incorporated into Douglas County, was like Washoe County some distance from the Comstock. Since the Carson River flowed thorough it, it had access to waterpower. In addition, unlike Washoe County, it had direct access to the Comstock mines through the

²⁵ "Biennial Report of the State Mineralogist...1867 and 1868" *Appendix to Journal of Senate*, 4th Legislative Session (1869), 21. Grant Smith cited the same figure without any source in *The Comstock Lode*, 80.

²⁶ Lord, *Comstock Mining and Miners*, 122-123. Lord did not give a price tag to build a miniature city.

²⁷ "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), insert after p. 26.

²⁸ "Biennial Report of the State Mineralogist...1871 and 1872" in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 138-139.

Virginia and Truckee Railroad, which opened in late 1869. The number of operating mills actually dropped from eight to six (a decline of 25 percent) between the Surveyor-General's report in 1866 and the Mineralogist's report in 1873. At the same time the number of stamps increased from 170 in 1866 to 210 (up 24 percent). The explanation for this was renovations at Santiago (from 24 to 34 stamps, 42 percent increase) and Brunswick (from 8 to 56 stamps, 600 percent increase). During the early years of mill-construction frenzy two Comstock mining companies built expensive mills in Ormsby County: Mexican built a steam- and water-powered mill for \$300,000 in 1863 in the town of Empire (under the ownership of Alsop & Company in 1866) and Yellow Jacket built a water-powered mill in 1864 for \$150,000 in the same town. The 1866 survey reported that the eight mills, built between 1860 and 1864, cost a total of \$825,000 or slightly more than \$100,000 apiece on average. With the aforementioned 170 stamps the cost per stamp was just under \$5,000. By 1866 two of the mills, Brunswick and Carson, had come under the control of Ralston and Sharon. It had fewer mills than Washoe in 1866, but the level of capitalization was somewhat higher. Whereas Washoe faded Ormsby remained a part of the milling complex associated with the Comstock until the end. In 1873 the Mineralogist reported that Brunswick, Mexican and Yellow Jacket were then processing ore from Crown Point, whose bonanza began in 1871. With more stamps Ormsby's monthly capacity jumped from 7,360 to 15,300 tons, an increase of 107 percent. This was accounted for in large part because Brunswick's capacity skyrocketed from 20 to 120 daily or 500 percent. In a curious twist Ralston and Sharon had bought the Crown Point Mine in the late 1860s, and then lost control of it just as the bonanza began in 1871. Who owned the mills, and in particular who owned Brunswick, which was currently processing ore from a mine that they no longer owned? The Mineralogist's Report was of little help because it did not list any of the owners of the mills in Ormsby. Eliot Lord wrote, however, that Ralston and Sharon after having lost Crown Point were further disappointed because they did not secure any contracts for Union Mill and Mining to refine Crown Point's ores. Crown Point had a mill in Gold Hill (Rhode Island) near the mine, and that mill surely processed some of the ore. What was not refined there was processed at mills owned by Nevada Mill and Mining, which Crown Point's owners, Haywood and Jones, had established in the mould of Union Mill and Mining. If the Mineralogist's information was correct that these Ormsby County mills were fully occupied with ores from Crown Point, then Brunswick, Mexican and Yellow Jacket may well have belonged to Nevada Mill and Mining. Union Mill and Mining had sold other mills, and it may well have disposed of Brunswick. Whoever the owners of Ormsby's mills were in the early 1870s, they had valuable properties as a consequence of the recovery of the Lode's southern end. None of the mills was idle, and none appeared to be processing tailings.²⁹

From 1866 to 1873 Lyon County fared better than Washoe but less well than Ormsby. Lyon had the highest population of mills in Nevada, but if only quartz mills were counted, then it was second behind Story. Lyon County sat between Story and

²⁹ "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), insert after p. 21; "Biennial Report of the State Mineralogist...1871 and 1872" in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 115-117, 132; Lord, *Comstock Mining and Miners*, 283-284.

Ormsby, and the availability of water from the American Flats and Carson Rivers made it a natural site for mill construction. The Virginia & Truckee Railroad from Virginia City to Carson City passed through the heart of Lyon County's milling district and further enhanced its position. In 1866 there were 27 amalgamation mills in Lyon County with 395 to 424 stamps in plants that cost between \$1.4 and \$1.5 million to build, or approximately \$3,500 per stamp.³⁰ According to Lyon County's Assessor, George McFadden, who collected the Lyon County data that the Mineralogist incorporated in his 1873 report, the 24 quartz and tailings mills were located in the following areas: eight in Silver City (closest to the Comstock), six along the Carson River (farthest from the Comstock), five in Gold Cañon (between Silver City and Dayton), three in Dayton (a few miles southeast of Silver City) and two in Spring Valley (west of Dayton). Of the 24 mills 19 were classified as quartz (amalgamation) mills and five as tailings mills. More than half of Lyon County's milling capacity was from tailings. If all the mills listed in the 1866 Surveyor-General's survey were quartz mills (this seems likely) then the county had lost eight mills between 1866 and 1873. Over time as the volume of tailings grew mills specializing in tailings also increased in number. In 1873 all of Lyon's tailings mills were in operation whereas among the quartz mills five were idle. The Mineralogist's Report did not explain why the mills were idle or how long they had been idle. Two of the idle mills were in Gold Cañon, and one each along the Carson River, in Dayton and in Spring Valley. The largest of the idle mills was Rock Point Mill (also known as Imperial because it was built by Imperial Mining) with 56 stamps and a monthly capacity of 112 tons. When it was built in 1861 at a cost of \$250,000, it was the county's largest and most expensive mill. At the time only the Gould & Curry Mill in Story County and the Mexican Mill in Ormsby County cost more to build. In the 1873 Mineralogist's report the number of stamps remained the same at 56, but the capacity of the mill had risen from 90 tons per day to 112 tons per day. Its stamps were of average size with 16 weighing 600 pounds and 40 weighing 550 pounds. The Imperial Mining Company had enjoyed some success in the early 1860s, but along with many other Gold Hill mines Imperial produced little profitable ore after 1868, and that may explain why this large facility was idle in 1873. Despite the trend toward private milling companies Imperial may have remained a mine-specific mill. The other idle mills were of moderate size. Given that nearly a third of the quartz mills were not operating and all the tailings mills were, tailings operations had obviously grown in importance in Lyon County's milling business. It was certainly more prominent in Lyon County than in any of the other three counties.

Two points of clarification should be made. That a mill was running with a certain capacity did not mean that it was running a full capacity every day. The Mineralogist's report simply indicated what the potential capacity was and not what was being milled every day. Further tailings yielded metals of far less value per ton than amalgamation so that the quartz mills with less daily capacity might actually produce gold and silver of greater worth.³¹ Mills could make profits from tailings, however, and since Lyon County had so many quartz mills from the early 1860s, it probably had an ample supply of

³⁰ "Annual Report of the Surveyor-General...1866" in *State Journal and Appendix*, 3rd Legislative Session (1867), insert after p. 21.

³¹ If Lyon County Assessment Rolls have survived, and I assume that many have although I have not consulted them, the relationship between quartz and tailings mills could be studied in greater detail.

tailings for millers to buy and reprocess. The two largest tailings mills were the Carson Valley Mill along the Carson River and the Birdsail & Co. mill in Dayton, which could process up to 300 tons daily. The remaining three mills were smaller with a capacity of 25 to 50 tons. The largest of the operating quartz mills was Eureka on the Carson River with 60 stamps and a capacity of 120 tons (compared for example to the idle Imperial with 50 stamps and a 112-ton capacity. Built in 1861 for \$100,000, its owners in 1866 were Hurd, Wheeler & Dunker. It cannot be verified that they built the mill in 1861 or still owned it in 1873. It had been enlarged since 1866 when it was of average size with 20 stamps and a daily capacity of 22 tons. Even though it was 6.5 miles from the Comstock mines, it had access to the Carson River to power a large turbine and was close to the Virginia & Truckee railroad. According to the 1873 report Eureka was an operating mill, but the report made no reference as to who owned it or whose ore was being processed. Some of the other quartz mills noted by the County Assessor served mainly Lyon County mines: Dayton Mine-Atlanta Mill; Buckeye Mine-Horn and Hope Mills; and Cook & Geyer Mine-Franklin Mine. Only the Franklin Mill appeared on the 1866 survey with Sharon as its owner. Several other mines were described as flooded or abandoned. The remaining amalgamation mills, like Eureka, listed by the Surveyor-General were not identified with any mines. Five of those mills – Devil’s Gate, Bacon, Trench, Kelsey and Sacramento – will end up in the stable of mills owned or controlled by The Firm through the Pacific Mill and Mining Company to process ores from Consolidated Virginia and California Mines.³²

For Story County the 1873 Mineralogist’s report added an important component. It had information on size and location of the mills, but it also included information on which mines the mills served. Story had a total of 29 mills only three of which processed tailings. Occidental was classified as a dual quartz and tailings mill. Eight mills (28 percent), none of which were tailings mills, were idle, about the same proportion as in Lyon County. Among the amalgamation mills the average number of stamps per mill was 13 and the average capacity was 37 tons per day or 1,100 tons a month. Story’s average-sized mill tended to be smaller in terms of stamps and capacity when compared to the average in Lyon and Ormsby but especially in Ormsby. Eight (28 percent) mills were located in Lower Gold Hill, six (21 percent) in Gold Cañon (further south where was drawn the boundary between Story and Lyon Counties), five (17 percent) each in 6-Mile and 7-Mile Cañons (east of Virginia City) and the remaining five (17 percent) in Virginia City (3), Silver Star (1) and Cedar Hill (1). Pacific (Gold Cañon) had the most stamps with 30 and a capacity of 70 tons per day or 2,100 tons per month while Petaluma (Lower Gold Hill) had 6 fewer stamps but the highest capacity of 75 tons per day or 2,100 tons per month. The three mills in Virginia City proper – Hoosier State, Nevada and Sierra Nevada – had more than the average number of stamps but only slightly more than the average capacity. Although the capacity of the tailings mills was not given, they seemed to play a smaller role in Story County’s milling business. Two tailings mills – Park & Bowie, Nos. 1 & 2 – were in 6 Mile Cañon, and the other, Occidental, was located in Silver Star. Half of the County’s mills listed in 1873 inventory appeared in the earlier 1866 survey. Among the largest (25 stamps and 50-ton per-day capacity) was Rhode

³² “Biennial Report of the State Mineralogist...1871 and 1872” in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 100.

Island, built at a cost of \$100,000 in 1862 by Crown Point Mining Company. When Sharon and Ralston took control of Crown Point, they probably took control of Rhode Island. It is unclear if it became a property of the Union Mill and Mining Company because when the rivals of Sharon and Ralston won control of Crown Point in the early 1870s they apparently also came into possession of Rhode Island. Between 1866 and 1873 the capacity of Rhode Island was not increased so that its 50-ton-daily capacity had become fairly common. Most of the mills on both inventories had undergone some enlargement and improvement. Both Pacific and Petaluma increased the number of stamps and their capacity after 1866. Several mills reduced the number of stamps but increased capacity. Although the total number of mills had declined from 33 in 1866 to 27 in 1873 or 18 percent, excluding tailings mills and the number of stamps had fallen from 607 to 399 or 34 percent, capacity had risen 18 percent. Like Lyon County Story had idle amalgamation mills – seven of the 27 or 26 percent. They accounted for a quarter of the daily capacity. The reason for their idleness was not recorded. Four of the seven dated from the early 1860s, and age may have made them less competitive. Despite the bonanzas on the Comstock's southern end Story County could still be saddled with milling overcapacity. Several of the idle mills, however, will be reactivated during the great bonanza that was just beginning on the northern end.³³

In the early 1870s the output of four mines – Crown Point, Chollar Potosi, Savage and Belcher – dominated the milling business in Story County. Twelve of the 27 quartz mills with more than half of the stamps and daily capacity were engaged in processing ores from these mines. Among the operating mills this was to 72 percent of the stamps and 68 percent of the capacity. Four Story County mills – Ione (a small “croppings” mill), Petaluma, Sapphire and Rhode Island - with 69 stamps (17 percent) and 180-tons per-day capacity (18 percent) were processing ores from Crown Point, which the Mineralogist described as “the most valuable silver mine in the world”. These four mills, however, constituted a minor contingent of Crown Point's milling facilities. The bulk of the ore was shipped to three mills – Brunswick, Mexican and Yellow Jacket – on the Carson River in Ormsby County.³⁴ Their combined capacity was 345 tons per day, almost twice the volume of the Story County mills. The largest of the Story County contingent was Petaluma with a capacity of 75 tons that was equal to the capacity of Yellow Jacket, which ranked third on the list of Ormsby mills. It is possible, of course, that mills in Lyon County also processed Crown Point ore, although none was so identified. As noted earlier, the new owners of Crown Point set up their own private milling company, Nevada Mill and Mining, but what cannot be documented yet is which of these mills were folded into the Nevada operation. Three other Story County mills – Winfield, Landy and Nevada – with a total of 60 stamps and 150-tons capacity per day (4,500 tons per month) milled ores for Chollar Potosi Mining Company, and three other mills – Atlas, Hoosier State and Evans – with 38 stamps and 93 per-ton per-day capacity (2,800 tons per month) worked ores for Savage Mining Company. It was not stated

³³ “Annual Report of the Surveyor-General...1866” in *State Journal and Appendix*, 3rd Legislative Session (1867), insert after p. 21; “Biennial Report of the State Mineralogist...1871 and 1872” *Appendix to Journal of Senate*, 6th Legislative Session (1873), 138.

³⁴ “Biennial Report of the State Mineralogist...1871 and 1872” in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 132.

whether these mills belonged to a milling combine under the control of the mine owners or were independent, custom mills. In the case of Savage the Mineralogists did state that except for a small quantity Savage's ores were processed at customs mills. Savage owned two mills – Atchison and Minnesota – in Washoe County, both built in the early 1860s, and one of them (name of mill not given in report) processed about 1,000 tons. Low yields from Savage ores made the cost of transportation to Washoe prohibitive. A fourth mine, Belcher, at the onset of a bonanza that will overshadow its neighbor, Crown Point, had new owners, Ralston and Sharon, who had acquired it after being displaced at Crown Point. Of the two mills handling Belcher ores Pacific, the second largest Story mill, was a Sharon property. Presumably other mills owned by Sharon in Story and other counties could be enlisted to mill ore from Belcher that would nearly match the output of Crown Point in the two years following the 1873 report. As powerful and profitable as the milling combines were, they did not put an end to custom mills and company mills, although they certainly forced changes on the former with regard to milling prices.³⁵

When the Mineralogist's Report (1875) filed his 1875 report with the 7th Biennial Legislature, it contained no mill surveys and very little general information about milling. It was regrettable that he did not provide a more detailed review of milling operations in Story and the surrounding counties at a point when the Comstock was about to enter its most flourishing period. In Lyon County he noted that most of the processing was tailings, a pattern that we observed in the 1873 report. Without naming the two tailings mills he reported that they had the combined capacity of 1,350 tons per day, more than twice what had been reported two years earlier. In Story County, he advised, there was insufficient milling to handle the upsurge in ore production mainly from Consolidated Virginia and California mines. He included some milling-operation accounts at Crown Point, Belcher and a few others mines, but he devoted most of this report to evolving milling behemoth in connection with Consolidated Virginia and California, a topic to be looked at closely in the next chapter. The bulk of his report, however, focused on mining rather than milling, which in everyone's mind was on the verge of fulfilling the promise often made for the Comstock.³⁶

The published accounts of Crown Point's mining and milling operations for the fiscal year 1873-1874 offer details on the cost of preparing and processing the ores.³⁷ For the fiscal year 1873-1874 11 mills were required to process slightly more than 140,000 tons of ore.³⁸ Figure 3 lists pertinent information about the mills. Eight of the 11 mills were included on the Survey-General's 1866 Report and nine of the 11 were included in the Mineralogist's 1873 report. The two mills that did not appear on earlier inventories

³⁵ "Biennial Report of the State Mineralogist...1871 and 1872" in *Appendix to Journal of Senate*, 6th Legislative Session (1873), 131-132, 134-136, 138.

³⁶ "Biennial Report of the State Mineralogist...1873 and 1874" in *Appendix to Journals of Senate and Assembly*, 7th Legislative Session (1875), 91-101, *passim*.

³⁷ The Superintendent's Report covered the period May 1873-April 1874. Excerpts and summaries are found as a part of the "Biennial Report of the State Mineralogist...1873 and 1874" in *Appendix to Journals of Senate and Assembly*, 7th Legislative Session (1875), 106-112.

³⁸ Ore that was described as "ore worked" or as "working ores" usually meant ore that had been put through the refining process from crushing to amalgamating. Worked ore could be less than the volume of ore extracted from the mine and shipped to the mill.

were Morgan and Sherman: the former was near Carson City in Ormsby County and Sherman was on the southern edge of Story County. More than a quarter of the ore was processed at Brunswick in Ormsby County. Behind Brunswick were two other Ormsby County mills, Mexican (19 percent) and Morgan (18 percent). These three accounted for 64 percent of the refined ore. In fourth place (11 percent) was Crown Point's own mill, Rhode Island, built a decade before. The remaining seven mills handled a quarter of the ore. The yields ranged from a high of \$67 per ton at Hoosier State Mill on 376 tons, the smallest quantity of ore processed by any of the mills, to a low of \$35 per ton at Sherman Mill on 449 tons, the next smallest quantity. The average yield was \$51 per ton, a figure that characterized the yields of the four largest refiners (noted above). At this point the accounts require some interpolation. The milling costs at Rhode Island were included along with the general mining accounts, and the inclusion of milling accounts within the mine's financial accounting suggests that the mill was still a property of the mining company. The refining costs of the other mills, some or perhaps all of which may have been properties of Nevada Mill and Mining, were listed under a single entry called crushing.³⁹ The mining company spent \$1.5 million to process 124,000 tons (the difference between the total of 140,000 and Rhode Island's share of 16,000). The per-ton cost was \$12 per ton (\$11.99). Rates at individual mills were not recorded. If \$12 per ton was more or less the standard, it amounted to about a quarter of the average per-ton yield in bullion of \$51. Add the \$12 per-ton refining cost to the \$9 per ton mining cost for a total of \$21 to \$22, leaving a surplus of nearly \$30 per ton.

Refining costs at Rhode Island Mill appear to be somewhat lower per-ton than the calculated average. For the 16,000 tons processed at Rhode Island the cost including more than \$1,000 for mill improvement was \$174,000. Some other costs such as haulage and assays may not have been fully accounted for under entries for Rhode Island. In any event the per-ton rate there was \$11 (\$10.84), slightly lower than the rate for the other 10 mills. The breakdown (less precise than for an earlier discussion of Gould & Curry) is as follows: mercury, chemicals etc. - \$66,602 or 39 percent; labor - \$45,659 or 26 percent; wood - \$28,987 or 17 percent; machines & castings - \$23,003 or 13 percent; and water - \$8,400 or 5 percent. Clearly mercury had assumed a large role in the refining business. Two factors can be cited. First the demand for mercury had risen in step with increasing tonnage of ore to be processed, and that led to higher mercury prices. Further, the richer the ore the more "new" mercury had to be incorporated with each batch – in short more mercury was lost. In the case of Rhode Island mercury *et al.* cost about \$4.19 per ton. If that were used as a benchmark for all the mills, then more than \$550,000 was spent on mercury purchases. The next highest cost was labor at about \$2.88 per ton. Firewood to power the steam turbine and machinery cost \$1.81 and \$1.44 per ton respectively and water cost slightly more than 50 cent per ton. Even as milling rates had declined since the early 1860s the allotment of those costs had also changed. No doubt part of this arose

³⁹ I have deduced if the quantity refined at Rhode Island is subtracted from the total ore processed, the difference is the amount of amount listed as crushed. I have assumed, therefore, that in order to estimate the cost of refining at the other mills the figure for "crushing" really refers to the refining of the ore outside of the Rhode Island Mill. The per-ton cost reached by dividing the total crushing figure by the tonnage delivered to the mills except Rhode Island is within a few cents of the per-ton refining cost stated for all the mills in the accounts. It is not clear why the per-ton cost was presented in this way without more detail.

from the introduction of greater efficiencies in the preparing and processing of the ores, but the most change arose from the heavy, constant demand for mercury without which the Comstock's success would have been greatly limited.⁴⁰

FIGURE 3
MILLS REFINING OF CROWN POINT ORES, 1873-1874

Mill	County	Tons	Bullion Value	Per-Ton Yield	% Tons
Brunswick	Ormsby	37,620	\$1,910,659	\$50.79	26.85%
Mexican	Ormsby	26,333	\$1,366,538	\$51.89	18.79%
Morgan	Ormsby ?	25,480	\$1,280,062	\$50.23	18.18%
Rhode Island	Story	16,044	\$850,362	\$53.00	11.45%
Petaluma	Story	12,333	\$624,544	\$50.64	8.80%
Pioneer	Lyon	10,486	\$522,080	\$49.78	7.48%
Atlas	Story	7,490	\$386,122	\$51.54	5.35%
Sapphire	Story	1,804	\$84,637	\$46.90	1.29%
Devil's Gate	Lyon	1,713	\$75,829	\$44.25	1.22%
Sherman	Story/Lyon ?	449	\$15,858	\$35.22	0.32%
Hoosier State	Story	376	\$25,048	\$66.70	0.27%
Totals		140,128	\$7,141,739	\$50.97	

See footnote 37.

Not much on milling appeared in subsequent reports by the Mineralogist, and with the abolition of the office in 1879 public reports on mining and milling on the Comstock and in Nevada almost ceased entirely. Some new mills were built and some old ones refurbished during the boom years of the middle 1870s, but as the boom receded, many mills, new, old and remodeled, were abandoned. The mills that continued to have some business were the tailings mills because as the output of ore from underground fell, the tailings were seen as potentially profitable especially as the techniques for recovering minerals from them were being improved. The state of the mines rather than the mills remained the principal interest of the official investigators.

Links:

⁴⁰ "Biennial Report of the State Mineralogist...1873 and 1874" *Appendix to Journals of Senate and Assembly*, 7th Legislative Session (1875), 107. The percentage calculations are mine.