

**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION**

CLEANUP AND ABATEMENT ORDER NO. R5-2014-XXXX

**ATLANTIC RICHFIELD COMPANY
UNITED STATES DEPARTMENT OF AGRICULTURE,
UNITED STATES FOREST SERVICE**

**WALKER MINE TAILINGS
PLUMAS COUNTY**

CLEANUP AND ABATEMENT ORDER NO. R5-2014-YYYY

ATLANTIC RICHFIELD COMPANY

**WALKER MINE
PLUMAS COUNTY**

EXPERT WITNESS STATEMENT

of

FREDRIC L. QUIVIK, PhD.



17 January 2014

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I. GENERAL REMARKS**A. Statement of the Problem**

The Walker mine, located in Plumas County, California, produced copper ore during the period 1916-1941. The Walker Mining Company, which operated the mine, was controlled by the International Smelting & Refining Company. International was in turn a wholly-owned subsidiary of the Anaconda Copper Mining Company (ACM), which changed its name to The Anaconda Company in 1955. The Atlantic Richfield Corporation (ARCO) acquired and merged with The Anaconda Company in 1977. The mine is now discharging copper and other pollutants into the Little Grizzly Creek watershed, and threatens to discharge acid mine drainage as well. The California Regional Water Quality Control Board for the Central Valley Region, which has jurisdiction over such discharges, has investigated conditions at the Walker mine and proposed separate Cleanup and Abatement Orders regarding the Mine and Tailings against ARCO, the oil company that is the corporate successor to the ACM.

B. My Assignment/Personal Background/Qualifications

My name is Fredric L. Quivik. I am a historian by profession. My specialty is the history of technology and industrial history. I am the author of the following witness statement on the matter of the Central Valley Regional Water Board's proposed Cleanup and Abatement Orders regarding the Walker Mine and Tailings (R5-2014-XXXX and R5-2014-YYYY) against ARCO.

In August 2013, the California Regional Water Quality Control Board for the Central Valley Region asked me to investigate the history of the Anaconda Copper Mining Company and its relationship with the Walker Mining Company, which operated the Walker mine in Plumas County, California. The Water Board asked me to pay particular attention to the question of whether officials of the ACM or its subsidiary International managed or directed the operations of the Walker Mining Company at the Walker mine.

As an industrial historian, I am academically trained in the history of technology and I have extensive experience in the field of industrial history, both in the context of litigation and in other applications. I earned a PhD in History and Sociology of Science from the University of Pennsylvania, and I have developed expertise in the history of technology, especially mineral processing technologies, as well as expertise in related fields, such as the history of big construction projects like bridges and dams. I have worked as a consultant since 1982, when I formed an historic preservation consulting firm, Renewable Technologies, Inc. (RTI), in Butte, Montana. Through both my academic training and my professional experiences, I have developed expertise in using the historical method.

The historical method is well-established and widely used by reputable historians in conducting inquiries and reaching conclusions. It allows historians to ask questions about the past which spring from our concerns in the present. The purpose of the historical method is to allow a historian to reconstruct, as reliably as possible, a truthful rendition of occurrences in the past. It involves developing questions to guide research, finding sources of information that

allow one to answer those questions, evaluating the authenticity and credibility of the information, and then using the information to create a coherent and verifiable narrative recitation of the past. Such a work of history must include sufficient detailed references to the sources of information upon which it relies to allow a reader to evaluate the work.

In the process of my academic course work and professional experience, I have had to demonstrate my ability to use the historical method, both by evaluating the effectiveness of various other authors and scholars in applying the historical method, and by writing research reports using the historical method.

I received a Bachelor of Arts degree from St. Olaf College in Northfield, Minnesota, in 1971. As part of my coursework, I took classes in mathematics and the sciences; my science courses included chemistry and physics. In those classes, I was introduced to the scientific method. The scientific method involves developing hypotheses and conducting tests in a laboratory or the field to test those hypotheses. I also learned how the scientific method had evolved historically. This knowledge about the scientific method has helped me to identify problems that need to be solved, and to decide how to approach them from a scientific viewpoint, and is thus relevant to my work as a historian of technology.

I earned a Bachelor of Environmental Design from the School of Architecture at the University of Minnesota in Minneapolis in 1975. Through that course work, I increased my general familiarity with the engineering profession with more specific knowledge about the kinds of problems that engineers address and how they solve them. I also took courses in architectural history, the history of technology, and American history, all of which provided me with important background and experience.

I then obtained a Master of Science in Historic Preservation from the Graduate School of Architecture & Planning at Columbia University in New York City. At Columbia, I took courses in preservation design and American architecture. I also took graduate courses in the History Department. The graduate courses in history provided my first formal introduction to the historical method. I learned and applied the method in papers I wrote at Columbia.

In 1990, after working for more than thirteen years in Butte, Montana, I decided to return to graduate school and work toward a PhD in the history of technology. I was accepted into the Department of History and Sociology of Science at the University of Pennsylvania in Philadelphia. The history of technology program in the Department of History and Sociology of Science is widely regarded as one of the best in the United States. Through my course work for the PhD at Penn, which I received in 1998, I gained further training in history and the historical method. I chose to focus my scholarly work on industrial history and in particular the history of mining and mineral processing.

While at Penn, I worked as a research assistant to Professor Thomas Parke Hughes, who at one time had been Chairman of the Department of the History and Sociology of Science. One of Professor Hughes' specialties was the study of the organization and management of complex, large-scale technological systems. Through my work for Professor Hughes, and the courses that I took with him, I learned to analyze historical examples of such systems. I also received more

intensive training in historical methods, research and writing. I have used this experience with Professor Hughes in my work as an expert witness, especially in the Pinal Creek, Midnite Mine, and Lava Cap cases described below. In each of those three cases, the major focus of my work was on the organization and management of a mining enterprise which was diverse geographically and which had key managers located at considerable distance from actual mining operations.

After completing course work and passing qualifying exams for the PhD degree, I worked on my dissertation. A PhD dissertation is a work of significant and original scholarship. My dissertation is entitled “Smoke and Tailings: An Environmental History of Copper Smelting Technologies in Montana 1880-1930.” Completed in 1998, my dissertation is a historical analysis of the mining and metallurgical technologies employed by the Anaconda Copper Mining Company and its predecessors in Butte and Anaconda, and in particular the ways in which those technologies interacted with the environment. Because of my knowledge and training in history and the history of technology, I was able to understand the technologies and then to research and analyze how developments in metallurgy were related to political and legal conflicts of the time concerning the impacts of those technologies on the environment.

While a student at Penn, I prepared and presented several papers at scholarly conferences. The papers were on such topics as the history of EPA’s Superfund program as a technological system, and the environmental impacts of mining and smelting. Since receiving my PhD from Penn in 1998, I continue to present papers on these and other topics at scholarly conferences. I have revised some of the papers for publication. A complete list of my scholarly presentations and publications may be found in my curriculum vitae, attached to this report as Exhibit 1.

In addition to my scholarly training, I have considerable professional experience as an historian. In 1982, I founded the firm of Renewable Technologies, Inc. (RTI), a historic preservation consulting firm in Butte. I did some work in preservation architecture, but I moved my focus toward projects involving historical research and writing. I worked on an evaluation of the historic mining town of Jardine, Montana, including a survey of the structures and landscapes that were associated with mining and processing gold and tungsten ores. I also worked on projects involving old mining camps where mining companies wanted to resume mining. All of these projects involved research into relevant primary documents. To prepare myself for these projects, I studied relevant historical engineering texts that described such fields as the theory and practice of mining and metallurgy and the design and construction of bridges and dams.

During the 1980s, RTI had a contract with the Butte Historical Society to develop a master plan for the preservation and interpretation of industrial sites in Butte and Anaconda, most of which were associated with mining and metallurgical enterprises. Anaconda is the smelter city about 26 miles west of Butte. The project included researching the histories of the thirteen surviving steel head frames in Butte and their associated mine yards. It also included researching the three historic smelter sites adjacent to Anaconda. As a part of the project, I researched the corporate and technological history of the Anaconda Copper Mining Company.

During two summers while studying for the PhD at Penn, I worked for the Historic American Engineering Survey, National Park Service, researching and writing a business and

technological history of the Connellsville Coke Region in southwestern Pennsylvania. The project thereby gave me the opportunity to study large corporate combinations in the early twentieth century and to study the history of an important energy sector, that which provided metallurgical fuel to the iron and steel industry.

I also have experience as an industrial archeologist. Unlike many historians who generally derive information solely from written documents, archaeologists derive information through their analysis of artifacts. Not all information about our industrial past was written down. Industrial archeologists supplement the written record of our industrial past with information derived from artifacts. Such artifacts may be maps, illustrations, photographs, objects produced by an industrial operation, pieces of industrial equipment, buildings that house industrial equipment, entire industrial complexes or sites, or even an industrial landscape.

I became a member of the Society for Industrial Archeology in about 1980. As a result of membership in the organization, I have been able to work with others who practice in the field of industrial archeology. I have learned from their experiences about the kinds of analyses they do, and I have applied those skills in my own work. At annual meetings of the Society for Industrial Archeology, one full day is dedicated to studying industrial processes at operating industrial enterprises. The Society arranges for process tours through industrial operations, some of which are old and historic, and some of which are very modern. The purpose of these tours is to see the processes and systems of production, to talk to employees and managers, and thus to develop a better ability to understand a wide array of industrial processes. I apply these experiences when I study a particular industrial site; it makes me better able to comprehend whole systems. The information I derive from non-written sources makes me better able to understand what is described in written documents. This deeper comprehension helps me to ask more informed questions of the documents.

I served on the board of directors of the Society for Industrial Archeology for three years (1990-1993) and served as president of the organization for two years (1996-1998). Serving as president also entailed being vice president for two years (1994-1996) and past president for two years (1998-2000). Since January 2011, I have served as editor of the Society's journal, *IA: The Journal of the Society for Industrial Archeology*.

As a result of my expertise in industrial archeology, Michigan Technological University offered me a teaching position at the Associate Professor level. I accepted the offer and began teaching in January 2010. I teach courses in industrial heritage, history of technology, and environmental history in the Department of Social Sciences, which houses a graduate program in industrial archeology and industrial heritage. It is the only graduate program in industrial archeology in the U.S., offering both M.S. and PhD degrees. I am part of the group of faculty in the industrial archeology graduate program.

My expertise as a historian of technology, particularly a historian of mineral processing technologies, has been employed in several cases of Superfund litigation. Two of them involved the histories of ARCO and the Anaconda Copper Mining Company. I served as an expert historian for the United States in *U.S. v. ARCO* (the Clark Fork Superfund case in Montana). I was deposed by ARCO, but I did not testify at trial because the parties agreed to settle. I served

as an expert historian for the Pinal Creek Group in *Pinal Creek Group. v. Newmont Mining Corporation, et al* (the Pinal Creek Superfund case in Arizona). I was deposed by ARCO (one of the defendants in addition to Newmont), but I did not testify at trial because ARCO and the Pinal Creek Group agreed to settle. My opinions in the case concerned the corporate relationships between the Anaconda Copper Mining Company and its subsidiaries, including the Inspiration Consolidated Copper Company.

I have worked on four cases for which I testified at trial. I served as an expert historian for the United States in *U.S. v. Asarco, et al* (the Bunker Hill Superfund case in Idaho). My expert report concerned the history of silver, lead, and zinc mining and metallurgical operations in the Coeur d'Alene mining district. I was deposed by Asarco and the other defendant mining companies in the case, and I testified at trial in Boise, in January 2001 during the liability phase of the case and in July 2001 during the counter-claims phase. Judge Lodge ruled in favor of the U.S. citing my expert testimony in his opinion.

I served as an expert historian for the United States in *U.S. v. Newmont Mining Corporation, et al* (the Midnite Mine Superfund case in the state of Washington). I was deposed by Newmont, and I testified at trial in Spokane in July 2008. In my understanding, Newmont's defense was to assert that under U.S. corporate law a parent corporation is not liable for its subsidiary's actions; therefore, Newmont should not be held liable for its subsidiary's operations at the Midnite mine. In my expert report and in my testimony I showed that historically Newmont had managed its subsidiary's operations. Judge Quackenbush ruled that Newmont had managed its subsidiary's operations and so was liable under CERCLA as an operator of the Midnite mine. The Judge cited my testimony in his opinion (2008 WL 4621566 (E.D. Wash.)).

In November 2012, I testified for the United States in *U.S. v. Sterling Centrecorp*, the Lava Cap Superfund case in California. I testified about the history operations of the Lava Cap Mining Corporation, and I testified about the corporate relationship between Sterling Centrecorp, which acquired Lava Cap Mining Corporation's assets and liabilities, and Sterling's subsidiary Keystone Copper Corporation, which held title to the Lava Cap property. Judge England ruled in favor of the United States, citing my testimony extensively in his ruling that Sterling managed Keystone's operations (2013 WL 3166585 (E.D. Cal.)).

In December 2012, I testified for the United States in *U.S. v. Marmon Holdings*, the final trial in the series of trials concerning the Bunker Hill Superfund site in Idaho. I testified about the history of operations of the Golconda mill, which had been owned and operated by a Marmon predecessor, and my testimony included opinions concerning the Golconda mill's practice of discharging its tailings directly into the nearby stream.

I am working on one other case in which Atlantic Richfield is the defendant, *Gregory A. Christian, et al, v. BP/ARCO Corporation, et al*. My expert report offers opinions on the Anaconda Copper Mining Company's history of knowingly discharging contaminants, such as arsenic, onto the property of residents in Opportunity, Montana. ARCO has taken my deposition, but the trial has yet to be held.

C. Materials Considered and Methods Used

I used my training and experience in history and the history of technology, including the organization and management of technological systems, in writing my report in this matter. I began by developing general histories of the Walker Mining Company and the International Mining & Smelting Company operations from the 1910s through 1940s. International Smelting was a wholly-owned subsidiary of the Anaconda Copper Mining Company, a predecessor of ARCO. I developed the histories by reviewing secondary sources I had consulted in previous cases, in which I have researched the ACM, and by conducting research on the Walker Mining Company operations in *Engineering and Mining Journal*, the principal trade journal for the mining industry in the U.S., and *Mineral Resources of the United States/Minerals Yearbook*, an annual publication of the federal government summarizing major developments in the nation's mining industry.

In developing my opinions and in preparing this Declaration, I then considered the primary documents that the Water Board provided me. These are documents that a researcher at the Water Board retrieved from the Anaconda Geological Documents Collection at the American Heritage Center, University of Wyoming, and in the Papers of the Anaconda Copper Mining Company at the Archives of the Montana Historical Society. They are the kind of primary documents that a historian uses in drawing historical conclusions. As I reviewed documents for this case, I evaluated them to make sure that the information they contained was authentic and credible. The footnotes in this report comprise the list of my relied-upon documents.

D. Compensation

I am being compensated by the California Regional Water Quality Control Board as an expert witness in this matter at the rate of \$180.00/hr. for pre-trial consulting and at the rate of \$360.00/hr. for depositions and trial testimony.

II. SUMMARY OF OPINIONS

The purpose of this report is to provide as detailed a corporate and operational history of the Walker Mining Company and its Walker mine in California as documentation permits. Details of this history support my opinion that officials of the Anaconda Copper Mining Company and its wholly-owned subsidiary, International Smelting & Refining Company, managed the operations of the Walker mine during its roughly two decades of full-scale production. A summary of my opinions regarding the relationship between Anaconda/International and the Walker Mining Company is as follows:

- A. The Walker Mining Company developed and operated the Walker mine in Plumas County, California, from 1916 to late 1941, during which time the Walker mine was an important producer of copper in California.
- B. In 1918, the Anaconda Copper Mining Company, through its wholly-owned subsidiary International Smelting & Refining Company, acquired a controlling interest (50.4%) in the stock of the Walker Mining Company.
- C. During its period of operation, the Walker mine was one of the major suppliers of copper concentrates to the Tooele smelter of the International Smelting & Refining Company.
- D. During the time the Walker mine operated, the Anaconda Copper Mining Company was one the world's leading copper producers and one of the largest industrial corporations in the world, with mining, smelting, refining, and fabricating operations numerous locations in the United States as well as in Mexico and Chile.
- E. Like other large, complex, and geographically diverse industrial enterprises of the early twentieth century, the Anaconda Copper Mining Company developed a tightly-managed corporate structure that allowed top managers of the parent corporation to direct the operations of its several subsidiaries and far-flung operations. Anaconda's top managers in the areas of geology, mining, and metallurgy directed those facets of operations in the ACM's subsidiaries, including the Walker Mining Company.
- F. Although the Walker Mining Company had its own board of directors, corporate officers, and local managers, management of the Walker mine was fully integrated into the Anaconda Copper Mining Company's enterprise and its management system, so that the ACM's top managers in charge of geology, mining, and metallurgy directed activities at those area at the Walker mine. In this respect, the ACM and its subsidiary International managed the Walker mine concurrently with the Walker Mining Company from 1918 to 1941.

The main narrative of this report is divided into two sections. The first provides a chronological overview of the Anaconda Copper Mining Company, International Smelting & Refining, and the Walker Mining Company. The first section relies largely on secondary sources and on technical and professional journals from the period described. The second section is

divided into sub-sections that analyze various facets and periods in the relationship between Anaconda/International and the Walker Mining Company. It relies largely on primary sources: correspondence among ACM/International officials and managers responsible for the Walker mine, correspondence between ACM/International people and Walker Mining Company staff in California, annual reports of the Walker Mining Company, and unpublished reports produced by ACM experts during the period of the Walker mine's operation.

III. COMPLETE STATEMENT OF OPINIONS AND THE REASONS AND BASES THEREFOR:

A. CORPORATE AND OPERATIONAL HISTORIES OF INTERNATIONAL SMELTING & REFINING COMPANY AND THE WALKER MINING COMPANY

1. Historical Background of the Anaconda Copper Mining Company and the International Smelting & Refining Company

International Smelting & Refining Company was a wholly-owned subsidiary of the Anaconda Copper Mining (ACM). The two companies emerged in that parent-subsiary relationship in 1914 after more than a decade of corporate consolidation in the copper industry. The ACM had been the largest of several large mining companies operating in Butte, the world's most productive copper-mining district at the time. The Amalgamated Copper Company, a holding company, was incorporated in 1899 to consolidate those Butte corporations, including the ACM. After Amalgamated acquired control of their stock, the companies continued to operate as distinct corporate entities until 1910, when they deeded their property to the ACM, which then became the principle operating company in Butte, consolidating nearly all the mining operations there into a single technological system. Meanwhile, International, which was another company associated with Amalgamated, was consolidating as well, so that by 1914 it owned copper smelters in Utah and Arizona, a copper refinery in New Jersey, and a lead refinery in Indiana. That year, the ACM implemented a stock exchange with International shareholders, as of result of which the ACM emerged as International's sole shareholder. In 1915, Amalgamated ceased to exist, after it transferred all its stock holdings to the ACM. Those holdings included shares in the Inspiration Consolidated Copper Mining Company in Arizona and shares in Greene-Cananea Mining. Inspiration mined copper in the same mining district where International operated its Arizona smelter.¹

Over the next decade or so, the ACM developed a highly integrated corporate management structure, with several important individuals serving key positions on the ACM board and the boards of its subsidiaries. One was William Wraith, who began his work in Montana in 1897, three years after graduating from the Michigan College of Mines. He joined the staff of the Boston & Montana Consolidated Copper & Silver Mining Company (B&M) as an engineer. The B&M was acquired by Amalgamated in 1901 and then absorbed into the ACM in 1910. During that time, Wraith transferred to the Anaconda smelter, where he moved up the corporate organization. In early 1913, he was sent to Tooele, Utah, to take charge of the International Smelting & Refining Company's operation there, and he remained as manager after the ACM formally took possession of the Tooele smelter and reorganized the International

¹ F. Ernest Richter, "The Amalgamated Copper Company: A Closed Chapter in Corporation Finance," *The Quarterly Journal of Economics* 30 (1916): 387-407; and Isaac F. Marcossou, *Anaconda* (New York: Dodd, Mead & Company, 1957), 143-144.

corporate structure. He was then placed in charge of the Andes Copper operation at Potrerillos in 1916 and transferred to New York in 1918 to take administrative charge of Andes and, in 1923, Green-Cananea and Inspiration as well.²

W.D. Thornton was the son of an early Butte mining entrepreneur and became one of ACM president John D. Ryan's close associates shortly after the latter moved to Butte in 1901. They worked together on many business ventures. The two were allied in the formation of the Montana Power Company, which remained closely linked to the ACM for many years and of which Ryan became president in 1913. Thornton became president of Greene-Cananea. He was instrumental in negotiating the deal whereby the facility that would become the International Smelting & Refining Company's smelter at Tooele was able to lure the Utah Consolidated Copper Company's smelting contract away from ASARCO. When the ACM formed the International Smelting Company to take over ownership and operation of the International Smelting & Refining Company's properties, Thornton was one of the new company's directors.³

In 1916, International was a wholly-owned subsidiary of the Anaconda Copper Mining Company (ACM). Its president was Con Kelley, an ACM vice president. International vice president was W.D. Thornton, president of Anaconda subsidiary Greene-Cananea in Mexico; treasurer was Albert H. Melin, who had been secretary-treasurer of Amalgamated; secretary was David B. Hennessy. International directors included B.B. Thayer, who had been Anaconda president until 1915, when he became Anaconda vice president, and John D. Ryan, who had been Amalgamated's president until it dissolved in 1915, when he then took over from Thayer as Anaconda president. International's ore purchasing agent in 1916 was J.B. Whitehill. International owned and operated a copper and lead smelter at Tooele, Utah, and a copper smelter at Miami, Arizona, and it operated the Raritan copper refinery at Perth Amboy, New Jersey, and the smelter of the International Lead Refining Company at East Chicago, Indiana. Over the next fifteen years, International's top corporate officials changed little. In 1920, C.E. Mills, who was general manager of the smelter at Miami, joined International's board of directors, and William Wraith had been named general manager of the Tooele smelter. By 1922, J.O. Elton was general manager of the Tooele smelter. In the early part of this period, International only operated metallurgical facilities. It did not own mines, until 1926.⁴ It did, however, begin to own mining companies, such as the Walker Mining Company.

² A.B. Parsons, *The Porphyry Coppers*, (New York: American Institute of Mining Engineers, 1933), 331-332; Marcossou, *Anaconda*, 212-213.

³ Marcossou, *Anaconda*, 258; *Engineering & Mining Journal* 86 (12 December 1908): 1176; 97 (6 June 1914): 1164; Richter, "The Amalgamated Copper Company," 393; Carrie Johnson, "Electric Power, Copper, and John D. Ryan," *Montana: The Magazine of Western History* 38 (Autumn 1988): 24-37.

⁴ Walter Harvey Weed, *The Mines Handbook* (New York: The Stevens Handbook Co., 1916), 625; Weed, *The Mines Handbook* (New York: W.H. Weed, 1920), 88-93; Weed, *The Mines Handbook* (New York: The Mines Handbook Co., 1922), 98-103; Weed, *The Mines Handbook*, 1926 issue (New York: The Mines Handbook Co., 1927), 91-95; Lenox H. Rand and Edward B. Sturgis, *The Mines Handbook* (Suffern, NY: Mines Information Bureau, Inc., 1931), 96.

As described in the next section, International exercised an option in order to purchase controlling interest in the Walker Mining Company in 1918. In other acquisitions of mining property, International purchased all the stock of the Utah Consolidated Mining Company at a foreclosure sale in March 1924 and then incorporated the Utah Delaware Mining Company to become the successor corporation of Utah Consolidated. Utah Consolidated had operated mines in Utah's Tintic mining district before going bankrupt. That same year, International acquired the North Lily Mining Company, which owned properties in the Tintic district. Through the North Lily, International acquired and/or leased several neighboring properties in the Tintic district. During that period, International also gained control of the Park Utah Consolidated Mines Company. In 1926, International purchased the Potosi Lead mine, in Nevada's Yellow Pine district, from the Empire Zinc Company.⁵

The integrated nature of the ACM's corporate structure is nicely illustrated in a two-part series that appeared in *Fortune* in 1936 and 1937. The first article, appearing in December 1937, describes the history and the geographical reach of the company, featuring a two-page map labeled, "The United States of Anaconda." It shows the locations of the metal mines, smelters, refineries, fabricating plants, and support facilities, like a lumber mill and a coal mine, that the ACM and its subsidiaries owned in the U.S., Mexico, and Chile. The map has arrows showing how mines fed copper concentrates to smelters, smelters fed blister copper to refineries, and refineries fed copper to market, to rod and wire mills, and to brass and bronze factories. One of the mines featured on the map was the Walker mine in California, which fed copper concentrates to the International smelter at Tooele, Utah.⁶

The second article in the *Fortune* series describes the ACM's management structure and features a photograph of ACM president Cornelius Kelley and the top ACM executives sitting at a table in the New York corporate headquarters for their weekly meeting. Beneath the photo is an organizational diagram showing the ACM's major subsidiaries and the executives roles in those companies. Kelley was president of the ACM and most of the top tier of subsidiaries, including International Smelting & Refining. Thornton was president of Greene-Cananea. Wraith was vice president of Andes Copper, one of the ACM's Chilean subsidiaries. Another man at the table is Frederick Laist, who was the ACM's chief metallurgist in charge of research operations. *Fortune's* organizational chart for the ACM enterprise shows four International subsidiaries: Walker Mining Company, Utah-Delaware Mining Company, Mountain City Copper Company, and North Lily Mining Company.⁷

⁵ Walter Harvey Weed, *The Mines Handbook* (1916), 625; Weed, *The Mines Handbook* 1920), 88-93; Weed, *The Mines Handbook* (1922), 98-103; Weed, *The Mines Handbook*, 1926 issue (1927), 91-95, 1512-1513, 1521-1523; Rand and Sturgis, *The Mines Handbook* (1931), 96, 1912, 1866-1867, 1878-1879.

⁶ "Anaconda: I," *Fortune* 14 (December 1936): 88-89.

⁷ "Anaconda: I," *Fortune* 14 (December 1936): 88-89; "Anaconda: II," *Fortune* 15 (January 1937): 76, 143-144.

2. Historical Background of the Walker Mining Company

The Walker Mining Company was incorporated in 1913 under the laws of Arizona. The company located its offices in Salt Lake City, where president Joseph R. Walker resided, and its sole mining property was the Walker mine in Plumas County, California. In August 1916, the International Smelting & Refining Company, a wholly-owned subsidiary of the Anaconda Copper Mining Company, acquired an option to purchase control of the Walker Mining Company. In August 1918, International exercised its option, two months before the option was scheduled to expire, purchasing 630,000 shares of Walker stock (50.4% of total shares issued) at one dollar per share. The key changes to the Walker's management structure were that William Wraith was placed on the board of directors and J.B. Whitehill was named secretary-treasurer of the corporation. Wraith was general manager of International's Tooele smelter and Whitehill was International's ore purchasing agent.⁸

The Walker Mining Company had begun operating the Walker mine in Plumas County, California, in 1916. During the first few years of operation, the company transported ore from the mine shaft to the concentrator, nearly a mile away, by means of an aerial tramway. The original concentrator had a capacity to treat 75 tons of ore daily. Its capacity was quickly expanded, and by 1918 it was treating 200 tons per day. Because the mine and mill were located about twenty miles by road from Portola, to the southeast, the company built, in 1920, an 8.2-mile aerial tramway to haul concentrates from the mill to the Western Pacific Railroad at Spring Garden, southwest of the mine and mill, and to haul supplies from Spring Garden to the mine and mill. Operations at the mine and mill were suspended in October 1920, due to the slump in the copper market. Operations resumed in July 1922, about which time the Walker company began to develop plans for a new mill, based on testing done in the original mill. The new mill, located near the portal to an adit, driven about a mile to the mine workings, began operating in December 1923 with a capacity of 750 tons per day. The 205,903 tons of ore treated in 1924 was more than twice the volume of ore the Walker had treated at its old mill in 1923. Ore treated reached a peak in 1929, in September of which the Walker company doubled the mill's capacity to 1,600 tons per day.⁹

⁸ Walter Harvey Weed, *The Mines Handbook* (New York: The Stevens Handbook Co., 1916), 1202-1203; Weed, *The Mines Handbook* (New York: W.H. Weed, 1918), 608-609.

⁹ George Baglin, "Analysis of Facts and History of the Walker Mining Company, Subsidiary of the Anaconda Copper Mining Company," 24 November 1922 (Prosecution Exhibit 50), p 4; Weed, *The Mines Handbook* (New York: W.H. Weed, 1920), 492; Weed, *The Mines Handbook* (New York: The Mines Handbook Co., 1922), 542; Walker Mining Company, "A General Report of Operations of Walker Mining Company Ending April 30, 1923," n.d.; George J. Young, "Anaconda's Walker Mine and Mill," *Engineering and Mining Journal* 117 (3 May 1924): 725; Weed, *The Mines Handbook* (New York: The Mines Handbook Co., 1927), 554-555; Lenox H. Rand and Edward B. Sturgis, *The Mines Handbook* (Suffern, NY: Mines Information Bureau, Inc., 1931), 686-687; M.R. McKenzie and H.K. Lancaster, "Milling Methods at the Concentrator of the Walker Mining Co., Walkermine, California," U.S. Bureau of Mines Information Circular No. 6555, March 1932, pp 2-3.

With the onset of the Great Depression, the market for copper weakened, and the Walker Mining Company operations were intermittent in the 1930s. The longest period of suspended operations was early 1932 to sometime in 1935. Mine and mill closed for several months in some subsequent years, including 1937, 1938, and 1941, when they closed permanently. When it operated, the company continued to extract copper ore from the mine, mostly through the adit, which made contact with the underground workings at the 700-foot level. By 1940, the company had developed the adit about 8,000 feet along a shear zone where the ore bodies were located. There was not a continuous vein along the shear zone, however. Rather, the company encountered five distinct ore bodies, which it called the South, Central, North, 712, and Piute ore bodies. The richest had been the Central ore body, which in the early years had yield ore assaying as high as 4% copper. Other ore bodies yielded material about 1.5% copper. The company developed several shafts and other workings below the 700 level, in an effort to follow ore bodies downward, but in general they did not yield richer ore. They did yield ore in the range of 1.5% copper, which kept the company prospecting for more. Costs of extracting ore above the adit level, of course, was less than the costs of extracting ore from below that level, so the Walker's most profitable operations were in the upper areas of the mine. By 1940, capacity of the Walker mill had been increased to 1,800 tons per day.¹⁰

I have yet to see primary documents indicating the Walker Mining Company's corporate organization immediately after the ACM, through International, bought controlling interest. Weed reported in the 1916 edition of *The Mines Handbook* that the Walker Mining Company's officials included J.R. Walker, president; G.L. Bemis, vice president; and John F. Cowan, general manager. The 1916 edition did report, however, that the ACM, through International, had acquired an option to purchase shares of Walker stock. The 1918 edition of *The Mines Handbook* (the year International exercised its option) reported that Walker was still president, but now J.B. Whitehill (International's ore purchasing agent) was secretary-treasurer and the ACM's William Wraith was one of the directors on the Walker board. V.A. Hart was Walker's manager. The 1920 edition of *The Mines Handbook* reported that Walker was president, O.M. Kucks (who had become the superintendent of International's Tooele smelter in 1913 and was assistant general manager of International in 1920) was vice president, and Whitehill was secretary-treasurer.¹¹

¹⁰ Walker Mining Company, "Statement 1932," annual report dated March 15, 1933; Walker Mining Company, "Statement 1933," annual report dated March 17, 1934; Walker Mining Company, "Statement 1934," annual report dated March 25, 1935; Walker Mining Company, "Statement 1937," annual report dated March 24, 1938; Walker Mining Company, "Statement 1938," annual report dated March 14, 1939; Walker Mining Company, "Statement 1941," annual report dated April 1, 1942; Walker Mining Company, "Statement 1942," annual report dated March 31, 1943; Clyde E. Weed and Reno Sales, "Report Covering Present Conditions at the Walker Mine," 15 June 1940, p. 1 (Prosecution Exhibit 1, Item 238).

¹¹ Weed, *The Mines Handbook* (1916), 1202; Weed, *The Mines Handbook* (1918), 608; Weed, *The Mines Handbook* (1920), 492; Weed, *The Mines Handbook* (1922), 100.

Placing V.A. Hart in the position of manager of the Walker Mining Company suggests the ACM taking charge of the Walker's operations. Born in 1876, Vernon Abel Hart was a mining engineer who had graduated from the University of Missouri in 1906. After working as a geologist for the Cananea Consolidated Copper Company (the Mexican operating company owned by Greene-Cananea Copper Company, which was in turn owned by the ACM), he became a geologist and the superintendent of mines for International Smelting in 1915. When Anaconda, through its subsidiary International, took an option on the Walker Mining Company, International put Hart in charge of operations at the Walker mine. Reports on developments at the Walker, prior to International exercising its option, sometimes stated that the Walker was already a subsidiary of International, with Hart in charge of operations.¹² A report in early 1918 stated that the Walker mine was "being operated under bond by International Smelting interests, under the management of V.A. Hart."¹³

After International, on Anaconda's behalf, exercised its option to purchase the Walker Mining Company in 1918, improvements at the Walker mine ensued throughout the 1920s, including the construction of a new mill in 1924 and expansion of the mill's capacity toward the end of the decade. Because I have not seen documents that ARCO may have in its possession describing the exact nature of the management relationship between the Walker mine and the Anaconda/International organization, I must rely on other sources, and those sources suggest that Anaconda/International did indeed manage operations at the Walker mine. The most compelling direct statement is a 1920 report in *The Salt Lake Mining Review*, in which the Walker Mining Company president is cited making a statement about management of the mine. According to the report, "The Anaconda company is under contract with the Walker Copper people to operate the mine for the best interest of the Walker Copper and the management of the property has been entirely satisfactory to the Walker interests, he said."¹⁴

Although I have not seen a contract between Anaconda and the Walker Mining Company, I can attest that I have seen such contracts in other episodes of U.S. mining history, most notably in the relationship between Newmont Mining Corporation and its subsidiary, Dawn Mining Company. The agreement gave Newmont the means to participate directly in the management of Dawn's operations.¹⁵ Although I have not seen such a management agreement

¹² John William Leonard, *Who's Who in Engineering* (New York, John W. Leonard Corporation, 1922), 566; *Mining & Scientific Press* 118 (21 October 1916): 613; *The Salt Lake Mining Review* 19 (30 December 1917): 38.

¹³ *The Salt Lake Mining Review* 19 (30 March 1918): 39.

¹⁴ *The Salt Lake Mining Review* 22 (30 November 1920): 42. Please note that the quote is of *The Salt Lake Mining Review*, and not a direct quote of J.R. Walker.

¹⁵ I prepared an expert report concerning the management relationship between Newmont and Dawn in *U.S. v. Newmont USA Limited, et al*, the Midnite Mine Superfund case in Washington, and I testified about the relationship at trial in U.S. District Court in Spokane. Under terms of the 1956 agreement between Newmont and Dawn, Newmont was to provide Dawn with "management, technical, and administrative services." Newmont provided Dawn with its on-site

between Anaconda and Walker, the documentary record concerning management of geological and mining activities at the Walker mine is consistent with such an agreement having been in effect during the years of operation at the Walker mine, as the narrative below demonstrates.

Another document that suggests Anaconda's management role in operations at the Walker mine is a 1924 article in *Engineering and Mining Journal*, the leading trade journal of the mining industry in the U.S. Written as the new mill was nearing completion, the article describes both mining methods and operations at the old and new mills. The last paragraph of the article begins with the sentence, "The control of the [Walker] property as a whole is in the hands of the Anaconda Copper Mining Co., through its subsidiary, the International Smelting Co." The article's author then acknowledges the help he received from general manager V.A. Hart as well as superintendents of the property. He also notes that Anaconda's F.C. Torkelson superintended construction of the mill, and International's Julius Kurtz installed the electrical equipment at the mill.¹⁶ Such a practice was observed by Newmont in the case of its subsidiary's operation's at the Midnite mine as well. For day-to-day operations, like supervising the mine and the mill, Newmont would provide its subsidiary with a full-time manager, but for special activities, like construction, Newmont's managers took charge.

The earliest primary document I've seen showing the ACM's presence in the Walker corporate hierarchy is the company's 1923 annual report, which shows that J.O. Elton was vice president and Whitehill was secretary-treasure, and both men were on the board of directors. James Orr Elton was an ACM metallurgical engineer who had worked in the testing department of the Washoe Reduction Works at Anaconda, for the Anaconda Smelter Smoke Commission during the 1910s studying impacts of smelter smoke on the environment (the Commission grew out of an agreement between the ACM and the U.S. government in response to a suit the U.S. had brought against the ACM), and as assistant superintendent of the ACM's Great Falls smelter, before moving to Salt Lake City in 1922 to work for International as general manager of the Tooele smelter. In addition to his work for International, he served in later years as an official of several International subsidiaries: president of the North Lily Mining Company, manager of the Utah-Delaware Mining Company, director of Park Utah Consolidated Mines Company, and vice president and director of Walker. The Walker's annual reports in 1924 (the year the new mill went into operation), 1925, and 1926 showed that the ACM's William Wraith was again a vice president (along with Elton) and that Wraith was a director on an expanded board of directors. The 1927 annual report shows that Robert E. Dwyer had replaced Wraith as director and vice president. Dwyer had become an ACM vice president in 1926.¹⁷

resident manager and, from time to time, other top operations officials.

¹⁶ George J. Young, "Anaconda's Walker Mine and Mill," *Engineering and Mining Journal* 117 (3 May 1924): 730. The mill superintendent, by the way, was Walter C. Page, who had graduated from the Colorado School of Mines in 1915 and went from the Walker mill (and a brief stint at the Hardinge; see *Mining and Engineering World* 42 (5 June 1915): 1041, *Mining and Metallurgy* (June 1922): 46, and *Engineering and Mining Journal* 122 (23 October 1926): 670.

¹⁷ "Memorandum of Services of Messrs. Elton, Kellogg and Welch (H.V.), with the Anaconda

In my work as an expert witness in matters for which I was asked to develop opinions concerning management relationships between parent corporations and their subsidiaries, I have seen that the office of vice president of a subsidiary is often key in giving the parent a conduit for directing the subsidiary's manager of operations, a conduit for doing so within corporate norms that separate the parent from liabilities of the subsidiary. Such an officer will have a top management position with the parent, such as Elton had at International, having charge of operations for the parent's broad enterprise. This gives an official such as Elton access to all of the top experts in the parent's corporate hierarchy. At the same time, an official like Elton will serve as an officer with one or more subsidiaries, having executive charge of operations for each of those subsidiaries. A mining company's top operating official at the mine, mill, or smelter usually had a title like manager or general manager. He would typically report to the corporate officer in charge of operations. In the 1920s at Walker, Hart was the manager, and he reported to Elton, Walker's vice president, who also served as International's general manager. As long as Elton was wearing the hat of Walker vice president while directing Hart, he was observing the rituals of corporate separation that protected the parent from the liabilities of its subsidiary.¹⁸

The original Walker officials and minority stockholders were happy to receive such management expertise from the ACM. In a November 1922 interview, Walker president J.R. Walker said, "I believe that the minority stockholders should be congratulated in having a highly efficient organization like the Anaconda Mining company [sic] in charge of development and

Commission," unpublished, undated memo, Box 84b, General Files Prior to 1954, Record Group 70, Records of the U.S. Bureau of Mines, National Archives, College Park, MD; Weed, *The Mines Handbook* (1920), 492, 961; Weed, *The Mines Handbook* (1922), 100; Walker Mining Company, "A General Report of Operations of Walker Mining Company Ending April 30, 1923," n.d.; Walker Mining Company, "Report of Operations of Walker Mining Company for the Year Ending July 31, 1924," report dated 12 September 1924; Walker Mining Company, "Report of Operations of Walker Mining Company for the Year Ending July 31, 1925," report dated 18 September 1925; Walker Mining Company, "Report of Operations of Walker Mining Company for the Year Ending December 31, 1926," report dated 31 March 1927; Marcossou, *Anaconda*, 161; "Highest Honor in Metal Field Given to S.L. Man," (Salt Lake City) *Deseret News*, 8 February 1933.

¹⁸ I had opportunity in *Pinal Creek Group v. Newmont Mining Corporation, et al*, to observe the importance of the vice president in directing the operations of Inspiration. ACM officials with expertise in geology, mining engineering, metallurgy, and construction were able provide technical advice to Inspiration's vice president, who was also an official in the broader ACM enterprise. When I testified at trial in *U.S. v. Newmont Mining Corporation, et al*, the Midnite mine Superfund case tried in federal court in Spokane, I explained a similar system by which Newmont managed the operations of its several subsidiaries. For example, Marcus D. Banghart was Newmont's vice president of operations in the 1950s and 1960s. He also served a vice president of the Dawn Mining Company (which operated the Midnite mine) and other Newmont subsidiaries. Wearing the hat of v.p. for each of those subsidiaries, he was able to direct their on-site managers. When Newmont ran afoul of those corporate norms, it was when other Newmont officials, who had no title in the Dawn corporation, gave direction to Dawn operations.

exploitation of the property. The conduct of the affairs of the Walker Mining company [sic] by the Anaconda company has always been for the best interests of all the stockholders.”¹⁹

3. The Historical Context for Understanding Twentieth-Century Management of Large-Scale Mining Enterprises

In order to understand how the Walker Mining Company was managed historically, and how its management fitted within the larger ACM system, it is important to review mine management hierarchies during the first half of the twentieth century. Such organizational structures were described in standard texts of the mining industry.²⁰ Management methods in the mining industry match those described by Alfred D. Chandler, the foremost historian of American business corporations, who has described the evolution of management methods in American industry generally. As was typical of corporations in the United States of the twentieth century, stockholders owned shares in a mining company, and large mining companies often had hundreds if not thousands of stockholders. Representing the stockholders in the management of the corporation was the board of directors. In the words of J.R. Finlay, who wrote the chapter on mine organization for Peele's *Mining Engineers' Handbook*, "In large corporations the management comes to lie in a practically self-perpetuating committee of stockholders, called the 'Board of Directors.'" ²¹ Typically, directors of large mining corporations were composed partially of individuals representing institutions of finance and investment and partially of individuals expert in mining, metallurgy, and allied fields. The president of the corporation was the chief executive officer of the corporation. Large mining corporations also had vice presidents who were the executive heads of major departments. The chief operating officer was usually called the general manager. He was appointed by the president and board of directors. The superintendent of each of the operating departments (mining, milling, smelting, geology, mechanical and electrical engineering, accounting) reported to the general manager.²²

¹⁹ Baglin, "Analysis of Facts and History of the Walker Mining Company," 3.

²⁰ George J. Young, *Elements of Mining* (New York: McGraw-Hill Book Company, Inc., 1916), chapter on "Mine Organization and Operation," 507-540; Young, *Elements of Mining* (New York: McGraw-Hill Book Company, Inc., 1946), chapter on "Mine Organization and Operation," 625-658; Robert Peele, *Mining Engineers' Handbook* (New York: John Wiley & Sons, Inc., 1918), chapter on "Mine Organization and Accounts," 1268-1281; Peele, *Mining Engineers' Handbook* (New York: John Wiley & Sons, Inc., 1941), section 20 on "Mine Organization and Accounts," 2-12. Note that there was little change in the organization of a mining enterprise as described by Young and Peele in their volumes from the 1910s and their volumes from the 1940s.

²¹ Peele, *Mining Engineers' Handbook* (1918), 1268; Peele, *Mining Engineers' Handbook* (1941), 20-02.

²² Peele, *Mining Engineers' Handbook* (1918), 1268-1269; Young, *Elements of Mining* (1916), 509-510.

Beneath the general manager and his superintendents or department heads were foremen, shift bosses, and the workers who did the actual physical labor, like miners, muckers, trammers, mill men, and shop workers. An important part of the management structure was the system of daily, weekly, and monthly reports that foremen prepared for superintendents, superintendents prepared for the general manager, and the general manager prepared for the executives and directors. These reports allowed management to monitor grade of ore being worked, percentage of metal being recovered, costs being incurred, and work being accomplished. It was the responsibility of management to direct the operations, back down through the hierarchy, to ensure that output was maximized and costs minimized. George Young wrote:

In the operation of a mine, labor, power, materials and mechanical appliances are brought together to accomplish a specific end, the winning of ore or mineral, its treatment and the marketing of the products. Profit is the dominating motive. Stockholders put their money into an enterprise in order to make more money. The success of the business is measured by the dividends returned. In order to pay dividends the income must be greater than the outgo. Income is controlled by the grade of the ore, the percentage extracted and the selling price of the product. Outgo is controlled by good management. Good management means the close control of expenditures, efficient working and the coordination of all the parts which go to make up the whole. A comprehensive plan, a well-designed plant and the careful selection of staff men, foremen and workers is essential.²³

The Walker Mining Company abided by these principles of sound management, but it is important to understand that it did so as part of the larger, tightly-managed ACM system. Nature, of course, controlled the grade of the ore, but to the extent that the Walker ore body could be controlled by understanding it, the Walker Mining Company depended during its operating years upon services of the ACM, particularly its geology department, headed by Reno Sales, and its top mining engineer, William B. Daly (and later Clyde E. Weed). Walker's milling cost reports were circulated to the ACM's top metallurgist, Frederick Laist, to ensure that operations were being conducted as effectively as possible. A key Walker executive position was filled by J.O. Elton, a top manager in the ACM/International organization who ensured the efficient coordination of all the parts comprising the Walker whole, but Elton was free of operating biases toward the Walker mine, relative to the overall ACM/International system. From documents I have reviewed, it is apparent that the ACM monitored and controlled the geological, mining, and metallurgical facets of the Walker management structure that made the Walker mine as efficient and profitable as it was.

All the evidence (and I have reviewed a considerable volume of evidence concerning the ACM's oversight of the Walker's geological and mining operations, evidence assembled by the Water Board from the corporate records of the ACM held at the University of Wyoming and the Montana Historical Society) creates a clear and powerful pattern showing that the ACM had established an extensive, geographically-diverse but tightly-managed, corporate structure, that

²³ Young, *Elements of Mining* (1916), 510; Young, *Elements of Mining* (1946), 628.

the Walker Mining Company was part of the ACM structure, that the ACM controlled Walker, and that by means of such control the ACM managed the Walker's operations, including operations at the mine.

To appreciate the ACM's corporate structure and to distinguish it from a structure in which the Walker Mining Company would be a corporate entity with its own managers who were answerable solely to the Walker's executives and board of directors, I will lay out two models for organizing a mining operation. The first is what I call the traditional corporate hierarchy for a mining operation. Such an organization is described by George J. Young in his classic text, *Elements of Mining*. After a prospect has been proved worthy of large-scale investment and development, a corporation takes ownership of the right to mine the property and takes charge of the mining operation. The organizational structure for the operation resembles an hour glass, with the general manager at the narrow neck of the hour glass. Expanding above the focal point of the general manager, the hour glass broadens to the president and the other officers of the corporation. Above them, the hour glass broadens to the board of directors and then broadens again to all of the stockholders. Below the general manager, the organizational hour glass broadens to the professionals in charge of various facets of the operation including mining engineer, geologist, metallurgist, and accountant. The professional specialists supervise various foremen and shift bosses, who in turn supervise the workers who perform the vast bulk of the jobs necessary to a mining operation, including miners, powdermen, equipment operators, mill hands, shop workers, and bookkeepers. About the general manager, Young writes:

The chief operating official is the general manager, or as he is sometimes called, the managing director, general superintendent, or superintendent [this person at Walker mine was called the manager]. He is selected by the president and board of directors. Whether the mine is small or large the individual selected for the direct charge of the property must have technical knowledge, experience, and must have shown ability to manage men. Personality and character are not overlooked. Good management is one of the first requisites toward the success of a mining enterprise, and a man who has a successful record inspires confidence in the minds of the stockholders and directors. Tact, a keen business sense, and balanced judgment are essential factors in the success of a manager.

The general manager selects his own staff of technical assistants. As the members of the staff are directly responsible to the manager, it is desirable that they owe their appointments to him. The staff of a large mine consists of a mining engineer, geologist, metallurgist, mine surveyor, assayer, mechanical and electrical engineer, accountant, and very often a physician. The members of the staff are directly in charge of the separate departments or divisions of the work.²⁴

²⁴ George J. Young, *Elements of Mining* (New York: McGraw-Hill Book Company, Inc., 1916), 509-510. An almost identical text appears in the fourth edition of Young's *Elements of Mining* (1946), 626-627.

Such an organizational structure is evident in many of the nineteenth-century mining companies I have studied, including the Boston & Montana Consolidated Copper & Silver Mining Company (B&M) in Butte, and the Standard Mining Company in Bodie, California.²⁵ In each case, the general manager was hired by and accountable to the company's president and board of directors. When the manager needed the services of a specialist mining engineer, geologist, or metallurgist, he hired the expert, who then reported findings or made recommendations to the manager. Based on the findings or recommendations, the manager decided the course of action to take and was accountable to the president and board of directors for his decisions.

A different model began to emerge around the turn of the twentieth century as mines in various localities were consolidated under one or more dominant corporate umbrellas and as those corporations began to seek mines in other locations. An excellent example of this new model is the Anaconda Copper Mining Company (ACM), which began in the late nineteenth century as an exemplar of the traditional model of a company, with a single group of mines at Butte, Montana. The ACM was the largest of several Butte mining companies, including the B&M, which were acquired at the turn of the century by a giant holding company, the Amalgamated Copper Company. Although each of the Amalgamated companies continued to exist as a distinct corporate entity and to manage its own set of mines, mills, and smelter, Amalgamated almost immediately put a mining engineer, John Gillie, in charge of coordinating developments at the several Butte operations. In 1910, Amalgamated caused each of its subsidiary Butte companies to transfer its property and operations to the ACM, and in 1915 Amalgamated ceased to exist as a holding company, leaving the ACM as its successor. During that same period, John D. Ryan, Cornelius Kelley, and other top ACM/Amalgamated officials began acquiring mining and metallurgical properties elsewhere in the U.S. as well as in Mexico and Chile. To manage its far-flung operations and continue to develop new ones, the ACM went through an evolution of management structures, eventually settling on one described in the two-part article that appeared in *Fortune* in the mid-1930s. In addition to officers of the ACM itself, the enterprise's core group of managers included W.D. Thornton and William Wraith, who served as president and vice president, respectively, of several the ACM's wholly-owned, majority-owned, and non-majority owned subsidiaries. Other top managers included William B. Daly (and later Clyde E. Weed), Reno Sales, and Frederick Laist, who had charge of mining operations, geology, and metallurgical operations, respectively, throughout the enterprise.²⁶

In my work as an expert witness, testifying in Superfund litigation, I have encountered other instances as well in which a global mining enterprise created a management system in

²⁵ Quivik, "Captain Couch of the Boston & Montana: A Self-Trained Mining Engineer and the Industrialization of Butte's Copper Mining District," unpublished paper presented at the annual meeting of the Western History Association, Denver, CO, October 1995; "Gold & Tailings: The Standard Mill at Bodie, California," in *IA: The Journal of the Society for Industrial Archeology* vol. 29, no. 2 (2003): 5-27.

²⁶ "Anaconda I," *Fortune* 14 (December 1936): 88-89; "Anaconda II," *Fortune* 15 (January 1937): 76; Marcossou, *Anaconda*, 110, 259-261.

which the parent corporation's top officials could manage the operations of its several subsidiary corporations, even while the subsidiaries' local operations were managed by individuals wearing appropriate local subsidiary hats. A notable example of this management structure was that of the Newmont Mining Corporation, about which I testified in *U.S. v. Newmont, et al*, the Midnite mine Superfund case in the State of Washington. Newmont did not fit the traditional model of a mining enterprise; it was not a corporation that grew up around a mining operation at a single location. Rather, Newmont fit the model exemplified by the mature Anaconda. The two corporate histories, of course, were not identical. Anaconda emerged as a global corporation from a company that had operated a group of mines at a single place, Butte. Newmont on the other hand was created by W.B. Thompson to promote mining investments at a variety of locations. Despite the different origins, Newmont and the ACM evolved to have similar organizational structures for managing their respective arrays of mining properties. Each corporation owned a number of subsidiaries, some wholly-owned and some not. Each corporation had a group of corporate officials and top managers who were responsible not for one subsidiary but for one facet of operations, such as exploration, metallurgy, or operations, at several subsidiaries. And it was in this latter facet of their organizational structures that both Newmont and the ACM diverged from the traditional model.²⁷

A key feature in the way Newmont's management structure diverged from the traditional structure was evident in the relationships local managers of the various subsidiaries maintained with other corporate officials and employees. In the case of the Midnite mine operation, the president of Dawn and Dawn's board of directors did not find and hire a resident manager. Rather, the Newmont hierarchy selected a manager from within the Newmont community, and then the Dawn directors ratified the Newmont appointment. If the Dawn operation faced a major problem, the resident manager did not turn to his subordinates to help decide on a solution (although he certainly received valuable ideas and suggestions from them), nor did he hire outside experts in mining engineering, geology, or metallurgy, who would be accountable to him, and then, with their advice, make decisions for which he was accountable to Dawn's president and board. Rather, Dawn's manager remained a Newmont employee and part of the Newmont organizational structure. As part of the Newmont structure, he took direction from top managers at Newmont who were responsible for mining, geology, and metallurgy throughout the Newmont enterprise. And if the Dawn operation faced a major problem, the resident manager turned to his Newmont superiors for advice and direction.

U.S. v. Newmont was tried in federal court in Spokane in July 2008. I testified at trial about the various means through which Newmont managed the operations of the Dawn Mining Company, the Newmont subsidiary that operated the Midnite mine. The judge ruled that Newmont did indeed manage Dawn's operations and was therefore liable as an operator for response costs in the Superfund cleanup. The judge cited my testimony frequently in his ruling.

This arrangement, of top officials and managers of the parent directing staff and operations of the subsidiary, which was also the practice at the Walker mine, was not unusual in the development of American corporate management systems in the early twentieth century. The

²⁷ Fredric L. Quivik, "Expert Report," in *U.S. v. Newmont USA Ltd, et al*, 7 November 2006.

renowned historian of American business, Alfred D. Chandler, describes the evolution in his classic work, *The Visible Hand*. In the early twentieth century, even as American elected officials, judges, and government bureaucrats were debating whether and how to place limits on the extent to which corporations could consolidate (for example, the Clayton Act and the Federal Trade Commission Act were enacted in 1914), managers of large corporations were devising ever more effective means of control over enterprises that were increasing in scale, geographical breadth, and complexity. Chandler has called this change "The Managerial Revolution in American Business."²⁸ Through the process of mergers that characterized much of late-nineteenth- and early-twentieth-century American business history, a new corporate form came into being that Chandler calls "the managerial enterprise." His opening paragraphs of a chapter describing top management in the managerial enterprise are worth quoting at length, because they describe the early twentieth-century transition in management leading to the model adopted by the ACM to administer its geographically-dispersed operations.

The practices and procedures of modern top management had their beginnings in the industrial enterprises formed by merger rather than those that built extended marketing and purchasing organizations. The process of merger brought more persons, with more varied backgrounds, into top management. In the new consolidations a family or single group of associates rarely held all the voting stock. It was scattered among the owners of the constituent companies and the financiers and promoters who had assisted in the merger. It became even more widely held after the company sold stock to finance the reorganization and consolidation of facilities. After merger the initial administrative problems were more complex than those in the companies that grew by internal expansion. The facilities of the constituent companies had to be reshaped and their administration centralized. Moreover, a merger, the reorganization that followed it, and then the carrying out of the process of vertical integration all required continued planning.

The shift in strategy from horizontal combination to vertical integration first brought the managerial enterprise to American industry. In the terminology of this study a managerial firm differs from an entrepreneurial one in that full-time salaried executives dominate top as well as middle management. The owners no longer administer the enterprise. The experienced manufacturers, who helped to carry the merger and who, normally with the advice of one or two financiers, rationalized the facilities of a new consolidation, became the core of its top management. Although they were still large stockholders, they rarely controlled the company as did the owners of entrepreneurial firms. Moreover, they hired and promoted managers with little or no stock ownership in the company to head the new functional departments and the central office staff.

²⁸ The phrase is the sub-title of Alfred D. Chandler's prize-winning book, *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: Harvard University Press), 1977.

In carrying out the reorganization after the merger, these top managers began to define their specific tasks. The centralizing of administration caused them to institute uniform accounting and statistical controls. In hiring and allocating managerial personnel they began to think more systematically about evaluating managerial performance. And because the reorganization of production and the building of a sales and buying network created numerous and often conflicting claims for capital expenditure, these senior executives were increasingly forced to pay close attention to the systematic long-term allocation of capital and personnel. The methods fashioned during the process of consolidation and integration--sometimes the process took years--were further refined as the company began to grow and to compete oligopolistically with other large integrated enterprises.²⁹

In applying Chandler's description of the managerial revolution to the mining industry, one may substitute "experienced mining engineers, geologists, and metallurgists" for "experienced manufacturers."

As the ACM acquired more properties and absorbed some of the talent associated with those properties into the corporate hierarchy, one challenge to decision-making would be to avoid conflict arising from loyalties to the various locales being exercised by the various managers. The ACM eventually adopted an organizational model to surmount the challenge that was pioneered, according to Chandler, by General Motors. As the 1920s unfolded, General Motors perfected a system for managing several autonomous but integrated divisions. General Motors' central executive committee had on its staff specialists with expertise in each of the functions, like sales or manufacturing, performed by the several divisions. The central staff specialists therefore reviewed all of the reports and procedures of each division's sales managers, manufacturing managers, etc. Chandler describes other techniques developed at General Motors as well to enhance the management of a large, complex enterprise featuring several operational divisions, each with parallel and nearly identical functions.

By these several techniques top management was able to free itself of operating biases and responsibilities, and at the same time keep in touch with the corporation's widespread operations. Policy and planning were no longer made through negotiations between the senior managers of powerful operating departments or divisions. Policy was formulated by general executives who had the time, information, and psychological commitment to the enterprise as a whole, rather than to one of its parts.³⁰

This characterizes the top corporate officials, executives, and managers of the ACM enterprise very well. They were committed to the ACM enterprise as a whole; they wanted each of the ACM's ventures to prosper, both to feed profits and dividends to the ACM balance sheet and to provide the ACM's engineers and managers with engineering and management challenges that

²⁹ Chandler, *The Visible Hand*, 415-416.

³⁰ Chandler, *The Visible Hand*, 462-463.

they could surmount, and then carry their experiences and successes to other ventures, each with its own set of challenges and each, hopefully, contributing profits to the ACM's coffers and to the ACM's stockholders.

B. HISTORICAL DETAILS IN THE ACM'S MANAGEMENT OF THE WALKER MINING COMPANY'S OPERATIONS

In order to understand the various roles in managing a mining operation, it is important to appreciate the several facets involved in extracting ore from the ground, processing the ore to make it ready for transportation and smelting, and then smelting and refining the ore to produce pure metal (in this case copper) for the market. Some mining companies only extract ore, relying on others to mill and smelt their ore. Other companies, as the Anaconda Company Mining Company was, are fully integrated and possess the technical and management capabilities to mine, mill, and smelt ore. The International Smelting & Refining Company, as its name suggests, originally specialized in smelting and refining materials produced by others, but in time International developed its own mining and milling operations as well. The Walker Mining Company mined and milled its own ore but did not smelt it.

Mining, in turn, consists of several facets in addition to the production of ore from sub-surface deposits. Exploration entails the systematic search for ore, either by opening the ground with trenches, shafts, or adits, or by drilling. When ore is found, the next step, before production of ore can commence, is development, which entails the systematic excavation of underground workings so designed to allow for efficient extraction of ore. Only when ore is extracted from a mine can the mining operation yield revenue. Occasionally, underground workings can be developed in ore, so the mine can yield some revenue. Often, however, development work is conducted in rock that is above, below, or adjacent to the ore body and is rock that has no value. Such development work is a cost to the mining company, but it yields no revenue and is therefore called "dead work." Mining companies try to keep dead work to a minimum, yet they must always undertake sufficient development of new underground workings, opening new portions of the ore body, for the mine to keep producing. Moreover, the development work—the shafts, crosscuts, and drifts that give miners access to underground bodies of ore—should be well-designed to allow for the efficient conveyance of ore to the surface, where it can be further processed.³¹

Had the Walker Mining Company been an independent enterprise with a conventional management structure for the Walker mine, as outlined by Young, a geologist and a mining engineer, hired by and responsible to the manager, would have had charge of prospecting for extensions of the veins and of developing underground workings to access the ore.³² Because the Walker Mining Company was integrated into the management structure of the Anaconda Copper Mining Company, however, exploration and development were directed not by the manager of

³¹ Young, *Elements of Mining*, 394-402.

³² Young, *Elements of Mining*, 509-513.

the Walker mine but rather, as the following narrative will show, by high-ranking specialists in the Anaconda organization, including high-ranking officials in the International organization in Salt Lake City, who had no positions with the Walker Mining Company.

Documents I have reviewed for this matter show that the Walker Mining Company did have a local manager, but that decisions about exploration and development—decisions about whether and how to explore for new ore and how to develop the underground workings to yield both an effective operation and enhance the likelihood of finding new ore bodies—were made by Anaconda/International officials. The Anaconda/International geologists and mining engineers in Butte and Salt Lake City who directed exploration and development at the Walker mine coordinated with the local manager, to be sure, because it would be miners and foremen working under the manager's direction who would implement the development work. Moreover, the local Walker geologists, although on the Walker payroll while at the mine, did not answer to the Walker manager but rather to the geologists in the Anaconda/International organization. The documents show numerous occasions in which ACM or International managers, who had no official positions within the Walker organization, gave direction directly to the local Walker staff, bypassing the Walker manager.

In sum, documents suggest that, as the management relationship between the ACM and Walker evolved, the geologist and engineer at the Walker mine, who would normally have reported to the Walker's general manager, reported instead to International's chief geologist and International's manager of mines. The narrative below describes this evolving management structure by narrating episodes in the history of operations at the Walker mine that show how the ACM managed operations there.

For example, in 1922, in preparation for construction of the new mill at the Walker mine, Walker manager V.A. Hart did not contract with a metallurgical consultant to help plan and design the mill. Rather, the ACM sent Bernard Morrow, superintendent of concentration at the Washoe Reduction Works, to California to analyze the current Walker mill. Morrow circulated his report among the ACM hierarchy, and top officials like Frederick Laist and William Wraith conferred before recommending to Elton the developments that the Walker should implement in building a new mill.³³

Similarly, the ACM's top geologist, Reno Sales, had sent ACM geologists to California in 1923 to recommend development work that Walker manager Hart should undertake. For example, at the 600 level, Hart was to develop a straight drift that was roughly parallel to the vein, which exhibited fluctuations. Crews would then develop crosscuts to the vein every one hundred feet. Rather than driving a straight drift, however, Hart had had his crews try to follow the richest part of the vein, resulting in a very crooked drift that would not be effective for production and further development. Sales was frustrated that Hart was not following

³³ Bernard S. Morrow, "Inspection of the Walker Mining Company's Concentrating Plant Located Near Spring Garden, Plumas County, California," unpublished report dated August 1922 (Prosecution Exhibit 1, Item 5); William Wraith to Frederick Laist, letter dated 31 August 1922 (Prosecution Exhibit 1, Item 6).

instructions. Sales wanted to establish lines of communications so that his office could direct Hart's development of the Walker mine without having to go through Elton.³⁴

Evidently such a process was established; in October 1923, Paul Billingsley, an ACM/International geologist, wrote Hart summarizing the decisions that had been made at a meeting the previous day concerning development work that would be undertaken at the Walker mine. Writing on behalf of International, Billingsley closed by stating that Hart should consider the letter authorization to begin the work. I have seen nothing to suggest that Billingsley wore a Walker hat, and he did not indicate to Hart that he was writing as a Walker official.³⁵ More than a decade later, Sales was corresponding with and giving direction to the Walker geologist in California, and the geologist was reporting directly on his work to Sales.³⁶ Such a pattern of local geologists working under the direction of Sales and others in the Anaconda/International organization, and without Walker titles, obtained from 1923 until the mine closed in 1941.

In September 1923, Billingsley had sent Elton the six recommendations that ACM geologist M.H. Gidel had made earlier in the month concerning development work to be undertaken in the Walker mine. In his cover letter to Gidel's recommendations, Billingsley informed Elton which of them he thought the Walker company should follow and which were unnecessary. At the bottom of each recommendation is the line, "Recommended by M.H. Gidel." At the bottom of the recommendations Billingsley approved is the line, "Approved by Paul Billingsley." Even though Billingsley was writing to Elton about work to be undertaken by the Walker Mining Company, Billingsley did not address Elton as a Walker official but rather as manager of International Smelting.³⁷

People at the Walker Mining Company would correspond directly with top ACM officials, rather than communicating through Elton. For example, in early 1922, F.C. Torkelson wrote a letter directly to Frederick Laist describing conditions at the Walker mine and mill and

³⁴ Paul Billingsley to J.O. Elton, letter dated 14 September 1923 (Prosecution Exhibit 1, Item 14); Reno Sales to Billingsley, letter dated 20 September 1923, (Prosecution Exhibit 1, Item 15).

³⁵ Billingsley to V.A. Hart, letter dated 12 October 1923 (Prosecution Exhibit 1, Item 16). After completing BS & MS degrees at Columbia University in 1908 and 1910, respectively, Paul Billingsley moved to Butte to work for the Anaconda Copper Mining Company. The ACM transferred him to its subsidiary, International Smelting in Salt Lake City, where he worked to find and develop ore for the International smelter at Tooele; see M.S. Hedley, "Memorial to Paul Billingsley," *Geological Society of America Bulletin* 75 (September 1964): 133-134.

³⁶ Sales to Seth K. Droubay, letter dated 27 October 1937 (Prosecution Exhibit 1, Item 119); Droubay to Sales, letter dated 1 November 1937 (Prosecution Exhibit 1, Item 120).

³⁷ Billingsley to Elton, letter dated 14 September 1923 (Prosecution Exhibit 1, Item 14); Recommendations for Development, nos. 1-6 (Prosecution Exhibit 1, Item 14).

the recommendations that he, Torkelson, had made to Elton and Hart for improvements.³⁸ As noted above, Torkelson was an Anaconda engineer, sent to the Walker mine to oversee construction of the new mill.

1. Management of Mining Operations at the Walker Mine

V.A. Hart served as manager of the Walker mine until early 1924, when he was replaced by I.L. Greninger, who served until the end of the year. Greninger had worked at the Inspiration Consolidated Copper Company's flotation mill in Arizona. In January 1925, Herbert R. Tunnell was named manager of the Walker Mining Company's operations. He had been foreman of the ACM's Pennsylvania mine in Butte prior to taking the position at the Walker mine.³⁹ During his tenure as manager at the Walker mine, Tunnell reported to and took direction from a number of people in the Anaconda/International organization who had no positions with the Walker Mining Company. Regarding exploration and development, that direction was typically funneled through Tom Lyon, International's chief geologist. Lyon had graduated from the Montana School of Mines in Butte in 1916 and went to work as a junior geologist for the ACM. In 1922, the ACM transferred him to work as a geologist for International in Salt Lake City. He became International's chief geologist in 1926.⁴⁰ I have seen no evidence of Lyon ever having a title with the Walker Mining Company.

As outlined above, had the Walker Mining Company been managing its own operations, Tunnell, as the manager of operations, would have reported directly to the Walker officers and board of directors. Had he need of geological or mining engineering expertise, he would have hired a geologist or mining engineer, who would have reported to him. Together with his expert subordinates, he would have made decisions about exploration and development, for which he would have been answerable to the Walker officers and board of directors. Instead, as the correspondence shows, Tunnell took direction from geologists and mining experts in the Anaconda/International organization who had no Walker titles. The chain of command for managing operations, from the Anaconda Copper Mining Company, down through International, to the Walker Mining Company, was evident in the second half of 1925, when a number of new developments in the mine workings, including drifts and crosscuts as well as vertical connections between levels, had to be determined.

The episode featured visits to the Walker mine by Reno Sales, the ACM's chief geologist, William B. Daly, the ACM's manager of mines, and Tom Lyon, International's chief geologist. And decisions that were made involved direction from B.B. Thayer, ACM vice president, and William Wraith, a top ACM official with positions as officer and/or director of

³⁸ F.C. Torkelson to Frederick Laist, letter dated 4 November 1922 (Prosecution Exhibit 1, Item 7).

³⁹ *The Anode* 1 (April 1915): 3.

⁴⁰ "Lyon Pulls Out," *The Kansas City Star*, 24 June 1953.

several ACM subsidiaries, including the Walker Mining Company, for which he was then serving as director and vice president. When Tunnell wrote Wraith, reporting on the developments that were underway, he copied Thayer, Elton, and Lyon.⁴¹ Among the decisions were the location and sequencing of the excavation of winzes and/or raises linking levels of mine workings. The correspondence shows that Tunnell awaited approval from Lyon before proceeding with development work: “Regarding the proposed shaft and winze, I believe we should do the preliminary work at once and as you approve the locations suggested in my letter we will get the hoists installed as soon as possible.”⁴² On August 28, Lyon wrote Tunnell, “By this time you have had my letter of August 25th regarding the development work proposed by you. I think that letter will give you the authority to proceed with the winzes as you are able.”⁴³

Such authorization of work by Lyon continued into the fall and winter. At the end of September, Lyon wrote Tunnell, “Mr. Billingsley is now back and will visit the Walker mine next week and will take up the matter of development work at that time. During the interval you are authorized to drift north and south on the ore disclosed by crosscut 647 S. Crosscutting will be recommended by Mr. Billingsley.”⁴⁴ In early February 1926, Tunnell wrote Paul Billingsley, “The following work is being done with the approval of Mr. Wm. B. Daly,” and he went on to describe drifting Walker crews were doing.⁴⁵ Reference to Daly concerned his recent trip to the Walker mine. After Daly returned to Butte, he discussed conditions at the Walker mine with Reno Sales, and the two developed plans for further exploration, which Daly then proposed in writing to Con Kelley. In a letter to Billingsley, Sales reported that Kelley had approved the exploration plans. Sales also instructed Billingsley how to communicate findings and recommendations from a pending trip Billingsley was to take to the mine; he was to write Sales and Daly in Butte, rather than sending copies of his reporting to the ACM’s New York office. Then Daly would forward Billingsley’s letter to Kelley, along with comments.⁴⁶

Likewise, Paul Billingsley was approving exploration and development work being undertaken at the Walker mine, and he was doing so in part based on direction from Butte. In 1926, exploratory drilling and a new crosscut at the 600 level were underway. Tunnell kept

⁴¹ Report of the Walker Mining Company for the Year Ending July 31, 1925; Report of the Walker Mining Company for the Year Ending December 31, 1926; Sales to B.B. Thayer, letter dated 20 July 1925 (Prosecution Exhibit 1, Item 34); H.R. Tunnell to William Wraith, letter dated 19 August 1925 (Prosecution Exhibit 1, Item 37); Tom Lyon to William Wraith, letter dated 20 August 1925 (Prosecution Exhibit 1, Item 38); H.R. Tunnell to Tom Lyon, letter dated 25 August 1925 (Prosecution Exhibit 1, Item 39).

⁴² Tunnell to Lyon, letter dated 27 August 1925 (Prosecution Exhibit 1, Item 40).

⁴³ Lyon to Tunnell, letter dated 28 August 1925 (Prosecution Exhibit 1, Item 41).

⁴⁴ Lyon to Tunnell, letter dated 29 September 1925 (Prosecution Exhibit 1, Item 44).

⁴⁵ Tunnell to Billingsley, letter dated 4 February 1926 (Prosecution Exhibit 1, Item 52).

⁴⁶ Sales to Billingsley, letter dated 9 February 1926 (Prosecution Exhibit 1, Item 53).

Billingsley and others apprised of progress, indicating that he would continue drilling “hole D” until he received instruction from Billingsley to cease. When the hole had reached a depth of almost 500 feet, Billingsley instructed Tunnell to cease, but Tunnell had just learned that William B. Daly, the ACM’s mines manager in Butte, wanted the hole extended to 1,000 feet. When the hole exceeded 1,400 feet, Daly told Tunnell that drilling could cease, subject to Billingsley’s approval, which the latter provided on June 1. Regarding the crosscut, Tunnell wrote Billingsley that he was ready to commence, subject to Billingsley’s approval, and Billingsley responded with approval of the plan.⁴⁷

The overall plan for exploration, development, and mining at the Walker mine was being overseen by the ACM’s top officials, as is evident in a February 1926 letter from Sales to Billingsley. William Daly had visited the Walker mine in early 1926. While there, he approved development of a drift along the vein that would be parallel to the main adit and that would be connected to the main adit by crosscuts at 100-foot intervals. After Daly returned to Butte, he met with Reno Sales, and the two agreed on a plan for the Walker. Based on that meeting, they developed a set of recommendations for exploration and development at the Walker, which Daly sent to Con Kelley in writing. Kelley authorized the work.⁴⁸

A 1927 letter from A.D. Hunter of the Accounting Department in Salt Lake City to new Walker manager H.A. Geisendorfer shows how fully the Walker Mining Company was integrated into the International operations management system. The letter is on Accounting Department letterhead; above the name of the department is the phrase, “Inter Departmental Correspondence.” Flanking the name of the department are the names of the companies served by the Accounting Department in Salt Lake City: International Smelting Company, Tooele Valley Railroad Company, Utah-Delaware Mining Company, North Lily Mining Company, Walker Mining Company, East Tintic Coalition Mining Company, and Pelleyre Mining & Milling Company. Hunter notified Geisendorfer of concerns that a filing fee may not have been made to accompany an application for a patent on some land near the new mill and surface plant at the Walker mine. Signing his name over the title, cashier, without reference to any particular company, Hunter instructed Geisendorfer in steps to take to clear up the matter with attorneys who had represented the Walker company in the transactions with the U.S. Land Office.⁴⁹

⁴⁷ H.R. Tunnell to Billingsley, telegrams dated 14 and 16 April and 31 May 1926 (Prosecution Exhibit 1, Items 59, 61 and 63); Billingsley to Tunnell, telegrams dated 14 April and 1 June 1926 (Prosecution Exhibit 1, Items 60 and 64); Tunnell to Billingsley, letter dated 24 May 1926 (Prosecution Exhibit 1, Item 62); Billingsley to Tunnell, letter dated 2 June 1926 (Prosecution Exhibit 1, Item 65).

⁴⁸ Tunnell to Billingsley, letter dated 4 February 1926; Sales to Billingsley, letter dated 9 February 1926 (Prosecution Exhibit 1, Item 52).

⁴⁹ A.D. Hunter to H.A. Geisendorfer, letter dated 15 September 1927 (Prosecution Exhibit 1, Item 68).

In the letter, Hunter quoted a letter written by Walker's previous manager, H.R. Tunnell, in June 1926:

The new mill and surface works have been built on the Dolly Gulch Placer, which was unfavorably reported. Mr. Sales' recommendation will be carried out by the exchange of land with the Forest Service. Mr. Sales' instructions to make enough lode locations to cover the mill and all buildings or other surface improvements not included in the original mill site locations have been carried out, and a Proof of Labor covering Plumas, Plumas Extension, Plumas No. 1, Plumas No. 2, Plumas No. 3 has been filed at Quincy.⁵⁰

Tunnell's letter demonstrates that Reno Sales, who wore no Walker hat, was making decisions about lands that the Walker Mining Company should acquire for its mining and milling operation, and he was giving direction to Walker management about how to implement the acquisitions.

Not only did the manager of the Walker Mining Company seem to take direction from Lyon and others in the Anaconda/International organization, correspondence from 1930 suggests that others at the Walker mine who would normally be subordinate to the manager also reported directly to Lyon. The best documentation of this seemingly anomalous situation (were the Walker Mining Company managing its operations alone) is the letters from and to D.D. MacLellan, a geologist in the International organization who was assigned to the Walker Mining Company at the time. Lyon addressed him at the Walker Mining Company, and when MacLellan wrote Lyon, he used Geisendorfer's Walker Mining Company letterhead. Yet, his correspondence with Lyon was kept confidential from Geisendorfer. International apparently first sent MacLellan to the Walker mine in 1929 to conduct surface surveys relative to the possible acquisition of adjoining property. In time, however, MacLellan also took on responsibilities concerning underground work, including engineering. In one instance, Geisendorfer even asked Lyon to instruct MacLellan to make a drawing of one of the stopes in the Walker mine, suggesting that while MacLellan was at the mine, he remained in the International chain of command. In another instance, Lyon instructed MacLellan that sending two copies of his reports on development work at the Walker mine, instead of three, would suffice, because Lyon would send one to Geisendorfer (who by then was working in the Salt Lake City office) and keep one for his own files.⁵¹

An instance in which MacLellan corresponded with Lyon, explicitly bypassing Geisendorfer, occurred in November 1930, when MacLellan wrote asking for information about a suit against the Walker Mining Company being tried in federal court. MacLellan wanted to terminate the employment of a Russian stope engineer named Antoshkin (and called Atkinson in

⁵⁰ Ibid, p. 2.

⁵¹ Lyon to D.D. MacLellan, letters dated 29 July 1929 and 26 February 1930 (Prosecution Exhibit 1, Items 74 and 75); MacLellan to Lyon, 5 March 1930; Lyon to MacLellan, letters dated 8 September and 25 November 1930 (Prosecution Exhibit 1, Item 77).

a later letter) for being disruptive, but Geisendorfer wanted to wait until the suit was settled, out of concern that if Antoshkin were fired, he would testify against the Walker Mining Company in the litigation. MacLellan wanted information from Lyon about the case, and he wanted to learn as soon as it was settled so he could immediately fire Antoshkin. In a postscript, he informed Lyon that he had not discussed the matter with Geisendorfer. In a follow-up letter, MacLellan provided Lyon with an analysis of why there had been some friction among the foremen at the foremen at the Walker mine and why some of the fault lay with Geisendorfer for not delineating each man's sphere of authority.⁵²

In the wake of the 1929 stock market crash and the ensuing slump in copper prices, the Walker Mining Company had to make changes to adjust to the worsening market. Low-grade material, which had qualified as ore at higher prices, could now not be mined profitably. And the company needed to try to cut costs, including labor costs. Reno Sales wrote J.O. Elton in October 1930, recommending steps to be taken to classify various reserves in the mine as either minable not minable at current low prices. Sales also recommended placing all geological work, engineering, and sampling under the auspices of one person, to be called the chief geologist-engineer. He recommended that Elton try the reorganization by placing geologist MacLellan in that supervisory position.⁵³ I have not seen documents explicitly stating whether or how the organization at the mine was revised, but as the narrative below describes, staffing levels were indeed cut and consolidated, somewhat along the lines Sales suggested.

The lines of authority in hiring at the Walker mine were also blurry. For example, in July 1930, William E. Young appeared at the mine bearing a letter from Tom Lyon and addressed to the mine superintendent, John Wallblom, recommending Young for a job underground. In November, Sales made a more blatant move regarding a position at the Walker. He wrote to notify Geisendorfer that Fred Strandberg had accepted Sales' offer of a position as engineer at the Walker mine, with a salary of \$250 per month.⁵⁴

In mid-December 1930, MacLellan wrote Strandberg to say that he had notified two Walker employees (including "the Russian") that their employment by the Walker Mining Company would end on December 31. The two had been measuring stopes, and doing that work would be Strandberg's responsibility, with the assistance of two helpers of Strandberg's choosing. Saying the choice was Strandberg's, MacLellan recommended two men for the work, one of whom was William Young. MacLellan sent copies of his Strandberg letter to Lyon and Geisendorfer. In another instance of bypassing Geisendorfer, MacLellan added, in a handwritten note at the bottom of the copy for Lyon, that, while Geisendorfer was getting a copy, it

⁵² MacLellan to Lyon, letters dated 12 and 20 November 1930.

⁵³ Sales to Elton, letter dated 8 October 1930 (Prosecution Exhibit 1, Item 78).

⁵⁴ Lyon to Jack Walbloom [sic], letter dated 21 July 1930 (Prosecution Exhibit 1, Item 76); Sales to Geisendorfer, letter dated 5 November 1930 (Prosecution Exhibit 1, Item 81); Geisendorfer to Sales, letter dated 13 November 1930 (Prosecution Exhibit 1, Item 82).

would probably be better if Geisendorfer did not know that Lyon was also getting one.. MacLellan also wrote to Geisendorfer with suggestions for rate of pay for the helpers. At the bottom of Lyon's copy of the letter, MacLellan suggested that Geisendorfer might object to the plan, because the "old order" had been of Geisendorfer's devising. Lyon responded that Geisendorfer would have to approve the salary schedule, because the decision would directly affect Walker Mining Company costs, which were Geisendorfer's responsibility.⁵⁵

In September 1931, Lyon sent MacLellan a letter outlining his duties at the Walker mine. It suggests the nature of the management relationship between the Anaconda/International organization the local management at the Walker mine. He began the letter, "I do not know whether you have ever had a letter from me outlining precisely what your duties are at the Walker mine. I am writing you now as a matter of record and to avoid any controversies as to just what you are expected to do."⁵⁶ Lyon then named MacLellan's two sets of responsibilities:

1- You will be directly responsible for the engineering work, which of course includes the underground records of tonnage broken, etc.

2- You will be responsible for the development work at the mine. Recommendations for the development shall be properly written and handed to the operators who will, of course, do the work as they are able.⁵⁷

As the several episodes described above demonstrate, MacLellan and the others who had been in his position took their direction, regarding ground to be explored and regarding ground to be opened with shafts, drifts, and crosscuts, from the mining and geology experts in the Anaconda/International organization, typically funneled through Lyon. Once those decisions had been made, miners on the Walker Mining Company payroll undertook the actual excavation, both of development work and of the stoping that produced ore. Those miners were under the supervision of shift bosses and foremen, the mine superintendent (who at this time was John Wallblom), and the general manager of the Walker operations (who at this time was Geisendorfer). This means that the actual drilling, mucking, and tramming of rock was being undertaken by Walker crews under direction of Walker supervisors, but the decisions about where that work should be done were being made by the Anaconda/International organization. Lyon typically delivered the direction and conducted the immediate oversight, but he did so at the direction of the full ACM/International hierarchy, headed by the likes of Reno Sales and William B. Daly, whose decisions were overseen and approved by such top officials as Con Kelley and B.B. Thayer.

⁵⁵ MacLellan to Lyon, letter dated 16 December 1930 (Prosecution Exhibit 1, Item 83); MacLellan to Geisendorfer, letter dated 21 December 1920 (Prosecution Exhibit 1, Item 84); Lyon to MacLellan, letter dated 24 December 1930 (Prosecution Exhibit 1, Item 85).

⁵⁶ Lyon to MacLellan, letter dated 30 September 1931 (Prosecution Exhibit 1, Item 88).

⁵⁷ Lyon to MacLellan, letter dated 30 September 1931 (Prosecution Exhibit 1, Item 88).

In his letter to MacLellan, Lyon elaborated on how MacLellan should oversee the actual mining that was being conducted by Walker crews:

When a drift is being run on any vein you will, of course, watch this drift, and if the drift is being run off the vein you will notify the Superintendent in writing. You will not, however, unless especially requested by the Superintendent, give the miners any directions, but take the matter up in the proper manner with the Superintendent, and he will be responsible for giving the necessary directions to the miners.⁵⁸

Lyon closed the letter with instructions MacLellan was to give Strandberg for accurately measuring stopes, so that records being kept by the engineering department would comport with overall production records being compiled by Geisendorfer and his assistant Cooper (other letters of this period suggest that inconsistencies were arising in records being produced by different facets of the Walker operation).

In mid-1931, market conditions had reached the point at which the Walker mine might need to cease production. MacLellan wrote Lyon in early July to report that Geisendorfer had indicated, confidentially, that mining and milling might be suspended at the middle of the month. Were that to happen, Geisendorfer said that MacLellan and Strandberg, along with about twenty men would continue working. MacLellan told Lyon that he would like to include Strandberg's two helpers among those retained so that mapping of development work could continue, even if the mine ceased producing ore. Within a few days, however, Geisendorfer informed his assistant, J.H. Cooper, that officials had decided to continue production at existing levels, but every effort should be made to effect savings in costs, including discontinuing some development work.⁵⁹ The decision to keep operating was only temporary.

Late in 1931, Lyon wrote MacLellan in the context of the on-going economic depression and its impact on the copper market. Lyon informed MacLellan that operations at the Walker mine would probably be reduced to half of normal, and overhead costs would have to be reduced accordingly. Lyon had a job in Salt Lake City for which he could use MacLellan's help, which would relieve the Walker operation of MacLellan's salary. This would leave Strandberg in charge of the geological and engineering work MacLellan had been overseeing. Lyon asked MacLellan to inform Strandberg of the impending change but to keep the information otherwise confidential until a public announcement was made through normal channels.⁶⁰

In the new year, Walker operations during the first two months of 1932 were not cut quite as severely as Lyon had predicted (15% instead of 50%), but MacLellan did depart for Salt Lake

⁵⁸ Lyon to MacLellan, letter dated 30 September 1931 (Prosecution Exhibit 1, Item 88).

⁵⁹ MacLellan to Lyon, letter dated 6 July 1931 (Prosecution Exhibit 1, Item 86); Geisendorfer to Cooper, letter dated 11 July 1931 (Prosecution Exhibit 1, Item 87).

⁶⁰ Lyon to MacLellan, letter dated 9 December 1931 (Prosecution Exhibit 1, Item 89).

City, leaving Strandberg with the title chief engineer, in charge of geological and engineering operations, including sampling.⁶¹ MacLellan's absence, the reduced work schedule, and the larger threat of complete closure of the mine left Strandberg in a state of uncertainty. He sent Lyon a hand-written letter that summarized the difficulties of his personal situation, the turmoil that economic conditions were breeding at the Walker mine, and the climate in a mining organization that was a distinct corporate entity but which had certain key functions being managed and conducted by the parent organization. Only the latter is of concern to this report. Strandberg wanted to know, "Who I am to be responsible to and what I am to be responsible for." When MacLellan left, Cooper (the assistant manager) had taken charge of the sampling operation, which had previously been under MacLellan's supervision. Strandberg wanted Lyon to make it clear who should be giving orders to the sampler.⁶²

After describing the difficulty of getting one of his men to give a full effort under the reduce pay schedule, Strandberg then outlined an overall divide in the community at the Walker mine:

The attitude of the management here is such that they don't want an engineer around, much less one from Butte, who when he comes here is only another dam [sic] Anaconda man to try to get rid of.⁶³

Such an attitude is understandable, when one considers that under a conventional organizational chart at a mine, the geologist and the engineer would report to the general manager, but in the scheme by which the ACM had incorporated operations at the Walker mine into the larger Anaconda/International organization, the geologist and engineer answered to a supervisor, Lyon, who was part of the management organization of the Anaconda enterprise but who had no title in the Walker organization. A letter from Lyon to Sales in April 1932 suggests that the relationship between the ACM/International organization and the Walker organization had been deteriorating in the year prior to closure at the end of February.⁶⁴

Incidentally, the question of who had charge of the sampler was resolved in Strandberg's favor. Geisendorfer sent Cooper a letter telling him that sampling should remain as it formally had been, the responsibility of the engineering (Strandberg's) department. And Lyon sent Strandberg a letter quoting from Geisendorfer's letter to Cooper. Regarding the problem Strandberg was having with the man who did not want to give full effort, despite the reduced salary, Lyon assured him that he had the authority to fire anyone who was not working up to expectations.⁶⁵

⁶¹ F.W. Strandberg to Lyon, letter dated 5 February 1932 (Prosecution Exhibit 1, Item 92).

⁶² Strandberg to Lyon, letter dated 28 January 1932 (Prosecution Exhibit 1, Item 90).

⁶³ Strandberg to Lyon, letter dated 28 January 1932 (Prosecution Exhibit 1, Item 90).

⁶⁴ Lyon to Sales, letter dated 1 April 1932 (Prosecution Exhibit 1, Item 99).

⁶⁵ Geisendorfer to J.H. Cooper, letter dated 30 January 1932 (Prosecution Exhibit 1, Item 91);

When the Walker mine closed, Strandberg returned to Butte, but the Walker Mining Company only paid him for his time until he left the mine, four days in March, and not his travel time to Butte, as had been customary under earlier circumstances. Sales was resentful of this action on the part of the Walker Mining Company. More importantly, his letter expressing that attitude also indicates that, while Strandberg may have been part of an engineering department at the Walker mine that answered to International organization in Salt Lake City, he was paid by the Walker Mining Company.⁶⁶

The Walker Mining Company had tried to keep its men employed at a decreased rate through the winter months. After two months of curtailed operations, the Walker Mining Company closed the mine and mill at the end of February 1931. When the mine closed, the question arose concerning development work. Reno Sales and Tom Lyon recommended keeping a skeleton crew at the mine to complete some underground development work that had been neglected during curtailed operations prior to closure. Such development work would allow the mine to resume full production for a prolonged period, once the shut-down ended. Sales recognized, of course, that a decision to incur costs during a period of no production, and therefore no revenue, would have to be left in the hands of the Walker Mining Company. Evidently, the Walker Mining Company decided not to complete any development work during the shut-down, and annual reports indicate that the only expenses incurred were for watchmen at the property and minimal supervisory staff, who also completed some maintenance on the physical plant. The only revenue during that period was from cement copper recovered from mine water in a precipitation plant. This suggests that the company kept pumps operating to prevent the mine from flooding. Production at the mine and mill resumed in January 1937.⁶⁷

During the summer of 1937, Lyon sent M.B. Kildale to the Walker mine to report on development work being undertaken there. In addition to fairly detailed descriptions of development in various parts of the mine, Kildale reported on the organizational structure:

The geological work at the Walker mine is being well handled under the direction of Mr. Droubay, who is working in close cooperation with, and giving much

Lyon to Strandberg, letter dated 6 February 1932 (Prosecution Exhibit 1, Item 93).

⁶⁶ Sales to Lyon, letter dated 14 March 1932 (Prosecution Exhibit 1, Item 96); Sales to Lyon, letter dated 24 March 1932 (Prosecution Exhibit 1, Item 98).

⁶⁷ Lyon to Elton, letter dated 8 March 1932 (Prosecution Exhibit 1, Item 94); Lyon to Sales, letter dated 12 March 1932 (Prosecution Exhibit 1, Item 95); Sales to Elton, letter dated 14 March 1932 (Prosecution Exhibit 1, Item 97); Statement 1931 of the Walker Mining Company, annual report dated 15 March 1932; Statement 1932 of the Walker Mining Company, annual report dated 15 March 1933; Statement 1933 of the Walker Mining Company, annual report dated 17 March 1934; Statement 1934 of the Walker Mining Company, annual report dated 25 March 1935; Statement 1937 of the Walker Mining Company, annual report dated 24 March 1938.

valuable advice to the operating department. The development headings are mapped nearly every day and the valuable stope sections are posted up as soon as the engineering measurements are available. Closer underground direction of the development headings by either the operating or geological departments is needed, however, and closer check on carrying out of geological recommendations is advisable.⁶⁸

Direction for development was communicated among Sales, Lyon, and Droubay, it will be remembered, in the form of “recommendations.”

In the late 1930s, Reno Sales continued to direct work routinely in the Walker mine based on his position as the ACM’s chief geologist. In 1938, for example, M.H. Gidel, Sales’ top assistant in the ACM’s geology department, made a set of recommendations for development work to be conducted at the mine. Sales reviewed Gidel’s memorandum and then wrote Tom Lyon, International’s chief geologist, informing him of the recommendations with which he concurred and which he did not approve. A week after writing that letter, Sales met in Butte with Gidel and with Clyde E. Weed, manager of mining operations for the ACM’s entire enterprise, and the three agreed upon a course of development work to be implemented at the Walker mine. Sales recorded the decisions in a letter to Weed, with a copy to Lyon. Sales specified the actions that were to be taken, listed other recommendations that could be implemented at the mine if they proved convenient, and specified a recommendation, driving a particular crosscut, that was to be eliminated from the work plan. Actions to be taken at the mine included driving drifts and crosscuts in the mine.⁶⁹

Three men, Sales, Gidel, and Weed, who had no official roles at the Walker Mining Company, were deciding the course of development at the Walker mine, and they informed a fourth, Tom Lyon, of their decisions. As with the other three, Lyon was a man in authority, but he held no office in the Walker Mining Company. In late September, International’s John Dugan informed Weed by letter that the development work at the Walker mine was underway.⁷⁰ As development work continued into December, Walker geologist Seth Droubay suggested some revisions to the work plan. Again, Sales reviewed the proposals and decided which he approved and which he wanted to consider further. He communicated his decisions in a letter to Tom

⁶⁸ M.B. Kildale to Lyon, letter dated 24 August 1937 (Prosecution Exhibit 1, Item 115).

⁶⁹ Sales to Tom Lyon, letter dated 10 August 1938 (Prosecution Exhibit 1, Item 131); Sales to Clyde E. Weed, letter dated 17 August 1938 (Prosecution Exhibit 1, Item 132).

⁷⁰ John F. Dugan to Weed, letter dated 23 September 1938 (Prosecution Exhibit 1, Item 134). Dugan held a comparable position at International to Weed’s at the ACM: general superintendent of mines. He was also a director of the Walker Mining Company in the late 1930s, but I have not seen evidence that he was an officer or a manager; see the Walker Mining Company’s 1937 annual statement.

Lyon. The proposals Sales approved and the proposals he rejected included driving drifts and crosscuts in the mine.⁷¹

In January 1939, the ACM hierarchy of Weed, Sales, and Gidel had agreed on a new development plan for the Walker mine. Weed, who was the ACM's general manager of mines, authorized John Dugan, who was International's general superintendent of mines, to start work. At the same time, Sales wrote Lyon informing him of the development decisions the ACM managers had made for the Walker mine.⁷² Later in January 1939, Walker geologist Droubay wrote another letter to Lyon, recommending four more development projects in the Walker mine. Droubay copied Gidel (and not Sales, because Sales was in South America), and he told Lyon he would send maps of the recommendations to Dugan, letting Dugan know that the work was subject to Lyon's approval.⁷³ The letter makes it clear that Droubay understood himself to be working under Lyon's direction, even though Lyon was not Walker official.

As development work continued in spring 1939, Droubay wrote Lyon to indicate that he and the Walker's manager L.F. Bayer needed authorization from International's mining department in Salt Lake City to begin new development work. Droubay wrote that that he would send some new recommendations to Lyon and Dugan, and he and Bayer would await "approval or rejection" of the recommendations. He closed the letter, "I will assume that any approved recommendation received by Mr. Bayer has had your OK."⁷⁴ A few days later, Kildale wrote Dugan, addressing him as International's general superintendent of mines, to report that he and Lyon had reviewed Droubay's recommendations and that International's geology department approved them.⁷⁵

2. Management of Other Facets of Walker Operations

As a large, integrated enterprise, the ACM had officials who oversaw the various areas of expertise that were needed to conduct the various facets of operations. For example, Wilbur Jurden was an engineer who oversaw construction activities within the ACM enterprise. Thus, when the Walker Mining Company decided to expand its concentrator, Jurden oversaw the preparation of estimates for the construction; he estimated the work would cost \$72,130. He addressed his correspondence on the planning and the estimate to Elton at International, not Elton at Walker, and he copied the ACM's top metallurgist, Frederick Laist, because the

⁷¹ Sales to Lyon, letter dated 17 December 1938 (Prosecution Exhibit 1, Item 139).

⁷² Weed to Dugan, letter dated 4 January 1939 (Prosecution Exhibit 1, Item 147); Sales to Lyon, letter dated 5 January 1939 (Prosecution Exhibit 1, Item 148).

⁷³ Droubay to Lyon, letter dated 25 January 1939 (Prosecution Exhibit 1, Item 151).

⁷⁴ Droubay to Lyon, letter dated 20 April 1939 (Prosecution Exhibit 1, Item 161).

⁷⁵ Kildale to Dugan, letter dated 25 April 1939 (Prosecution Exhibit 1, Item 163).

concentrator was a metallurgical facility.⁷⁶ Once the Walker company authorized the construction, Elton wrote Laist, asking that Laist send Bernard Morrow with Elton on a site visit to the Walker mine to look over the plans that local managers were developing. Elton stated that he was not competent approve the plans, and he wanted Morrow's expertise.⁷⁷ Upon his return to Anaconda, Morrow reported on the trip to Laist, approving a few minor revisions to the plan for the concentrator. It is noteworthy that Laist used International letterhead with an Anaconda address, and he addressed Elton at International in Salt Lake City.⁷⁸ ACM officials were well equipped with letterhead that allowed them to wear appropriate hats as they wrote letters and issued directives.

Correspondence among the top ACM and International managers also suggests that the ACM and its wholly-owned subsidiary were making personnel decisions for the Walker Mining Company. In 1937, ACM managers trained Edward Broadwater in Butte to serve as a geologist at the Walker mine. Broadwater had been working at the ACM's sampling department. When the company transferred him to the geology department for training, it began charging his wages to the Walker company. Reno Sales, writing from New York, instructed Murl Gidel to have someone monitor Broadwater's development in learning the ACM's method of underground recording and then to notify Jack Dugan when Broadwater would be heading to the Walker mine. Dugan, International's general superintendent of mines, was a Walker director, but he was not a Walker officer or manager, yet he was the individual who had requested that Anaconda train someone to be sent to the Walker. Once Broadwater had completed training at several assignments in the Butte operations, Gidel notified Tom Lyon that Broadwater would be heading to the Walker in about a week.⁷⁹

In January 1939, a job for a geologist at Chiquicamata, the ACM's property in Chile, looked like it might open. Reno Sales wrote Tom Lyon, suggesting that Lyon encourage a Walker geologist named Broadwater to apply. Sales also had words for Lyon on how he, Lyon, would replace Broadwater, should Lyon be willing to allow Broadwater to transfer to Chile.⁸⁰ Lyon was not a top manager at Walker, so he would not normally be involved in hiring a Walker geologist, but given the structure of the management system of the Anaconda enterprise, it is not surprising that Lyon would be responsible for hiring a geologist for the Walker Mining Company.

In February 1939, the ACM decided to send Broadwater to Chile. Lyon sent a telegram to Gidel asking if Gidel had anyone in mind to hire for the Walker geologist position. Gidel sent

⁷⁶ Wilbur Jurden to Elton, letter dated 8 January 1929 (Prosecution Exhibit 1, Item 71).

⁷⁷ Elton to Laist, letter dated 25 March 1929 (Prosecution Exhibit 1, Item 72).

⁷⁸ Laist to Elton, letter dated 6 April 1929 (Prosecution Exhibit 1, Item 73).

⁷⁹ Sale to Gidel, letter dated 27 May 1937 (Prosecution Exhibit 1, Item 112); Gidel to Lyon, letter dated 8 June 1937 (Prosecution Exhibit 1, Item 113).

⁸⁰ Sales to Lyon, letter dated 5 January 1939 (Prosecution Exhibit 1, Item 148).

Lyon a telegram recommending Virgil Chamberlain for the job as geologist at the Walker mine. Gidel recommended that before Chamberlain went to California, he should train for two weeks in the ACM's geology department at Butte. While at Butte, Chamberlain would be paid by Walker, and the Walker company would also pay for Chamberlain's travel costs. Lyon responded to Gidel, asking that he give Chamberlain the two weeks' training at Butte and then send him to the Walker mine. Lyon stated that Walker would pay the expenses, and he asked Gidel to let the Walker's Droubay know when Chamberlain would be ready to leave Butte.⁸¹ Lyon took Gidel's recommendation and hired Chamberlain to work for the Walker Mining Company, even though Lyon was not an official of the Walker company. Gidel then told an ACM bookkeeper at Butte to put Chamberlain on the Walker payroll, told the bookkeeper what Chamberlain's salary would be, and told him to charge Chamberlain's travel expenses to California to the Walker Mining Company's account. Two weeks later, Gidel wrote Droubay to inform him that he had hired Chamberlain to work as Droubay's assistant, that Chamberlain would be paid \$160 per month, that Chamberlain's salary while in Butte and his travel expenses would be charged to Walker, and that Chamberlain was an ambitious young man. Gidel also noted that Broadwater had received similar training at Butte before being sent to the Walker Mining Company.⁸² This line of correspondence shows that the Walker manager was not responsible for hiring his geologist; officials in the ACM/International hierarchy hired the person who filled this key Walker staff position.

3. Operations at the Walker Mine in the Closing Years

In 1939, the Walker mine faced an uncertain future. Exploration for new leads had been disappointing, and the extraction of known reserves was nearing an end. Reno Sales summarized the situation for J.O. Elton (with copies to ACM president Con Kelley, Clyde E. Weed, Tom Lynn, and John Dugan): most of the Walker's production had been relatively profitable because it derived from ore bodies that were above the 700 level haulage adit. Such material could be mined at relatively low cost. Material that was being found at levels below the 700 level adit were of disappointingly low grade. Because of their location below the 700 level adit, they would have to be hoisted, in order to be extracted, thereby adding to the cost of mining. Sales and his colleagues in the ACM hierarchy had to decide how much longer they would spend money trying to find richer ore bodies. Sales drafted a list of recommended development and exploratory drilling programs. A month later, Lyon wrote Droubay a letter with instructions for beginning the drilling program.⁸³

⁸¹ Lyon to Gidel, telegrams dated 2 February 1939 (Prosecution Exhibit 1, Item 155) and 3 February 1939 (Prosecution Exhibit 1, Item 156); Gidel to Lyon, telegram dated 2 February 1939 (Prosecution Exhibit 1, Item 154).

⁸² Gidel to W.J. Wilcox, letter dated 6 February 1939 (Prosecution Exhibit 1, Item 157); Gidel to Droubay, letter dated 20 February 1939 (Prosecution Exhibit 1, Item 159).

⁸³ Sales to Elton, letter dated 1 July 1939 (Prosecution Exhibit 1, Item 168); Lyon to Droubay, letter dated 2 August 1939 (Prosecution Exhibit 1, Item 171).

John Dugan traveled to California in August 1939 to oversee the preparations for the new program. Upon his return to Salt Lake City, he discussed the developments with Lyon and wrote a letter reporting to Weed. Dugan, an International official, described instructions he had given Walker manager Bayer, and he described future exploratory work he wanted to have done at the Walker mine, if it was acceptable to Weed and Sales.⁸⁴ Once again, an International official without a management hat at Walker was giving direction the Walker manager, and he was seeking approval for actions from officials of his own company's parent corporation.

On the same day Dugan wrote Weed, Lyon wrote Sales. After reading both Dugan's and Lyon's letters, Sales responded to Lyon with further direction concerning the Walker drilling program. As the development and exploration programs proceeded at the Walker mine, geologist Droubay encountered some questions, about which he sought direction directly from Sales (with copies to Lyon and Dugan). Sales responded directly to Droubay, telling him which development work to continue and which to discontinue. Sales' letter did not reach Droubay in time to stop him from beginning to drill one of the holes, so the latter sent a telegram to Sales explaining why he had begun the work, extending the drill hole 300 feet. Sales took Droubay's telegram in stride and sent him another letter, giving more direction for how to proceed with the work at the Walker mine.⁸⁵

Sales' authority over operations at the Walker mine is clearly apparent in two episodes in late 1939. The first occurred in October, when Sales made an unannounced visit to the Walker mine, spending two days inspecting results of the exploratory drilling operation and developing a program for exploring the footwall of the 712 orebody.⁸⁶ Conventional protocol among mining companies, in my experience conducting research into the history of the American mining industry, is that officials of a company could make surprise visits to that company's facilities, but visits by people from outside the company were generally announced in advance. In this episode, however, Seth Dourbray appears not to have questioned Sales' authority to arrive unannounced at the Walker mine and to have access to results of the company's exploratory drilling program. Droubay also accepted Sales' direction in mapping a new program for exploration.

Sales' October 1939 visit to the Walker mine was made in the company of Dugan and H.M Hartmann of Salt Lake City. Together with Droubay they examined current maps of the mine. After Sales had formulated his development recommendations, Droubay documented

⁸⁴ Dugan to Weed, letter dated 23 August 1939 (Prosecution Exhibit 1, Item 176).

⁸⁵ Lyon to Sales, letter dated 23 August 1939 (Prosecution Exhibit 1, Item 177); Sales to Lyon, letter dated 26 August 1930 (Prosecution Exhibit 1, Item 1179); Droubay to Sales, letter dated 31 August 1939 (Prosecution Exhibit 1, Item 180); Sales to Droubay, letter dated 5 September 1939 (Prosecution Exhibit 1, Item 181) and 7 September 1939 (Prosecution Exhibit 1, Item 183); Droubay to Sales, telegram dated 6 September 1939 (Prosecution Exhibit 1, Item 182).

⁸⁶ Droubay to Lyon, letter dated 21 October 1939 (Prosecution Exhibit 1, Item 196).

them in a memorandum. Sales followed Droubay's memorandum with a letter to Dugan (copies to Lyon and Droubay) confirming that the document correctly conveyed his recommendations. Two months later, based on the results of the drilling program, showing that a vein ran further south than had been anticipated, Droubay sent Lyon a letter (with copies to Dugan and Sales), recommending that miners develop the vein by driving a crosscut from one part of the 600 level, rather than extending a drift from another part of the 600 level, which Sales had initially recommended.⁸⁷ Lyon responded to Droubay that he and Dugan had discussed the matter, and they concurred with Droubay's recommendation. Hartmann had also written a note on Dugan's copy of Droubay's letter indicating that he approved of Droubay's recommendation. Lyon concluded his letter to Droubay: "If Mr. Sales has any reasons for asking you to do the work as he originally suggested, you will hear directly from him."⁸⁸ Two days later, Sales wrote Droubay (with copies to Lyon, Dugan, and Weed), "I have no objection to doing the work as you have laid out."⁸⁹

These letters show clearly the chain of command at the Walker mine regarding exploration and development. Droubay received his direction from Lyon in Salt Lake City, and Lyon, who had no Walker position, provided that direction in consultation with Dugan, who was a Walker director but who had no title as an officer or manager of the Walker Mining Company. Lyon was International's chief geologist, and Dugan was in charge of International's mining operations. And Lyon and Dugan gave their direction to the Walker operation for exploration and development under the direct oversight of Sales and Weed, who were the ACM's chief geologist and manager of mines, respectively.

Sales' authority over Walker operations was also apparent in a November 1939 episode, in which Droubay needed immediate direction on how to resolve a situation. Droubay had encountered more problems with the drilling program, this time caused by snow. Seeking direction on how to proceed, he sent Sales two telegrams, one to the ACM's New York offices and one to Butte. Sales responded immediately, telling Droubay to discontinue the drilling program and await further instructions. The next day, Sales telegraphed instructions to Droubay on how to continue the drilling program. Once the immediate situation was resolved, Sales and Droubay continued normal correspondence through the mail, with Lyon participating.⁹⁰

⁸⁷ Droubay, memorandum dated 18 October 1939 (Prosecution Exhibit 1, Item 195); Dugan to Weed, letter dated 24 October 1939 (Prosecution Exhibit 1, Item 198); Droubay to Lyon, letter dated 22 December 1939 (Prosecution Exhibit 1, Item 213).

⁸⁸ Lyon to Droubay, letter dated 26 December 1939 (Prosecution Exhibit 1, Item 215).

⁸⁹ Sales to Droubay, letter dated 28 December 1939.

⁹⁰ Droubay to Sales, telegrams dated 14 November 1939 (Prosecution Team Exhibit 1, Items 201 & 202); Sales to Droubay, telegrams dated 15 November 1939 (Prosecution Team Exhibit 1, Item 203) and 16 November 1939 (Prosecution Team Exhibit 1, Items 204); Droubay to Sales, letter dated 18 November 1939 (Prosecution Team Exhibit 1, Item 205); Lyon to Sales, letter dated 20 November 1939 (Prosecution Team Exhibit 1, Item 206); Sales to Droubay, letter dated 21 November 1939 (Prosecution Team Exhibit 1, Item 207) and 22 November 1939 (Prosecution

Through the 1930s, the Walker mine's performance had been rather marginal, and in 1940 the ACM hierarchy began to considering whether it was reasonable to continue operations at the mine and mill. For a small company operating only a single mine and a mill, such considerations would have been deliberated solely in light of the company's profitability and the willingness of the stockholders to risk investment in further exploration and development in the hope of finding extensions of the known ore bodies that merited continued operation. When ACM officials weighed the costs and benefits, however, they did so with the overall well-being of the ACM enterprise in mind, and that included well-being of International's smelter at Tooele. The Walker mine was one of the smelter's sources of ore, and the smelter's ability to operate at a profit was dependent on being able to treat volumes ore sufficiently close to capacity that both fixed and variable costs could be covered by revenues. That ACM officials weighed the Walker mine's future in light of the smelter's well-being is evident in a March 1940 memorandum prepared by Reno Sales, in which he delineated those two lines of reasoning.⁹¹

The ACM's top managers took an active interest in both exploratory drilling and underground development work during the spring of 1940, as it appeared there might be some mineralized rock of adequate grade in an area north of what the company called the Piute ore body, in the north part of the mine. Both Reno Sales and Clyde Weed received reports from California and issued directives, both to their counterparts at International (Lyon and Dugan, respectively) and to Droubay at the Walker mine. Lyon also directed Droubay's development work from Salt Lake City.⁹² By May, Sales and Weed had concluded that there were no promising options for underground drilling remaining the Walker's underground workings, and the only remaining course of exploration would be surface drilling north of the Piute ore body. After Sales and Weed discussed the matter in Butte, Weed went to New York to discuss the future of the Walker mine with ACM president Con Kelley (also International president) and ACM executive vice president James R. Hobbins. Weed reported to J.O. Elton that Kelley and Hobbins "agreed to allow us to drill two or three of these holes at this time." Weed advised Elton to get locations for the new drill holes from Sales. Weed closed his letter to Elton, "Will you please advise me when Mr. Sales has approved this work, and send me a sketch showing the locations of the hole."⁹³ Once again, the ACM's top officials were making decisions about the future of the Walker mine and were issuing directives for how those decisions would be implemented at the mine.

Team Exhibit 1, Item 208).

⁹¹ Sales, memorandum dated 15 March 1940 (Prosecution Team Exhibit 1, Item 222).

⁹² Sales to Droubay, letter dated 23 April 1940 (Prosecution Team Exhibit 1, Item 226); Weed to Dugan, letter dated 25 April 1940 (Prosecution Team Exhibit 1, Item 228); Lyon to Droubay, letter dated 27 April 1940 (Prosecution Team Exhibit 1, Item 229).

⁹³ Weed to Elton, letter dated 8 May 1940 (Prosecution Team Exhibit 1, Item 234).

The Walker Mining Company's minority stockholders were clearly dependent on ACM management, not only for managing the mine's operations but also for understanding the performance they should expect of the mine. As Sales and Weed were preparing their plans for the new exploratory program, they also were preparing a report, apparently on the final operations of the mine, should no additional ore be found. Weed's initial draft showed estimated reserves of nearly 1,900,000 tons. Reviewing the draft, Sales observed that the estimate was only "probable or possible," but it was not the 989,190 tons of proven reserves, as of March 1940. He suggested using the smaller volume, so that when the mine closed after three years or so, and the minority stockholders looked at what had been mined in that time, they would not have cause to complain that the mine was closing before all the estimated reserves were extracted. Sales wrote that he would feel more comfortable adding to the known reserves during the period of winding down operations, if such were found, rather than having to explain why expectations had not been met.⁹⁴ In the report that Weed and Sales issued, they provided the figure of 1,869,000 tons "probable" recoverable ore, and another figure of 1,061,100 tons "developed" recoverable, suggesting that if no new recoverable ore was found, then the actual production between June 1940 and mine closing would be somewhere between the two figures. They recommended that if no new ore was found during the current exploration and development plan, then remaining known reserves at the Walker mine should be mined as quickly as possible.⁹⁵

As the Walker mine appeared to be entering its final stages of operation in 1940, Weed wrote ACM and International president Con Kelley, laying out the options for the last phases of exploration and for developing and extracting the remaining ores. He closed the letter by asking Kelley, "Will you please advise me if these recommendations meet with your approval, sending a copy of your letter to Mr. Elton so that he will be advised as quickly as possible."⁹⁶

Meanwhile, Droubay wrote a letter to International's chief geologist, Tom Lyon, documenting the agreement that had been reached when Lyon, Sales, and Weed had recently visited the Walker mine: the only development work to be done was that immediately needed to prosecute mining. He then outlined the development that such a program would entail for each ore body in the Walker mine, closing the letter, "This program covers all development which is at present both important and necessary and no additions, excepting headings necessary for stoping, will be made unless ordered or approved by you, Mr. Sales, Mr. Weed, and Mr. Dugan."⁹⁷ Once again, the local staff of the Walker mine were responding to orders given by ACM and International officials who had no positions in the management hierarchy of the Walker mine. Only Dugan was a director of the Walker Mining Company, but he held no known title as an officer or a manager of the Walker company.

⁹⁴ Sales to Weed, letter dated 15 May 1940 (Prosecution Team Exhibit 1, Item 237).

⁹⁵ Weed and Sales, "Report Covering Present Conditions at the Walker Mine," 15 June 1940 (Prosecution Team Exhibit 1, Item 238).

⁹⁶ Weed to C.F. Kelley, letter dated 7 October 1940 (Prosecution Team Exhibit 1, Item 242).

⁹⁷ Droubay to Lyon, letter dated 10 October 1940 (Prosecution Team Exhibit 1, Item 243).

By early 1941, operations at the Walker mine shifted in their orientation toward the cessation of production. With that reality in mind, calculations in planning for development shifted. Whereas a mine with a long future ahead of it would undertake development work that yielded an effective configuration of shafts, crosscuts, and drifts, even if the excavation was through country rock, in the expectation that production of ore through those developments some months in the future would pay the expenses of the dead work. In 1923, for example, Sales and his geologists had wanted Hart to drive a straight drift in developing a new level, and they were frustrated that Hart was creating a crooked drift, because he was following the richest part of the vein. In early 1941, however, there were no longer expectations that future production could pay the costs of current development. Therefore, in January 1941, Sales wrote Droubay a stern letter because a drift had turned away from the vein. He wrote, “If I have not made myself clear in the past, I will do so now and advise that development faces be kept in the vein as far as possible in order that the amount of waste broken be kept at a minimum.”⁹⁸

The next month, International’s general superintendent of mines, John Dugan, wrote H.M. Hartmann, who was by then manager at the Walker mine, with instructions for how to proceed with certain drilling and development operations. Dugan sent Weed, Sales, and Lyon copies of the letter.⁹⁹ This letter is noteworthy because it shows Dugan providing the Walker’s manager with a level of direction comparable to that which Lyon provided the Walker’s geologist. Because most of the records I have been able to analyze are from the records of the ACM’s geology department, they mostly document the geological direction that ACM officials were giving.

As operations at the Walker mine continued to wind down in 1941, manager H.M. Hartmann worked to try to keep costs down. At the end of June, he wrote International’s general superintendent of mines, John Dugan, asking if a decision had been made yet on whether to cease development work on the 1200 level. The company had considerable equipment at that level, and if development were to cease, Hartmann could move the equipment elsewhere in the mine, obviating the need to make new purchases. He informed Dugan, “It would be very nice and helpful, and save us money, if Mr. Weed and Mr. Sales could decide shortly whether there was any use of keeping this Level open or not.”¹⁰⁰ Clearly, Hartmann needed direction on this matter from higher in the organizational structure, and that organizational structure extended beyond the parameters of the Walker Mining Company’s corporate and management structure. Dugan forwarded Hartmann’s letter to Sales, with a copy to Weed, asking for an “early decision.” After Weed and Sales conferred on the matter, Sales wrote Dugan to say that the 1200 level could be abandoned and the Walker company could quit pumping water from the level. Accordingly, Dugan sent Hartmann a letter instructing him to discontinue work on the 1200 level.¹⁰¹

⁹⁸ Sales to Droubay, letter dated 9 January 1941 (Prosecution Exhibit 1, Item 254).

⁹⁹ Dugan to H.M. Hartmann, letter dated 13 February 1941 (Prosecution Exhibit 1, Item 269).

¹⁰⁰ Hartmann to Dugan, letter dated 30 June 1941 (Prosecution Exhibit 1, Item).

¹⁰¹ Dugan to Sales, letters dated 3 July 1941 (Prosecution Exhibit 1, Item 294) and 12 July

In July 1941, Eldon Lomnes, chief engineer at the Walker mine, sent Dugan a letter reporting that, at Dugan's suggestion, the staff at the mine had resumed using Development Recommendation Sheets for proposing new work. The next month, Sales wrote Lyon with the idea that, although it probably made little difference, the recommendation sheets should be from the Walker Mining Company, not International Smelting & Refining. Sales reported that Weed concurred and asked Lyon to discuss the matter with J.O. Elton.¹⁰² A few days later, Lyon wrote Lomnes, asking that in future he use recommendation sheets of the Walker Mining Company's Geological Department. Lyon wrote that International "is really not doing the work at the Walker and we would much prefer the geological department there be designated as the Walker Geological Department."¹⁰³

It is unclear why the ACM/International management was concerned about the printed heading of the Development Recommendation Sheets in summer 1941. There is a collection of recommendation sheets in the University of Wyoming collection of the ACM's geology department. Dates run from to October 1937 to August 1941, and they are all on paper headed: "Recommendation for Development Work, Geological Department, International Smelting & Refining Co."¹⁰⁴

By August 1941, the Walker mine had reached the point at which the ACM's managers did not believe there was any point in continuing operations at current copper prices. The mine had been losing money for more than a year. There was one more possibility, however, for prolonging the life of the mine. Clyde Weed wrote ACM president J.R. Hobbins (who had succeeded Con Kelley as president in April 1940, when Kelley became chairman of the ACM board) asking him to look into the possibility of the U.S. government taking an interest in the mine. This idea undoubtedly arose because the government was preparing for the possibility of war, in which case the nation would need all the copper it could produce for the war effort. The government wanted copper producers to identify all potential sources of copper ore that could help increase the government's supply of the strategic metal. Weed reminded Hobbins that an important factor in the future of the Walker mine was consideration for the minority stockholders. Weed copied his letter to Kelley, Elton, Sales, and Laist. Hobbins responded to Weed indicating that he thought that the government should be given an opportunity to consider the situation, but he doubted the government would act, given the relatively small output of the Walker mine. He also suggested that J.O. Elton should call a meeting of the Walker board of

1941 (Prosecution Exhibit 1, Item 299); Sales to Dugan, letter dated 9 July 1941 (Prosecution Exhibit 1, Item 300).

¹⁰² E.J. Lomnes to Dugan, letter dated 24 July 1941 (Prosecution Exhibit 1, Item 302); Sales to Lyon, letter dated 25 August 1941 (Prosecution Exhibit 1, Item 317).

¹⁰³ Lyon to Lomnes to Dugan, letter dated 28 August 1941 (Prosecution Exhibit 1, Item 319).

¹⁰⁴ Recommendation for Development Work, sheets dated 9 October 1937 to 25 August 1941 [these sheets are in file 16202_02b, pp 78-90].

directors and advise them it was no longer practical to operate the Walker mine with cost of production exceeding the price of copper.¹⁰⁵

In early September 1941, Hartmann informed workers at the Walker mine that it might close by October 1. The Walker mine received a brief reprieve when development work between the 900 and 1000 levels in the Piute ore body showed a body of copper ore with higher than usual gold assays. The reprieve was short-lived, however, and by November the Walker mine had closed.¹⁰⁶

Available documents show that ACM and International officials and managers were directing operations at the Walker mine, deciding where for example, shafts, drifts, and crosscuts would be located. The full extent of the ACM's and International's direct involvement in managing the Walker Mining Company's operations can be seen by the fact that ACM and International officials and managers often gave direction about Walker operations without going through the Walker manager, but rather by communicating directly with the Walker company's staff.

¹⁰⁵ Weed to Hobbins, letter dated 21 August 1941 (Prosecution Exhibit 1, Item 313); Hobbins to Weed, letter dated 9 September 1941 (Prosecution Exhibit 1, Item 323).

¹⁰⁶ V.R. Chamberlain to Gidel, letters dated 5 September 1941 (Prosecution Exhibit 1, Item 322) and 13 November 1941 (Prosecution Exhibit 1, Item 335); Sales to Weed, letter dated 4 October 1941 (Prosecution Exhibit 1, Item 327); Sales to Hartmann, letter dated 10 October 1941 (Prosecution Exhibit 1, Item 330).

RESUME

SUMMARY OF EXPERIENCE

Dr. Quivik is Associate Professor of History in the Dept. of Social Sciences at Michigan Technological University, where he also serves as editor of *IA: The Journal of the Society for Industrial Archeology*. He previously taught history of technology and environmental history as a lecturer in the Dept. of History & Sociology of Science at the University of Pennsylvania (2006-2009) and as a lecturer at the University of California at Berkeley in the Interdisciplinary Studies Program, College of Engineering, and in the History Dept. (1999-2001). He also taught as an adjunct at Montana Tech in Butte and at Montana State University in Bozeman.

Since 1976, Fred Quivik has been professionally active in the fields of history of technology, industrial archeology, and cultural resource management. He makes that experience available to clients as the principal historian in the firm Quivik Consulting Historian, Inc., which he incorporated in 1998. A significant body of his work in recent years has been as an expert witness (historian of technology) in Superfund litigation concerning the remediation of mining and metallurgical wastes in Montana (the Clark Fork Superfund project embracing Butte and Anaconda and the Libby Superfund project), Idaho (the Bunker Hill Superfund project in the Coeur d'Alene mining district, and the Stibnite Superfund project in the Yellow Pine district), the State of Washington (the Midnite Mine Superfund project), New York (the Li Tungsten Superfund project), and Arizona (the Pinal Creek project in the Globe/Miami mining district).

In 1982, Dr. Quivik founded Renewable Technologies, Inc. (RTI), an historic preservation consulting firm in Butte, Montana, that is still a thriving business. In 1990, Dr. Quivik left RTI to attend the University of Pennsylvania, where he was a William Penn Fellow. He received the PhD in History and Sociology of Science from Penn in 1998. The title of his dissertation is "Smoke & Tailings: An Environmental History of Copper Smelting Technologies in Montana, 1880-1930." While writing his dissertation, he continued to work as a consultant.

As an expert witness for the U.S. Dept. of Justice, providing litigation support in Superfund litigation, Dr. Quivik's specialty has been industrial history, especially the history of the mineral industries, with special attention to the discharge of byproducts and their historical impacts on the environment. He has extensive knowledge of the role of industrialization in the development of the American West. At RTI, he completed surveys and Historic American Engineering Record (HAER) documentation of dams and hydroelectric generating plants of the Montana Power Company, of the Corps of Engineers' Fort Peck Dam, and of Bureau of Reclamation dams and irrigation infrastructure in Idaho, New Mexico, Oregon, and Wyoming. He conducted statewide historic bridge inventories in Minnesota, Montana, Nebraska, and North and South Dakota. He has also prepared business and technological histories of the Connellsville Coke Region in southwestern Pennsylvania, the Kaiser shipyards in Richmond, CA, and the Ford Motor Company's Richmond assembly plant (a.k.a. the Richmond Tank Depot) for HAER.

Dr. Quivik's experience in cultural resource management includes conducting surveys of rural, urban, and industrial historic sites and districts, preparing National Register nominations, performing determinations of eligibility and impact assessments according to federal guidelines, preparing photo-documentation and measured drawings of historic sites, and developing planning documents for the preservation of historic districts. Dr. Quivik is particularly skilled at researching and developing historical contexts within which to assess the significance of cultural resources. He served for ten years on the Montana State Historic Preservation Review Board.

EDUCATION

PhD, History and Sociology of Science, University of Pennsylvania, Philadelphia, 1998.

Dissertation title: "Smoke and Tailings: An Environmental History of Copper Smelting Technologies in Montana, 1880-1930." M.A. in 1992.

Master of Science in Historic Preservation, Graduate School of Architecture and Planning, Columbia University, New York City, 1977.

Bachelor of Environmental Design, School of Architecture, University of Minnesota, Minneapolis, MN, 1975.

Bachelor of Arts in Art, St. Olaf College, Northfield, MN, 1971.

EMPLOYMENT HISTORY

Associate Professor of History, Department of Social Sciences and Graduate Program in Industrial Archaeology, Michigan Technological University, Houghton, MI, January 2010 to present.

Consulting Historian of Technology, principal in the firm Quivik Consulting Historian, Inc., working in litigation support as an expert witness, and in the evaluation of historic industrial and engineering sites as a cultural resources consultant, 1994-present.

Instructor, history of technology, environmental history, Dept. of History and Sociology of Science, University of Pennsylvania, Philadelphia, spring semesters 2006, '07, '08, '09.

Lecturer, history of technology, Interdisciplinary Studies Program, College of Engineering, University of California at Berkeley, January 1999 to May 2001; history of American science and technology, Department of History, U.C. Berkeley, January to May 2000.

Historian, Historic American Engineering Record, U.S. Dept. of the Interior, Jeannette, PA, June to August 1991, June to September 1992.

Architectural Historian (and founder), Renewable Technologies, Inc., Butte, MT, May 1982 to August 1990.

Adjunct Assistant Professor, School of Architecture, Montana State University, Bozeman, MT, winter quarter 1983.

Instructor, Engineering Graphics, Montana College of Mineral Science and Technology, Butte, MT, January 1981 to May 1981 (spring semester).

Building Recycling Specialist, National Center for Appropriate Technology, Butte, MT, April 1977 to September 1981.

Historian, Historic American Engineering Record, U.S. Dept. of Interior, Butte, October 1979 to April 1981.

PROFESSIONAL AFFILIATIONS

Society for Industrial Archeology: president 6/96 to 6/98; vice president 6/94-6/96; past-president 6/98 to 6/00; board of directors 6/90-6/93; journal editor 2011 to present.
Capitol Advisory Council (Montana), appointed by Gov. Racicot 1/96 to 8/98.
Klepetko (Montana) Chapter, Society for Industrial Archeology, president 9/87-8/90.
Committee on Historic and Archeological Preservation in Transportation, Transportation Research Board of the Nat'l Research Council, 1/91 to 6/93.
Board of Directors, Butte-Anaconda Historical Park and Railroad Corporation, 1986-1990.
Montana Historic Preservation Review Board, 1981-1990: appointed by Governor Schwinden, 10/81; reappointed 10/85; elected chairperson, 12/87.
Montana State Capitol Restoration Advisory Panel, appointed by House Speaker John Vincent, 5/85-4/89.
Board of Directors, Butte-Silver Bow Public Archives, 1979-1986.
Society of Architectural Historians.
Society for the History of Technology.
American Society for Environmental History
History of Science Society
Western History Association
Organization of American Historians
Norwegian-American Historical Association

SCHOLARLY and OTHER PUBLICATIONS

“Cooling Mass Concrete: Owyhee ,Hoover, and Building Large Dams,” *Engineering History and Heritage* 168 (November 2013): .

Architects as Designers of Pre-World War II, Large-Scale Technological Systems: Edward W. Tanner and the Design of the Fort Peck Townsite,” submitted to and being reviewed by *IA: The Journal of the Society for Industrial Archeology*.

“Overcoming Barriers: Milk River Irrigation Project, Montana,” *Engineering History and Heritage* 164 (November 2011): 245-254.

“Engineering Nature: the Souris River and the Production of Migratory Waterfowl,” *History and Technology*, 25 (December 2009): 307-323.

“Industrial Foundations of the Built Environments of Butte and Anaconda,” in the guidebook for the annual meeting of the Vernacular Architecture Forum, June 2009.

“The Industrial Undergirding to the Vernacular Architecture of Butte and Anaconda,” in *Coming Home*, Patty Dean, ed., special issue of *Drumlummon Views* devoted to the historic built environment and landscapes of Butte and Anaconda, Montana (Helena, MT: Drumlummon Institute, 2009).

“Authenticity and the Preservation of Technological Systems,” *CRM Journal* (Summer 2008): 26-36.

“The Historical Significance of Tailings and Slag: Industrial Waste as Cultural Resource,” *IA: The Journal of the Society for Industrial Archeology* vol. 33, no. 2 (2007): 35-54.

“The Tragic Montana Career of Dr. D.E. Salmon,” in *Montana: The Magazine of Western History* 57 (Spring 2007): 32-47, 92-94.

“New Deal Oasis on the High Plains,” a “Montana Traveler” feature on the Town of Fort Peck in *Montana: The Magazine of Western History* 54 (Winter 2004): 69-74.

"Smelters" and "Tailings," two entries in the *Encyclopedia of World Environmental History* (New York & London: Routledge, 2004).

“Of Tailings, Superfund Litigation, and Historians As Experts: *U.S. v. Asarco, et al*, the Bunker Hill Superfund Case in Idaho,” in *The Public Historian* 26 (Winter 2004): 81-104.

“Gold & Tailings: The Standard Mill at Bodie, California,” in *IA: The Journal of the Society for Industrial Archeology* vol. 29, no. 2 (2003): 5-27.

"Integrating the Preservation of Cultural Resources with the Remediation of Hazardous Materials: Assessment of Superfund's Record," *The Public Historian* 23 (Spring 2001): 47-61.

"Landscapes as Industrial Artifacts: Lessons from Environmental History," in *IA: The Journal of the Society for Industrial Archeology*, vol. 26, no. 2 (2000): 55-64.

"The Historic Industrial Landscape of Butte and Anaconda," in *Images of an American Land: Vernacular Architecture Studies in the Western United States*, Thomas Carter, ed. (Albuquerque: University of New Mexico Press, 1997).

Butte & Anaconda Revisited: An Overview of Early-Day Mining and Smelting in Montana, with Brian Shovers, Dale Martin, and Mark Fiege, Special Publication 99 (Butte: Montana Bureau of Mines, 1991). This is a reprint of "Guidebook to Historic Industrial Resources of Butte and Anaconda," October 1989, prepared by the same authors for the Annual Fall Tour of the Society for Industrial Archeology.

"Steel Transmission Towers & Energy for Montana's Copper Industry," Historic Landscapes feature in *Montana: The Magazine of Western History*, 38 (Fall 1988): 67-69.

"The Anaconda Company Smelters at Great Falls and Anaconda," in *The Speculator: The Journal of Butte and Southwest Montana History*, 1 (Summer 1984), expanded version of a paper given at the Annual Meeting of the Society for Industrial Archeology, St. Paul, MN, May 1983.

"Montana's Minneapolis Bridge Buildings," in *IA: The Journal of the Society for Industrial Archeology*, 10 (1984), no. 1, expanded version of a paper given at the Annual Meeting of the Society for Industrial Archeology, St. Paul, MN, May 1983.

Historic Bridges in Montana, (Washington, DC: U.S. Department of the Interior, National Park Service, Historic American Engineering Record, 1982).

"A Comparison Between Passive Solar and Superinsulated Retrofits," paper given at the Sixth National Passive Solar Conference, Portland, OR, September 1981. Published in the *Conference Proceedings*, AS/ISES, 1981.

"Retrofitting with Passive Solar," paper published in *New Energy From Old Buildings* (Washington, D.C: The Preservation Press, 1981), and presented at the Smithsonian Institution, Washington, D.C., during National Historic Preservation Week, May 1980.

SCHOLARLY REVIEWS

Review of *The Illusory Boundary: Environment and Technology in History*, edited by Martin Ruess and Stephen H. Cutcliffe, in *Environmental History* 16 (October 2011): 733-734.

Review of *Murder of a Landscape: The California Farmer-Smelter Ware, 1897-1916*, f in *Agricultural History* 85 (Spring 2011): 262.

Review of *Tungsten in Peace and War, 1918-1946*, by Ronald H. Limbaugh, in *Marine Corps University Journal* 2 (Spring 2011): 138-140.

Review of *Idaho's Bunker Hill: The Rise and Fall of a Great Mining Company, 1885-1981*, by Katherine Aiken, in *Oregon Historical Quarterly* 107 (Fall 2006): 471-473.

Review of *A Room for the Summer*, by Fritz Wolff, in *Montana: The Magazine of Western History* 56 (Summer 2006): 92-93.

Review of *The Government Machine: A Revolutionary History of the Computer*, by Jon Agar, in *IA: the Journal of the Society for Industrial Archeology* 31 (no. 2, 2005): 69-70.

Review of *Coal: A Human History*, by Barbara Freese, in *Technology and Culture* 46 (October 2005): 846-847.

Review of *Fish versus Power: An Environmental History of the Fraser River*, by Matthew D. Evenden, in *Environmental History Review* 10 (July 2005): 558-559.

Review of *DuPont: From the Banks of the Brandywine to Miracles of Science*, by Adrian Kinnane, in *Chemical Heritage* , 22 (Spring 2004): 44-45.

Review of *Mining Frontiers of the Far West, 1848-1880*, by Rodman Wilson Paul (Holt, Reinhart, and Winston, 1963, rev. ed. with additional chapters by Elliott West, University of New Mexico Press, 2001) in *Western Historical Quarterly* (Summer 2003): 242-243.

Review of *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester*, by Stephen Mosley, in *Technology and Culture* 44 (July 2003): 620-621.

Review of *The Subterranean Forest: Energy Systems and the Industrial Revolution*, by Rolf Peter Sieferle, in *Technology & Culture* 44 (January 2003): 216-218.

Review of *Virtual Rivers: Lessons from the Mountain Rivers of the Colorado Front Range*, by Ellen E. Wohl, in *Environmental History* 7 (July 2002): 517-518.

Review of *Wealth, Waste, and Alienation: Growth and Decline in the Connellsville Coke Industry*, by Kenneth Warren, in *Enterprise and Society* 3 (June 2002): 383-385.

Review of *Petrolia: The Landscape of America's First Oil Boom*, by Brian Black, in *Environmental History* 7 (January 2002): 139-140.

Review of *Metal Mining in Canada, 1840-1950*, by Jeremy Mouat, in *IA: the Journal of the Society for Industrial Archeology* 27 (no. 2, 2001).

Review of *Wounding the West: Montana, Mining, and the Environment*, by David Stiller, in *Environmental History* 6 (January 2001): 127-128.

Review of *Smelter Smoke in North America: The Politics of Transborder Pollution*, by John D. Wirth, in *Technology & Culture* 42 (January 2001): 151-152.

Review of *True Gardens of the Gods: Californian-Australian Environmental Reform, 1860-1930*, by Ian Tyrrell, in *Environmental History* 5 (April 2000): 254-255.

Review of *Common Fields: An Environmental History of St. Louis*, edited by Andrew Hurley, in *American Studies Journal* 40 (Fall 1999): 187-188.

Review of *Managing the Industrial Heritage*, edited by Marilyn Palmer and Peter Neaverson, in *IA: The Journal of the Society for Industrial Archeology* 24 (no. 2, 1998): 53-54.

Review of *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective*, by Joel Tarr, in *Historical Geography* 26 (1998): 228-230.

Review of *Race and Labor in Western Copper*, by Philip J. Mellinger, in *Montana: The Magazine of Western History* 47 (Autumn 1997): 84-85.

Review of *Environmental History Review*, Spring 1994, special issue on "Technology, Pollution, and the Environment," Joel A. Tarr and Jeffrey K. Stine, eds., and *Journal of Urban History*, May 1994, special issue on "The City and the Environment," Joel A. Tarr and Christine M. Rosen, eds., in *Technology & Culture* 36 (October 1995): 1038-1041.

Review of *Water Towers and Gas Tanks*, by Bernd and Hilla Becher, in *Design Book Review* 35/36 (Winter/Spring 1995): 56-59.

Review of *The Texture of Industry: An Archaeological View of the Industrialization of North America* by Robert B. Gordon and Patrick M. Malone, in *Environmental History Review* 18 (Winter 1994): 102-104.

Review of *Bisbee: Urban Outpost on the Frontier*, Carlos A. Schwantes, ed., in *Technology and Culture* 35 (April 1994): 435-436.

Review of *In the Servitude of Power: Energy and Civilization through the Ages* by Jean-Claude Debeir, Jean-Paul Deleage, and Daniel Hemery, in *Environmental History Review* 17 (Summer 1993): 97-98.

Review of *The Colossus of 1812: An American Engineering Superlative* by Lee H. Nelson, in *IA: The Journal of the Society for Industrial Archeology*, 16 (1990), No. 1.

Review of *Song of the Hammer & Steel* by Duane Smith, in *IA: The Journal of the Society for Industrial Archeology*, 14 (1988), No. 1.

SCHOLARLY PRESENTATIONS

“Historians As Experts in Environmental Litigation,” paper presented at the annual meeting of the American Historical Association, New Orleans, January 2013.

“A Case for the Preservation of Industrial Waste: The Historic Copper-Mining Industry of Southwest Montana,” paper presented at the annual meeting of the National Trust for Historic Preservation, Buffalo, NY, October 2011, and The International Conference on the Conservation of Industrial Heritage (TICCIH), Freiberg, Germany, September 2009.

“History of Fort Peck Dam,” keynote address presented at the annual meeting of the Missouri River Natural Resources Committee, March 2009.

“Addressing Global Warming by Means of History: Thinking in the Material World,” presented at the Nobel Peace Prize Forum, St. Olaf College, Northfield, MN, March 2009.

“Fort Peck and Its Shanty Towns: The Corps of Engineers Couldn’t Have It All,” paper presented at the annual Montana History Conference, Glasgow, Montana, October 2008.

“The Industrial Heritage of Energy,” paper presented at “Industrial Heritage: Premises & Practices for the 21st Century,” a conference at Michigan Tech, Houghton, MI, September 2008.

“Industrial Waste As Cultural Resource,” presentation made to colloquium of the Industrial Archaeology Program, Social Sciences Dept., Michigan Tech, Houghton, MI, November 2007.

“Engineering Nature: The Souris River and the Production of Migratory Waterfowl,” paper presented at annual meeting of the Society for the History of Technology, Wash, DC, Oct. 2007.

“Conflict in the Realm of Medical Science: Battling Veterinarians in the Anaconda Smelter Smoke Litigation” and “Mining in the West: Overview and Health Issues,” papers presented at the Seventh Annual Medical History of the West Conference, Montana State University, Bozeman, April 2007.

“Conflict along the Edges of the Living and the Non-Living Environments: Mining v. Farming in Montana’s Deer Lodge Valley in the Early Twentieth Century,” paper presented at the annual meeting of the American Society for Environmental History, Baton Rouge, March 2007.

Keynote Address on "Technology, Environment, and Work" at the North American Labor History Conference, Detroit, October 2006.

"The Question of Authenticity When Applied to the Preservation of Components of Complex, Large-Scale Technological Systems," paper presented at the Fifth National Forum on Historic Preservation Practice, Goucher College, March 2006.

"Inhaling a Microscopic Artifact: Asbestos Dust and the Vermiculite Mine at Libby, Montana," paper given at the annual meeting, Society for Industrial Archeology, Milwaukee, June 2005.

"Interpreting a Large Industrial Artifact: The Case of the Whirley Cranes at Kaiser's Richmond Shipyards," paper presented at the annual meeting of the Society for Industrial Archeology, Providence, June 2004.

"History As Compliment to Scientific Field Data in Superfund Litigation," presentation as part of a panel titled, "Reading the Issue: Environmental History in *The Public Historian*," at the joint annual meeting of the American Society for Environmental History and the National Council on Public History, Victoria, BC, April 2004.

"Gold & Tailings: The Standard Mill at Bodie, California," paper presented at the annual meeting of the Society for Industrial Archeology, Montreal, Quebec, May 2003.

Organizer of and participant in a scholarly panel on "The Environmental History of Mining" at the annual meeting of the Mining History Association, Wallace, ID, June 2002.

"From Slimes to Hens Eggs: Visions of Tailings in Idaho's Coeur d'Alene Mining District, 1888-2001," paper presented at the annual meeting of the Society for Industrial Archeology, Brooklyn, June 2002.

"Integrating the Preservation of Cultural Resources with Remediation of Hazardous Materials: An Assessment of Superfund's Record," paper presented at the annual meeting of the American Society for Environmental History, Tacoma, WA, April 2000.

"Physical Setting and the Shaping of Giant Smelters: A Comparison of the Great Falls and Anaconda Smelters," paper given at the annual meeting of the Society for Industrial Archeology, Savannah, GA, June 1999.

"Landscapes as Industrial Artifacts: Lessons from Environmental History," paper presented at Whither Industrial Archeology, a symposium sponsored by the Society for Industrial Archeology at Lowell National Historic Park, MA, November 1998.

"Government Intervention v. Economic Efficiency in the Abatement of Smelter Smoke Pollution: The Case of the Anaconda Smelter in the 1910s," paper given at the annual meeting of the Society for the History of Technology, Baltimore, MD, October 1998.

"Smoke and Tailings: An Environmental History of Copper Smelting Technologies in Montana, 1880-1920," public presentations based on PhD dissertation and illustrated with slides, Trinity Lutheran Church, Alameda, CA, July 2001; Environmental Studies Program, St. Olaf College,

Northfield, MN, October 1999; Colloquium of the Office for History of Science and Technology, University of California at Berkeley, April 1999; Parker Lecture Series, Lowell, MA, November 1998; Chemical Heritage Foundation, Philadelphia, October 1998; Froid Lutheran Church, Froid, MT, July 1998; Center for the Rocky Mountain West, Missoula, MT, March 1996.

"On the Nature of Tailings: An Overview of Early Attitudes Towards Tailings Disposal in the Montana Copper Industry," Montana State History Conference, Butte, MT, October 1996.

"Captain Couch of the Boston & Montana: A Self-Trained Mining Engineer and the Industrialization of Butte's Copper Mining District," paper presented at the annual meeting of the Western History Association, Denver, CO, October 1995.

"Conflict in the Science of Environmental Impact: The Anaconda Smelter Smoke Cases, 1902-1911," paper presented at the biennial meeting of the American Society for Environmental History, Las Vegas, NV, March 1995.

"Architects as Designers of Pre-World War II, Large-Scale Technological Systems: Edward W. Tanner and the Design of the Fort Peck Townsite," paper presented at session titled "Topics at the Intersection of Architectural History and the History of Technology" at the Annual Meeting of the Society of Architectural Historians, Seattle, WA, April 1995.

"The Concept of Industrial Waste: Smoke 'Nuisance' Cases in the Montana Copper Industry at the Turn of the Twentieth Century," paper presented at the annual meeting of the Society for the History of Technology, Lowell, MA, October 1994.

"Retarded Mechanization in the Connellsville Beehive Coke Industry," paper presented at the annual meeting of the Society for Industrial Archeology, Pittsburgh, PA, June 1993.

"EPA's Superfund in the Context of Other American Large-Scale Technological Systems," paper presented at the fifteenth annual meeting of the National Council on Public History, Valley Forge, PA, May 1993.

"Imposing an Industrial Order on the Northern Plains: Patterns of Truss Bridge Construction, 1880-1920," paper presented at the annual symposium of the Center for Great Plains Studies, Lincoln, NE, April 1993.

"Industrial Pollution on the Southwestern Pennsylvania Countryside: The Connellsville Beehive Coke Industry, 1880-1920," paper presented at the biennial meeting of the American Society for Environmental History, Pittsburgh, PA, March 1993. A longer version of this paper won the 1994 Newcomen Prize at the University of Pennsylvania.

"EPA Superfund: After a Decade, Why Is It Not an Effective Technological System?" paper presented at the annual meeting of the Society for the History of Technology, Madison, Wisconsin, October 1991.

"A Comparison of the U.S. Bureau of Reclamation's Cylinder-Gate and Ring-Gate Designs for Spillway Controls," paper presented at the 20th Annual Meeting of the Society for Industrial Archeology, Chicago, June 1991.

"Contribution of Railroads to Montana's Historic Bridge Landscape," presentation at the Montana History Conference, Livingston, MT, October 1988.

"Power for the Copper Industry: Hydroelectric Developments Along the Great Falls of the Missouri River, 1890-1957," paper given at the 17th Annual Meeting of the Society for Industrial Archeology, Wheeling, WV, May 1988.

"Historical Differences Between Hardrock Mining and Underground Coal Mining," presentation at the Montana History Conference, Helena, MT, October 1987.

"Industrial Urbanism on the Wheat Frontier: Minot, North Dakota, 1886-1929," paper given at the 15th Annual Meeting of the Society of Industrial Archeology, Cleveland, OH, June 1986.

"Appropriate Technologies and Historic Preservation," paper given at the International Conference on the Conservation of Industrial Heritage (TICCIH), Lowell, MA, June 1984.

"Maintenance and Stabilization of Historic Bridges," paper given at the Annual Meeting of the Association for Preservation Technology, Banff, Alberta, October 1982.

"The Great Falls Smelter: Some Reflections on Its Significance," paper given at the Montana State History Conference, Great Falls, MT, October 1982.

"Superinsulation vs. Passive Solar Energy in Historic Buildings," paper given at the Annual Meeting of the Association for Preservation Technology, Washington, D.C., October 1981.

"Passive Solar Retrofit of Historic Structures," paper given at the Annual Meeting of the Association for Preservation Technology, Denver, CO, September 1979.

SCHOLARLY and RELATED ACTIVITIES

Editor, *IA: the Journal of the Society for Industrial Archeology*, responsible for soliciting authors to submit manuscripts, arranging peer reviewers for manuscripts, making decisions about articles to publish, organizing special issues and working with guest editors, January 2011 to present.

Instructor for "Richest Hills" workshops, two week-long workshops on the history of Western mining for teachers sponsored by the Montana Historical Society and funded by the National Endowment for the Humanities; focus of instruction was on history of environmental impacts by industrial mining at Butte, and the cultural landscapes of the mining industry at Butte and Anaconda, July 2013 and July 2011.

Served as peer reviewer for articles submitted to the following scholarly journals: *BC Studies*; *Environmental History*; *IA: the Journal of the Society for Industrial Archeology*; *Montana: the Magazine of Western History*; *Technology & Culture*; *The Annals of Science*; *Health & History*.

Served as peer reviewer for book manuscripts for the University of Washington Press, the University of Tennessee Press, and the Montana Historical Society Press.

Served as a reviewer for grant proposals submitted to the National Science Foundation.

Chair of the Program Committee for the annual meeting of the Society for Industrial Archeology, Philadelphia, PA, June 2007; and Duluth, MN, June 2000.

Panel organizer, "Defining Environmental Edges to Anaconda's Global Mining Enterprise," panel of three papers presented at the annual meeting of the American Society for Environmental History, Baton Rouge, March 2007.

Panel organizer, "Emergency Shipyards during World War II in the San Francisco Bay Area," panel of three papers presented at the annual meeting of the Society for Industrial Archeology, Providence, June 2004.

Co-organizer with Brian Shovers, Fall Tour of industrial and engineering sites in NE Montana, organized by the Klepetko (Montana) Chapter for the Society for Industrial Archeology, September 2003.

Panel organizer, "A Roundtable on the Environmental History of Mining," panel of three papers presented at the annual meeting of the Mining History Association, Wallace, ID, June 2002.

Panel organizer, "Tailings As Cultural Artifact," panel of three papers presented at the annual meeting of the Society for Industrial Archeology, Brooklyn, June 2002.

Chair of the Program Committee, "Whither Industrial Archeology," a three-day symposium at Lowell, MA, featuring twenty-four speakers and co-sponsored by the Society for Industrial Archeology, Historic American Engineering Record, and Lowell National Historic Park, November 1998.

Panel organizer, "Topics at the Intersection of Architectural History and the History of Technology," a two-session panel featuring seven papers and a comment, presented at the Annual Meeting of the Society of Architectural Historians, Seattle, WA, April 1995.

Organizer, Coal and Coke Tour, organized for the Annual Meeting of the Society for Industrial Archeology, Pittsburgh, PA, June 1993.

Co-organizer with Brian Shovers, Fall Tour of Butte and Anaconda, Montana, organized by the Klepetko (Montana) Chapter for the Society for Industrial Archeology, October 1989.

Co-organizer with Brian Shovers, "Butte: The Urban Frontier," three-day history conference featuring twenty-six speakers and sponsored by the Butte Historical Society with major funding by the Montana Committee for the Humanities, Butte, MT, September 1982.

Project Director, Historic and Architectural Survey of over 3,000 structures in the Butte National Historic Landmark District, sponsored by the Butte Historical Society with major funding from the Montana State Historic Preservation Office and the Butte-Silver Bow Community Development Office, 1981-1985.

ORAL HISTORIES

Organized and conducted an oral history project as part of the research for an Expert Report for the U.S. Dept. of Justice in *U.S. v. Asarco, et al*; recorded 12 oral histories in communities in the Coeur d'Alene mining district, ID, December 2005 and April 2006.

Organized and conducted, in cooperation with the oral historian at the Montana Historical Society, the Libby Oral History Project as part of the research for an Expert Report for the U.S. Dept. of Justice in *U.S. v. W.R. Grace*; recorded 32 oral histories, April-June 2002.

Oral histories with three former shipyard workers, conducted in conjunction with research for the history of the Kaiser shipyards in Richmond, CA, being prepared for the Historic American Engineering Record.

Oral history of Guy Harris, retired chemist at Dow who developed and patented Z200, an important reagent used in the flotation of copper ores; Regional Oral History Office, Bancroft Library, University of California at Berkeley, 2001.

Oral histories with Joe & Carol Gwerder, farmers in California's Delta Region who spent their lives engaged in irrigated agriculture; Regional Oral History Office, Bancroft Library, University of California at Berkeley, 2001.

The Morrissey Oral History Workshop, training by Charles Morrissey during a three-day workshop at Fort Mason Center, San Francisco, March 2000.

Oral histories of thirteen early members of a rural electric co-op recalling the impacts of rural electrification on farm life in northeast Montana; sponsored by Sheridan Electric Co-op, 1997.

SELECT CONTRACT PUBLICATIONS AND PRESENTATIONS

“History of Federal Resources Corporation’s Activities at the Conjecture Mine,” expert report dated 18 April 2013, prepared for Lybeck Murphy on behalf of the defendant in *U.S. v. Federal Resources Corporation* in the Conjecture Mine Superfund litigation in Idaho. The report provides expert opinions concerning the history of operations at the Conjecture mine, including those of Federal Resources as well as those of previous owners of the property.

“History of Opportunity, Montana, and Its Environment,” expert report dated 12 April 2013, prepared for Lewis, Slovak, & Kovacich on behalf of the plaintiffs in *Gregory A. Christian, et al, v. BP Amoco Corporation, et al*, in Montana District Court for Silver Bow County. The report provides expert opinions concerning the history of the Anaconda Copper Mining Company’s practices of discharging pollutants into the Opportunity environment and of the company’s knowledge that it was doing so.

“Silver Bow Creek,” expert report dated 15 October 2012, prepared for Goetz, Baldwin, and Geddes on behalf of the plaintiffs in *Silver Bow Creek Headwaters Coalition v. State of Montana*, in

Montana District Court for Silver Bow County. The report provides expert opinions concerning the history of the name of an upper reach of Silver Creek, located within a portion of Butte undergoing Superfund remediation.

“Tailings Contributions of Golconda Lead Mines, Inc.,” expert report dated September 2011, prepared for the Environmental Enforcement Section, U.S. Department of Justice, in *U.S. v. Marmon Holdings*, a subsidiary case in the Bunker Hill Superfund litigation in Idaho. The report details the discharge of tailings by the Golconda mill during its years of operation.

“Lava Cap Mine,” expert report dated January 2011, prepared for the Environmental Enforcement Section, U.S. Department of Justice, in *U.S. v. Sterling Centrecorp*, the Lava Cap Mine Superfund case in California. The report details the history of the management relationship between Sterling and its subsidiary, Keystone Copper, which operated the Lava Cap mine.

“History of Mining, Milling, and Smelting in NE Washington,” November 2010, prepared for Teck Metals Ltd in *Joseph A. Pakootas, et al v. Teck Cominco Metals, Ltd.* The report details the histories of several mining and milling operations in northeast Washington which discharged tailings and other contaminants to the environment of the Upper Columbia River in the U.S.

“Mining on State Lands in NE Washington,” September 2010, prepared for Teck Metals Ltd in *Joseph A. Pakootas, et al v. Teck Cominco Metals, Ltd.* The report details the histories of several mining and milling operations in northeast Washington which operated on State lands and discharged tailings to the environment of the Upper Columbia River in the U.S.

“History of Potential Sources of the LNAPL Contamination beneath the Former DSCP Site in South Philadelphia,” February 2010, prepared for the Environmental Enforcement Section, U.S. Department of Justice, and the Defense Logistics Agency in *U.S. v. Sunoco, et al*, sub-contract to Stratus Consulting, Boulder, CO. The report details the histories of the Defense Supply Center Philadelphia (DSCP), Sunoco’s Point Breeze Refinery, and several smaller industrial operations for the purpose of showing that the LNAPL contamination had its historic source at the refinery and could not historically have had its source at DSCP or any of the smaller operations.

“Expert Report,” November 2006, prepared for the Environmental Enforcement Section, U.S. Department of Justice, in the Midnite Mine (WA) Superfund litigation (*U.S. v. Newmont USA Limited, et al*). The report details the history of the management relationship between Newmont and its subsidiary, Dawn Mining Company, which operated the Midnite mine.

“Expert Report,” October 2006, prepared for the Coeur d’Alene Tribe of Indians in support of a mediation hearing intended to resolve differences between the Tribe and Avista, (formerly Washington Water Power) concerning compensation Avista owes the Tribe for having inundated portions of the Coeur d’Alene Indian Reservation as a consequence of the construction of the Post Falls dam, which allows Avista to utilize the lake to provide annual storage for a system of hydroelectric generating stations along the Spokane River.

Testimony before a mediator on behalf of the U.S. Attorney’s Office for the Eastern District of New York in the case *TDY Holdings, Inc., v. United States* concerning allocation of costs for the Superfund remediation of the Li Tungsten site at Glen Cove, New York. Testimony concerned

history of operations at the Wah Chang tungsten refinery, corporate history associated with the operation, and the history of the federal government's involvement in the operations during the World War II years; January 2005.

"Synthesis Report," a report written under contract to the Historic American Engineering Record for the Rosie the Riveter/World War II Home Front National Historical Park (RORI), Richmond, CA, and synthesizing more than a dozen reports prepared for RORI on physical resources in Richmond dating from the WWII period, on historic sites in the San Francisco Bay Area relating America's WWII mobilization, and on historical themes reflecting Americans' experiences on the home front during the war, December 2004.

"The Kaiser Shipyards," business and technological history of Kaiser's Richmond shipyards, written under contract to the Historic American Engineering Record for the Rosie the Riveter/World War II Home Front National Historical Park, Richmond, CA, July 2004.

"The Ford Motor Company Assembly Plant," business and technological history of the Ford Assembly Plant in Richmond, CA, a.k.a. the Richmond Tank Depot, written under contract to the Historic American Engineering Record for the Rosie the Riveter/World War II Home Front National Historical Park, Richmond, CA, September 2003.

"Phase II Expert Rebuttal Report," January 2003, prepared for the firm Beshears Muchmore Wallwork, representing two of the plaintiffs (Phelps Dodge Miami, Inc., and Inspiration Consolidated Copper Company) in the Superfund litigation *Pinal Creek Group v. Newmont Mining Corporation, et al.* The report presents my expert opinions concerning the economic integration of mining companies operating in the Globe/Miami district of Arizona.

"Expert Report," July 2002, prepared for the Environmental Enforcement Section, U.S. Dept. of Justice, in *U.S. v. W.R. Grace*, the Libby, MT, Superfund case. The report describes the mining and mineral processing history of the W.R. Grace/Zonolite vermiculite operation at Libby.

"Second Supplemental Expert Report," July 2002, prepared for the firm Beshears Muchmore Wallwork, representing the plaintiffs in the Superfund litigation *Pinal Creek Group v. Newmont Mining Corporation, et al.* The report provides additional historical details concerning the corporate relationship between the Inspiration Consolidated Copper Company and the Anaconda Copper Mining Company.

"Supplemental Expert Report," January 2002, prepared for the firm Beshears Muchmore Wallwork, representing the plaintiffs in the Superfund litigation *Pinal Creek Group v. Newmont Mining Corporation, et al.* The report provides additional historical details concerning the corporate relationship between the Inspiration Consolidated Copper Company and the Anaconda Copper Mining Company.

"History and Heritage of Civil Engineering," historian of technology for developing an interactive web site (www.asce.org/history/) mounted in commemoration of the sesquicentennial of the American Society of Civil Engineers (ASCE); sub-contract to Convey, Inc., October 2001.

"Determination of Eligibility for the Contra Costa Power Plant," Antioch, CA, prepared under contract to URS-Dames & Moore for Southern Energy, Oct. 2000.

"The Standard Mill at Bodie, CA," narrative history written under contract to the Historic American Engineering Record for California State Parks, Sept. 2000.

"Expert Report," March 2000, prepared for the Environmental Defense Section, U.S. Dept. of Justice, in the Stibnite/Yellow Pine Superfund litigation (*Mobil Oil Corp. v. U.S.*) in Idaho. The report describes the tailings-disposal methods used by the Bradley Mining Company, 1932-1952.

"Expert Report," February 2000, prepared for the firm Muchmore & Wallwork, representing the plaintiffs in the Superfund litigation *Pinal Creek Group v. Newmont Mining Corporation, et al.* The report is a corporate and operational history of the Inspiration Consolidated Copper Company in the context of the corporate and operational history of the Anaconda Copper Mining Co., which owned a minority share of Inspiration stock but controlled the Inspiration operations.

"Expert Report," August 1999, prepared for the Environmental Enforcement Section, U.S. Department of Justice, in the Bunker Hill (ID) Superfund litigation (*U.S. v. ASARCO, et al.*). The report includes technological and business histories of the lead-silver concentrators operating in the Coeur d'Alene mining district and a history of the movement of tailings and other contaminants through the Coeur d'Alene River system.

"Expert Report," August 1997, prepared for the Environmental Enforcement Section, U.S. Department of Justice, in the Clark Fork (MT) Superfund litigation (*U.S. v. ARCO*). The report includes technological histories of the silver mills, copper smelters, zinc concentrators, and manganese plant at Butte and Anaconda, Montana, as well as histories of the Anaconda Smelter Smoke Commission and a series of land exchanges affected by the Anaconda Copper Mining Company and the U.S. Forest Service.

"The Anaconda Smelter Smoke Commission: A Technological History," May 1997, Expert Report prepared for the Environmental Defense Section, U.S. Department of Justice, in the Clark Fork (MT) Superfund litigation (*U.S. v. ARCO*). In addition to a history of the Smoke Commission, the report includes a technological and pollution history of the Anaconda Copper Mining Company's smelters at Anaconda.

"Sheridan Electric Co-op: A History of Its Organizing," a history written to commemorate Sheridan Electric's 50th annual membership meeting, October 1997. The project is accompanied by the recording of about a dozen oral histories of early co-op members recalling the impacts of rural electrification on farm life in northeast Montana.

"Connellsville Coal and Coke Study," a business and technological history of the Connellsville Coke Region for the America's Industrial Heritage Project, Historic American Engineering Record (HAER), National Park Service, September 1992. Transmitted to the Library of Congress as "Connellsville Coal & Coke Region, HAER No. PA-283," the historical narrative accompanying HAER measured drawings of beehive coke ovens in the region, 1995.

"Selby Avenue Bridge, HAER No. MN-61," Historic American Engineering Record narrative and large format photographs, sub-contract to Robert M. Frame III for the Department of Public Works, St. Paul, MN, September 1992.

"Historic Bridges in North Dakota," statewide survey and determination of eligibility, with Lon Johnson (RTI), Mark Hufstetler (RTI), and Charlene Roise, contract to North Dakota State Department of Transportation, May 1992.

"Deer Flat Embankments, HAER No. ID-17-B," with Amy Slaton (RTI), Historic American Engineering Record narrative history, contract to Pacific Northwest Region, U.S. Bureau of Reclamation, December 1991.

"Owyhee Dam, HAER No. OR-17," with Amy Slaton (RTI), Historic American Engineering Record narrative history, contract to Pacific Northwest Region, U.S. Bureau of Reclamation, September 1991.

"Boise Project Office, HAER No. ID-17-C," (RTI) Historic American Engineering Record history, contract to Pacific Northwest Region, U.S. Bureau of Reclamation, September 1990.

"Dams of the Upper Souris National Wildlife Refuge, HAER No. ND-3" and "Dams of the J. Clark Salyer National Wildlife Refuge, HAER No. ND-4," with Mary McCormick (RTI), Historic American Engineering Record narrative history & large-format photography, contract to St. Paul District U.S. Army Corps of Engineers for U.S. Fish and Wildlife Service, August 1990.