Irondale Iron and Steel Plant
Port Townsend vicinity
Jefferson County
Washington

HAER No. WA-7

PHOTOGRAPHS
WRITTEN HISTORICAL AND WRITTEN DATA
REDUCED COPIES OF MEASURED DRAWINGS

Historic American Engineering Record
Western Region
National Park Service
Department of the Interior
San Francisco, California 94102

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HISTORIC AMERICAN ENGINEERING RECORD

Irondale Iron and Steel Plant

HAER No. WA-7

Location:	Ten miles south of Port Townsend on the western shore of Port Townsend Bay Quad Name: Port Townsend South
Date of Construction:	1881; demolished 1919
Present Owner:	Cotton Engineering and Shipbuilding Corporation P. O. Box 111 Hadlock, Washington 98339
Present Use:	Vacant
Significance:	First established in 1881, Irondale is significant as the site of one of the first attempts to introduce heavy industry into western Washington, and was notable as an efficient and modern manufacturing facility.
Report Assembled by:	Diane and J. D. Britton Washington State Office of Archeology and Historic Preservation Olympia, Washington November 1983

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INTRODUCTION

The Irondale iron and steel plant is an historical/archaeological site in Jefferson County, Washington, on the northeast corner of the Olympic Peninsula. Crumbling brick and concrete foundations, now hidden by blackberry bushes and maple and alder trees, are all that remain of the plant (photos 1-19). The townsite of Irondale is located ten miles south of Port Townsend and 38 miles northwest of Seattle. Presently a quiet residential area, the central business district no longer exists. A bustling industrial center in its heyday, Irondale boasted an active commercial hub with daily steamer traffic arriving and departing from its dock.

The first blast furnace opened in 1881 after the discovery of a nearby iron ore deposit. The iron plant closed in 1889, marking the end of Irondale's first industrial era. Ambitious promoters put the operation into production again, eventually adding the first plant west of Colorado to produce steel from its own raw materials.

Based on the cost of importing iron and steel from the East, investors recognized the high profit potential of founding an industry in the Puget Sound area. However, prohibitive fuel prices and imported iron ore from British Columbia and China kept expenses high. In addition, owners raised an insufficient amount of capital to maintain operations within the confines of modern improvements. Despite Irondale's failure and final shutdown in 1919, the plant is significant as one of the first attempts to introduce heavy industry into western Washington. It drew eastern attention and population to the area, but in true boom town tradition, Irondale and its industry prospered and declined together.

INITIATION OF IRONDALE'S INDUSTRY

An iron-making industry started in Washington Territory when James Jones, E.L. Canby, H.L. Blanchard, and Samuel Hadlock together incorporated the Puget Sound Iron Company in Jefferson County in 1879.[1] The company expected to use a local hematite ore from a deposit in the Chimacum Valley located four miles south of Port Townsend to manufacture pig iron. A series of agreements made with landowners William Bishop, William Eldredge, Olaff Peterson, and John Lindley obligated the officers of the Puget Sound Iron Company to build a blast furnace and wharf near the head of Port Townsend Bay in Jefferson County in return for the right to mine the ore on their land and 25 cents per ton royalties. In addition, the officers promised that none of the ore would leave the county except as finished pig iron.[2]

The people of eastern Jefferson County, as well as Washington Territory, viewed the discovery of bog ore and subsequent formation of the Puget Sound Iron Company as a boon to their economy. The Washington Standard of Olympia reflected a mood of optimism when it reported that the man who discovered iron ore benefited not only the territory, but also assured his own fortune, more so than a find of gold or silver bearing minerals. Furthermore, in another article, a reporter described the Chimacum deposits as "inexhaustible."[3] However, a sign of foreboding appeared in an editorial letter published by the Puget Sound Weekly Argus. It warned that a blast furnace at Irondale did not necessarily mean prosperity. According to the writer, a successful iron industry required skilled workers drawing large salaries, a readily available market, a nearby population base, sufficient capital for further investment, and iron produced cheaply enough to compete with eastern products.[4] During the next forty years, Irondale took on many characteristics of a boom town as the iron industry alternately prospered and declined.

Construction of Irondale's first blast furnace, laying out the townsite, and establishment of several businesses including a hotel commenced and continued through the fall of 1880. Company workers built the 38-foot cone-shaped structure from large pebbles found on the beach, completing it early the next year. The furnace possessed a capacity to produce four thousand tons of pig iron annually. Employees of the Puget Sound Iron Company blew the furnace in on January 27, 1881, and then dumped a charge of Chimacum bog ore, charcoal for fuel, and limestone as flux, into the top of the stack. Every eight hours the workers tapped molten iron, freed of impurities, and allowed it to flow into adjacent sand molds called "pigs" and "sows." Another spout channeled slag away from the finished product to be discarded as waste (photo 26; also see Appendix I).[5]

In 1881, the Puget Sound Iron Company leased several iron ore mines on Texada Island, British Columbia, for $30,000 and bought them outright in less than five years. This hard magnetic ore, when combined with soft chimacum bog ore, produced a high quality pig iron. Limestone, a mineral used to attract impurities, arrived from San Juan and Orcas Islands. B.S. Miller, a local entrepreneur, employed about 70 men at nearby charcoal pits to supply the furnace with sufficient fuel. The Puget Sound owners estimated that a successful iron smelting operation required 912 cords of fir wood a day.[6]

The first blast furnace produced pig iron on a routine basis until March 1881, when the firebrick lining melted causing a temporary shutdown.[7] Irondale's industry was continually plagued with various problems causing similar closures throughout its history. Regardless of the setback, improvements to the iron plant and town progressed at a rapid rate. By May, the wharf extended far enough into Port Townsend Bay to accommodate ocean steamers. Installation of a roasting furnace and crushing machine allowed the plant to

run more efficiently. A company store opened early in the summer to supply needed goods to Irondale residents. About the same time, a local paper reported an offer by Puget Sound Iron Company for "liberal inducements" to those desiring to start related manufacturing enterprises or businesses in the area.[8]

At the end of the year the old stone furnace was torn down after producing 1,200 tons of pig iron, and replaced by a new steel plated model with a daily capacity of 50 tons. Construction proceeded throughout 1882, preventing the manufacture of pig iron that year.[9] On April 21, 1882, the newly formed Puget Sound Iron Company of California paid the Puget Sound Iron Company of Washington Territory $500,000 for the iron plant including 14½ acres of land on Port Townsend Bay, all structures, machinery, and mining rights at Chimacum Valley and Texada Island.[10] However, the new owners experienced similar problems despite the completely rebuilt furnace. The refractory nature, or high melting point, of the Texada ore required such intense heat that the blast furnace's firebrick lining melted. Late in 1883, the hearth burned out, once again resulting in closure for repairs. The second furnace, in operation for only a part of 1883, produced a total of 2,317 tons of pig iron.[11]

During 1884, a work force remodeled the iron plant, updating it with modern improvements. The 50-foot furnace, originally open at the top, was sealed by a bell and hopper to prevent carbon monoxide gases from escaping. A passageway called a downcomer channeled this combustible element under the hot stove and boiler where it burned as fuel. A new stove, boilers, and blowing engine worked in unison to provide a hot blast to the furnace (photo 23). The company also built 20 charcoal kilns at a cost of $42,000 to alleviate the unprofitable problem of hiring private parties to supply fuel. The

kilns, built of brick hound with wrought iron and plastered over with concrete, each measured 30 feet high, 30 feet at the base, and held 75 cords of wood (photo 24). Although the company spent most of 1884 renovating the plant, it still managed to produce 540 tons of pig iron.[12]

Between 1885 and 1888, despite various shutdowns, the Irondale blast furnace smelted an average of just under 3,000 tons of pig iron annually.[13] The locality of the plant ostensibly comhined the advantages of "cheap ore, cheap fuel, cheap limestone, and cheap transportation." Billed as "the seat of iron making in Puget Sound," newspaper hyperhole expounded on the many virtues of the young town and iron plant. Also by the mid-1880's, several accounts reported Puget Sound Iron Company's plan to expand into steel making.[14] However, since the company never committed itself to that proposition, the conjecture simply reflected wishful thinking.

During 1889, the plant turned out 10,371 tons of pig iron.[15] By this time the company employed over 400 men in mining, making charcoal, and smelting up to 40 tons of iron a day. The product's high quality accounted for its demand at the Union Iron Works in San Francisco, which used some of this iron in construction of the cruisers "Charleston" and "San Francisco," and the hattleship "Oregon." Ironically, after its highest annual production to date, the plant closed and remained dormant for the next 11 years.[16]

No single reason explains the 1889 closure. The use of crude and unprofitable machinery, a lack of competent supervision, and apathetic stockholders contrihuted to the company's failure. The distance between the San Francisco owners and the daily iron-making decisions at Irondale created disinterest in the operation of the plant. Furthermore, high lahor costs, an import duty on Texada ore, and the use of charcoal as fuel made the smelting process very expensive. Although charcoal produced a superior quality pig

iron, its exorbitant cost and the volume needed in the blast furnace became too prohibitory for the Puget Sound Iron Company to survive. Coke, another good fuel source, did not become available to Washington iron producers until the twentieth century.[17]

Although an industry dominated by eastern interests, westerners recognized the potential of iron-making from the time of their earliest settlement. In 1851, Mormon pioneers erected a blast furnace at Cedar City in Iron County, Utah, where they produced the first pig iron west of the Missouri River. This plant continued for seven years until financial and technical difficulties caused its closure. Another attempt in Iron County by the Western Iron Manufacturing Company lasted ten years, but financial failure forced it to shut down in 1873. The Oregon Iron Company in operation at Oswego, near Portland, began iron production in 1867. Over the next 27 years, its furnace experienced a series of owners, remodelings, and shutdowns until closing for good in 1894 after a total output of 93,404 tons of pig iron. To the south, the California Iron Company maintained a blast furnace at Clipper Gap between 1881 and 1886 and produced 14,635 tons of pig iron. High priced raw materials and poor management caused these ventures to suffer fates similar to that of the Irondale plant. Nevertheless, the era of the iron industry on the West Coast was far from over.[18]

DREAMS OF AN INDUSTRIAL EMPIRE

Rumors concerning the possible sale and restoration of tbe Irondale plant began circulating in 1900 when Homer H. Swaney, a lawyer from McKeesport, Pennsylvania, sent eastern iron-making experts to examine the Puget Sound Iron Company properties. J.H., Cremer of the Wellman-Seaver Engineering Company of Cleveland, Ohio, studied the technical problems of rehabilitating

tbe blast furnace and auxiliary equipment and submitted his report to Swaney. According to Cremer's analysis, implementation of successful pig iron production necessitated an expenditure of only $25,000 for repairs and improvements.[19]

Based on this favorable examination, Swaney organized the Pacific Steel Company in 1901 with eastern capital and bought the iron plant for $40,000. The company put approximately $60,000 into general repairs and the construction of a new hot stove and boiler. Furnace improvements included relining the 50-foot stack witb a two-foot thickness of firebrick and installing water cooled iron plates within the hearth and bosh area to protect them from melting (photos 23 and 25).[20] Restoration continued throughout the spring, employing up to 150 workers imported from McKeesport because of their first-hand knowledge of the iron-making process. Henry Hall of Wellman-Seaver directed this repair work as well as the construction of a new laboratory for iron testing. Frederick Crabtree, also of McKeesport, joined Pacific Steel to take charge of the lrondale furnace.[21]

In July, workmen started fires under the kilns to provide a large supply of charcoal before blowing in the furnace. However, hoping to ultimately offset the high cost of production, Swaney invested $6,000 for improvements and additions to the Irondale charcoal plant (photo 24). Company employees erected a sawmill, log splitting machine, and conveyor system to automatically feed wood into the kilns. As a result, the efficiency of charcoal production increased while its cost dropped substantially.[22]

In the meantime, Swaney acquired iron and other mineral properties large enough "to develop the iron industry to an enormous extent." Shipments of ore from Texada Island and Hamilton in Skagit County began in the fall of 1901 after Pacific Steel obtained leases to the claim deposits. Limestone

arrived from Roche Harbor in the San Juan Islands.[23] About the same time, iron deposits found in the Olympic Mountains prompted discoverers to claim that enough ore existed "to keep a half dozen smelters operating for an indefinite period." The possibility served to further boost the economic potential of the area.[24]

Local papers, reflecting an optimistic attitude, reported the return of "an air of prosperity." The town of Irondale, located on 300 acres of Pacific Steel property, grew with the iron plant (photo 20). New construction included a row of company officer's houses, a hotel, 19 cottages for employees and their families, bunk and boarding houses for single men, and several new businesses. In April, Swaney applied for the establishment of a post office to facilitate communication. Telephone and telegraph lines built between lrondale and Port Townsend gave the new town an air of permanency. The Seattle Post-Intelligencer reported lrondale's success as a "complete business revolution on the Pacific Coast."[25]

Swaney finally realized his ambitions on December 15, 1901, when his wife ceremoniously lit the lrondale furnace for the first time in twelve years. After blowing in, a "dense volume of black smoke shot out of the big flue, followed by a red blaze," a welcome sight.[26] Although less dependent on simple manpower, the operational procedure was similar to that of the Puget Sound Iron Company. A large steam derrick unloaded imported ore from scows and dumped it into bunkers on the pier. From the bunkers, a small locomotive hauled ore-filled cars to an area near the elevator to be roasted and crushed. Workers weighed specific amounts of ore, limestone, and charcoal, and hoisted the mixture to the top of the elevator. Deposited in carts on the bridge, employees wheeled the raw materials across the 50-foot span and dumped them into the top of the blast furnace. Once inside, the iron ore

gradually melted at a temperature of 3500 degrees and dripped down to the hearth. Workers tapped the furnace once every eight hours to allow the pig iron to run off into sand molds (photo 21, see also Appendix 1).[27]

Pacific Steel, from its remodeled plant at Irondale, produced 50 tons of high quality pig iron a day. No other blast furnace operated on the Pacific Coast at this time. Foundries and machine shops from Alaska to southern California used Irondale's product. The Irondale plant employed directly and indirectly about 300 men--100 at the smelter, 100 in the mines, and 100 felling trees. These workers manufactured 6,000 tons of pig iron before the plant closed in January 1903. Swaney considered this first run an experiment and concluded it a success. Consequently, he continued to buy raw material deposits and drew up ambitious plans to expand into steel production.[28]

Pacific Steel Company officers and a number of Seattle investors formed the Seattle Iron and Steel Company in March 1903 with a capital stock of $6 million. Swaney, as president, planned to expand Irondale's blast furnace operation to supply a proposed steel plant and mill in West Seattle. The company hoped the low cost of ore in the Pacific Northwest would make its products competitive with eastern mills. A large work force of skilled laborers "anxious to get away from plants controlled by the steel trust," was believed to be available for both operations.[29]

Expansion of the Irondale plant began in August 1903, and Swaney continued to formulate his grandiose plans for a gigantic iron and steel industry despite financial troubles. He secured a site on the waterfront in West Seattle for open hearths and rolling mills, and acquired a schooner to carry pig iron from Irondale to the new plant.[30] All activities of both companies ceased, however, when Swaney unexpectedly drowned on January 9, 1904, in the wreck of the steamer "Clallam." It capsized in the Strait of Juan de Fuca

during a storm. Within a week, a federal judge named Pacific Steel Company's secretary, M.J. Carrigan, as receiver of the now idle Irondale operation.[31]

The Pacific Steel Company was in deep financial trouble before Swaney's death. Swaney spent most of his time building an iron and steel monopoly, but left "the blast furnace with little or no attention." The Irondale furnace produced no pig iron during 1903, and yet Swaney continued to buy raw material deposits and plan for a Pacific Coast steel industry. Furthermore, the Irondale plant experienced "continual shut-downs owing to shortage of fuel, breakdowns of the hot-blast stove, and other difficulties which could have been avoided with sufficient capital."[32] With the passing of Pacific Steel, Irondale again lay dormant; however, another company would yet breathe life into a Pacific Coast iron industry.

RESTORATION OF IRON MAKING

On September 7, 1906, James A. Moore, a Seattle capitalist and owner of a large investment company, bought the Irondale property at a receiver's auction. No opposition appeared against Moore's $40,000 bid, the minimum price set by the Court. The property encompassed 320 acres on Port Townsend Bay with a half mile of water frontage covered by 31 residential and business buildings, the furnace, and factory structures (photo 20).[33] Moore first visited the Irondale plant in January 1902 when the Pacific Steel Company produced pig iron and realized the potential of an iron and steel industry in the Pacific Northwest.[34]

Moore immediately announced plans to spend $100,000 to increase the blast furnace's daily capacity, add up-to-date machinery, and completely rehabilitate the property. He proposed to solve the historic problem of expensive fuel by installing a plant to manufacture timber by-products and use the

profit to pay for charcoal production. An ambitious man with great dreams, Moore anticipated opening the Irondale furnace within six months.[35] Once again, the future of the area looked bright.

Moore originally planned Irondale as an auxiliary to a proposed steel rolling mill operation at Kirkland, Washington. However, the "mammoth works" fell through and Moore concentrated his efforts on reopening the Irondale plant under the Irondale Furnace Company, incorporated on November 6, 1906.[36] During the following spring, the company hired 60 workers to rebuild the plant and prepare the furnace for blowing in. William Price, general manager for the new Irondale company, traveled to the East and ordered necessary machinery for the plant; but labor strikes delayed the equipment's delivery until May. Meanwhile, Irondale laborers enlarged the blast furnace to 60 feet and built a new hot stove as soon as its parts arrived. Moore now planned to complete the plant's renovation and begin smelting in early 1907.[37]

Unable to hire a sufficient number of laborers in the Port Townsend and Irondale areas, Moore brought 40 men over from Seattle to work on the iron plant. Local residents seemed skeptical about committing themselves to the iron industry after two previous failures. Also, some of the eastern employees brought to Irondale under Swaney most likely left the area when Pacific Steel went into receivership. However, 40 additional laborers did not satisfy Moore's needs, consequently he "turned to the Japanese labor contractors" in Port Townsend and hired "a large delegation." To maintain peace between workers, foremen gave white employees "the cleaner work" while the Japanese were "turned loose where the dirt and grime" was thickest.[38]

Early in 1907, Moore arranged for the shipment of ore from mines on Quatsino Sound, Vancouver Island, by the San Francisco based Dollar Steamship

line. Later that spring, the Irondale Furnace Company leased the iron mine on Texada Island and purchased bog ore from Skagit County, Washington. The company also bought two large scows and a barge for $30,000 to transport the ore to Irondale.[39] Moore, confident of his success with the Irondale operation, later said "one of our iron deposits in British Columbia alone is capable of supplying our furnace for one hundred years." Furthermore, he would be "greatly disappointed" if the future did not "see the Irondale furnace turning out from 400 to 500 tons a day."[40]

The repair crew finished relining the blast furnace in July 1907, and lit drying fires to prepare it for the first charge. A series of unexplained explosions inside the furnace, however, delayed the plant's opening. Workers again repaired the furnace; but another explosion occurred "which killed one employee and injured several more." An exasperated Moore halted any further work and the plant remained idle until a crew of "experts" arrived from Pennsylvania in September to supervise the furnace's restoration. Production finally began in October and the Irondale Furnace Company manufactured a high grade of pig iron.[41]

Near the end of the year, an insufficient supply of charcoal forced the company to blow out the blast furnace. Despite the high cost of fuel, nearly double that of imported iron ore, Moore's plans for a by-products plant never materialized. In order to solve the crisis, the company ordered 6,000 tons of coke from British Columbia, but the plant remained closed through the rest of 1907. Nor did Irondale produce any pig iron in 1908. Besides the fuel problem, a financial depression reduced market demand. Even though the Irondale Furnace Company realized little or no profit during this period, it continued to make improvements and maintain the plant.[42]

FOUNDATION OF IRONDALE'S STEEL INDUSTRY

In December 1907, Moore returned from a trip to the East and announced the formation of a new million dollar corporation composed of eastern capitalists. On January 14, 1908, the Irondale Steel Company incorporated to take over the Irondale Furnace Company's property and holdings.[43] Moore arranged for the sale of $500,000 in honds to erect open hearth furnaces and rolling mills for "the first complete steel plant erected west of the Rocky Mountains." A numher of steel production plants, previously organized in Oregon and California, manufactured steel solely from iron and steel scrap.[44] Moore proposed to produce steel from pig iron smelted in the Irondale hlast furnace and scrap acquired from the Pacific Coast region. He claimed that steel magnates from New York and Pennsylvania promised to come forward with $10 million for expansion after a successful demonstration.[45]

Moore, wasting little time, placed an order with the Moran Brothers Company of Seattle for the construction of a steel plant "in the shape of an open hearth furnace." Meanwhile, the Irondale Steel Company gained a reputation with nation-wide publicity. The Wall Street Journal reported the company's acquisition of "the only blast furnace in the state of Washington" and proposal to build an "up-to-date" steel mill. The new company expended $400,000 for improvements, two open hearth furnaces, a train of rolling mills, and auxiliary equipment. Its owners assumed a profitahle future as they estimated Pacific Coast manufacturers consumed over one million tons of iron and steel annually. Furthermore, Irondale Steel believed high transportation costs for imported steel from the East created a natural protective tariff.[46]

Moore cleared and platted the Irondale townsite through the spring of 1909, modeling it after the "most successful industrial towns in the East"

(photo 41)[47]. Local papers gave extensive coverage to Irondale's growth, extolled the area's advantages for iron and steel production, and outlined its potential as an industrial town. The Port Townsend Weekly Leader published stories about successful Irondale investors, and often compared the future of Irondale to Gary, Indiana, "one of the largest and most profitable manufacturing centers in the entire world." Regularly scheduled excursions, many arranged by Moore, brought visitors from all around Puget Sound to witness the bustling activity at Irondale. He aimed the trips toward promoting and encouraging outside investment. Irondale became so popular that many Port Townsend residents chartered steamers to take them there for the Fourth of July celebration in 1909 (photo 42).[48]

By the end of the summer, Irondale Steel Company finished the preliminary work for the new steel plant. While laborers poured the foundations, Oscar Stromberg, consulting engineer from Seattle, designed two oil-fired 20-ton capacity open hearth furnaces (photos 28 and 29). Rail tracks on either side of the casting pit supported an electrically operated 25-ton ladle used to direct the flow of molten steel from the open hearth to the ingot molds below. The company ordered an 1800 horsepower Corliss steam engine, the largest "ever shipped to the Pacific Coast" (photo 33). This Corliss furnished power to the 22-inch rolling mills (photos 31 and 32). Workers poured the foundation for a new power house and installed six boilers to provide all the energy needs of the developing steel plant (photo 38).[49] Additional equipment continued to arrive as the outline of the Irondale steel operation took definite shape.

On October 2, 1909, Moore organized the Western Steel Corporation with a capital stock of $20 million to take over the holdings of the Irondale Steel Company.[50] The area continued to boom as the owners and local population

planned on a grandiose scale. The Port Townsend Weekly Leader leaked information concerning a second steel plant in British Columbia and the possibility of Moran Brothers relocating its shipbuilding enterprise at Irondale. The New Jersey Pipe company negotiated a deal to acquire a suitable site close to the steel plant. Symington Brothers, a railroad car parts manufacturer from Baltimore, Maryland, also investigated Irondale as a possihility for expansion. Western Steel purchased milling equipment for a complete horseshoe plant in the spring of 1910 and housed it on the south side of Chimacum Creek, just north of its steel making site. Although never in production, the horseshoe industry was the only auxiliary husiness ever constructed at Irondale.[51] Besides subsidiary plants, Western Steel looked forward to the huilding of a transcontinental railway line to the area.[52] This dream, also a potential hoon to the Olympic Peninsula, never materialized.

However, work on the steel plant progressed in realistic form throughout the spriñg of 1910. Western Steel drafted designs to reclaim 100 acres of tidelands for expansion and at the same time increased the harhor's depth to accommodate larger ships. Construction workers completed the open hearth furnaces, rolling mills, and steam plant hy the end of March. Other steel making equipment such as scrap shears, generators, a pumping system, skull cracker, billet shears, and rolling lathes arrived at the Irondale wharf, ready for installation. The first fuel oil shipment was transferred to a steel lined concrete tank of 6,000 harrels capacity just south of the hlast furnace area. Lahorers in the meantime surveyed and graded the right of way for a small railway to transport raw materials and finished steel products around the plant (photo 39).[53]

In April, wood fires lit under the open hearths to dry the furnace chambers sent the first smoke through the new chimneys. After several weeks, workers coated the open hearth bottoms with a mixture of 80 percent burnt magnesite and 20 percent basic slag.[54] As the steel plant prepared for its first charge, publicity and promotion testified to Irondale's importance to the region's economy. The Irondale News announced that the "commencement of operations in the plant . . . will certainly mark an important epoch in the history of empire building in this great new Northwest country."[55]

The phenomenal growth of the town of Irondale reflected its faith in the success of Western Steel's ambition. Although established in the early 1880's, Irondale's population totalled only 150 in 1909. As quickly as the steel plant developed, however, the town boomed with the promise of becoming the "Steel City of the Pacific Coast." After filing the Irondale plat in 1909, Moore sold lots and used the proceeds to invest in the steel plant. He claimed the double purpose established by other industrial cities of providing workmen a "convenient place of abode" and at the same time a share "in the profits" from platted lands. After production began, Western Steel transferred to the Irondale Realty Company all land holdings not essential to steel making.[56]

By February 1910, Irondale's population climbed to several hundred. The town boasted graded streets, a hotel, steam heat, electric lights, a newspaper, six store and office blocks, a school, and a complete water system. In addition, the Northwestern Hospital Company contracted with Western Steel to build a hospital, paid for by mandatory deductions from workers' wages.[57] While construction transformed the landscape, Western Steel continued to bring in visitors with financial interests to view the expanding town and plant (photo 37). A large influx of workers, many traveling from the East

with their families, also added to the general excitement. Within a year and a half, the population reached 1400, of which four hundred worked for Western Steel. Irondale took on the appearance of a well functioning city.[58]

While construction in the town and steel plant progressed, local newspapers churned out a constant flow of editorial boosterism. The Irondale News challenged the long established eastern industry, better known as the "steel trust," and claimed that "one indisputable fact should be kept constantly before the eyes of the public," namely that "both pig iron and steel can be manufactured here at a lower price than is possible in the eastern mills."[59] However, Western Steel relied on eastern experts to compensate for its lack of steel making knowledge. The company brought Carl E. Maeder, former superintendent at Duquesne Mills of United States Steel Corporation in Pennsylvania, and promoted him to general superintendent for the Irondale works. N.V.F. Wilson resigned a managerial position in a Pittsburgh steel plant to assist Maeder.[60]

Success of Western Steel's long range goals depended on access to an unlimited supply of high quality raw material deposits. To satisfy this need, the company signed a contract in March 1910 with the Han Yeh Ping Iron and Coal Company of Hankow, China, for 200,000 tons of pig iron and iron ore each year for 15 years.[61] The transaction represented one of the largest contracts ever signed between the Chinese and a foreign power. Furthermore, since the imperial government held a direct interest in the Han Yeh Ping Company, Moore viewed the contract not only as a great asset for Western Steel, but also as an "expression of friendliness" which might "bring about advantageous trade relations" between China and the business interests of Puget Sound. The first shipment, of 1,500 tons of pig iron and 5,000 tons of iron ore, arrived at the Irondale dock on June 10 (photo 40). The Dollar

Steamship line handled this and most subsequent shipments. Importation continued except during December and January when low water in the Yangtsze River made the inland Han Yeh Ping Company inaccessible to ships.[62]

In addition to the China contract, Western Steel acquired ownership of a number of raw material claims. The company bought a ten million ton bog iron deposit at the Quatsino Sound Mining District of British Columbia. Property on Barclay Sound, British Columbia, contained a deposit estimated at almost four million tons of magnetic iron ore. The company also purchased a tract consisting of 12 million tons of ore in Lyon County, Nevada, to serve as a reserve supply. Steamers transported coke from deposits located at Ashford in Pierce County, Washington, and Graham Island, British Columbia. An "inexhaustible" quarry in Skagit County, Wasington, furnished limestone for fluxing in both the iron and steel making process.[63]

On May 26, 1910, Western Steel's employees introduced a charge of pig iron and scrap into the first open hearth furnace (photo 30). Later that night, Harry Bevan, superintendent of the open hearth department, tapped the furnace and turned out the first Irondale steel. Molten metal poured from the open hearth tapping spout into a 25-ton ladle, which then passed over a line of molds forming ingots of 965 pounds each, or about eight tons of finished steel. After testing, the steel proved to be extremely high in quality. Although the first charge was small, each furnace possessed a maximum capacity of 25 tons. In less than a month, both furnaces operated on a 24 hour basis and steel workers tapped each two to three times daily.[64]

After producing a large stock, mill workers placed the ingots into the reheat furnace which turned them a glowing red. A crane hoisted the ingots to the 22-inch mill's lifting table, where they passed back and forth through

rollers until attaining "hillet" shape. The steel then rolled through additional stands on the 22-inch mill to manufacture marketable shapes or were reheated and rolled on the 14-inch mill for small dimension bars (photos 31-36, see also Appendix II).[65] Irondale, at long last, had achieved full scale steel production.

With production harely started, Moore and Western Steel officers hegan implementing plans for expansion. Removal of the old charcoal kilns increased the size of the waterfront storage yards. A repair crew overhauled the wharf and extended the railroad track system to the entire length of the dock for easier access to the ore hunkers. The company poured the foundation for an additional open hearth next to the original two. During the summer, carpenters framed an office building for clerks in the rolling mill department. A new twisting har machine produced steel reinforcing hars for the United States government for use in nearhy military estahlishments. Other plans included installation of a new electric crane, automatic charging machine, and 40-ton ladles for the open hearth department, an electrically operated hillet conveyor, continuous heating furnaces for the rolling mills, a nine-inch rolling mill, and a skull cracker to hreak up scrap steel. During the next several months, Western Steel accomplished most of these improvements (see Appendix 1I).[66] Reflecting a national trend in the iron and steel industry, the lrondale changes demonstrated that lahor saving devices increased the plant's output and provided greater profits.

While the steel plant received puhlicity and attention, Western Steel did not neglect the hlast furnace. During the spring of 1910, lahorers relined its hase with firebrick. The company expected to produce most of the pig iron needed to make steel in the open hearths. Chinese iron ore, mixed

with equal amounts of British Columbia and Washington ores, produced a "superior" grade of iron. Blown in on July 5, the furnace turned out 60 tons of pig iron daily and increased its output to 90 tons shortly thereafter (photo 22).[67]

A new foundry department, in conjunction with the blast furnace, began ingot mold and iron casting production in the fall of 1910. Foundry personnel made tool and machinery parts for use in the iron and steel plant, thereby avoiding delay from factory centers in the East. By October they turned out three to four tons of finished iron per day, so large an output that it necessitated doubling the size of the casting house. Eventually, Western Steel cast its own steel and shaped rollers for the rolling mills. In November, the company installed a 12-ton cupola to melt iron used for castings. By the end of the year, the foundry department claimed to be the fastest growing asset in the entire Irondale iron and steel operation.[68]

The Oregon Railway and Navigation Company, as well as a number of local manufacturers and hardware dealers in the Seattle area, purchased Irondale's first finished steel. Within a short time, the plant produced 700 tons of steel ingots weekly and rolled these into 690 tons of finished merchant bar. Existing orders kept the plant functioning day and night, and daily shipments prevented stock build up. The company sales manager reported substantial profit as representatives scoured the West Coast for prospective buyers.[69]

Further testing showed the strucutural quality of the Irondale product "far in excess of what government demands in its specifications." Satisfied customers testified to its excellence and expressed relief that they no longer depended on eastern industries for their building needs. Despite a general depression felt by iron and steel producers all over the country, Irondale's sales continued to climb.[70] Its success prompted the Irondale

News to report that "this city would repeat the history of the steel centers of the east, south and west" and possessed a future "brighter by far" than some that had become world famous.[71]

James A. Moore, recognized by his contemporaries as the "wizard of the real estate field of Seattle," devoted a large portion of his time traveling to promote Western Steel and seeking new investors. By July 1910, about two million dollars, representing investments from Seattle, British Columbia, San Francisco, and New York, poured into his enterprise. In October, Moore returned from New York and announced the acquisition of $10 million for future expansion and development. He placed a $2 million mortgage on Western Steel properties in favor of the Carnegie Trust Company of New York, who served as broker for the bonds. This prompted local speculation to predict the employment of 5,000 men within three years.[27] Few people, however, guessed the coming of Western Steel's imminent bankruptcy. Moore, a man who made a lot of money selling real estate in Seattle, now played for big stakes in a new market dominated by more experienced eastern financiers.

COLLAPSE OF IRONDALE'S INDUSTRY

Western Steel's plant closed for a week during Christmas of 1910 to allow for the installation of new machinery.[73] Despite the temporary shutdown, the company's business culminated at an all time high. It received orders from as far east as the George A. Lowe Company in Ogden, Utah, and as far south as the Union Hardware and Metal Company of Los Angeles. In early 1911, substantial orders for Irondale structural steel arrived from the Stone and Webster Construction Company and the Great Northern Railroad Company; both were engaged in major improvements and tunnel construction in western Washington. The construction of a commercial club in Tacoma and the St.

Ignatius Church in San Francisco also utilized Irondale's products. A $125,000 deal with the Leonard Construction Company of Chicago (doing business on the Pacific Coast) represented the largest contract with a local firm to date. The Irondale company continually broke its own monthly sales records.[74]

Despite high sales, the company faced serious financial trouble when Moore received word that Carnegie Trust suspended business the first week of January 1911.[75] After spending large sums of money building the Irondale steel plant and buying raw material deposits, the company now needed additional capital to keep the venture operating. In late January, Metropolitan Trust Company of New York lent Western Steel $300,000 and Moore traveled to Europe to find additional investors. In a short time he announced a $10 million loan from British capitalists, but for reasons unknown, the deal fell through. Moore returned to Europe and succeeded in a $5 million deal with French bankers. However, when he returned to New York, the Metropolitan Trust increased its original loan to $600,000 for four months. Moore put up $2 million in bonds as security and understood that the Trust Company would arrange for further financing.[76]

Leslie M. Shaw, former Secretary of the Treasury under Presidents McKinley and Roosevelt, accompanied Moore on his return trip to the West in April. Moore expected Shaw to rally local financial interest in support of the plant and gain recognition from the First Mortgage Warranty and Trust Company of Philadelphia. In May, Western Steel elected Shaw and seven leading Seattle bankers to the Board of Directors, thus signifying their approval of the venture. Two months later, Western Steel stockholders authorized a corporate bonding indebtedness of $5 million, to allow for further expansion to the Irondale Plant.[77]

Although financial arragements for the first half of 1911 seemed at best shaky, Moore continued to carry out his great industrial plans. Early in January he secured a site near the city of New Westminster, British Columbia, for the proposed second steel plant, and a month later purchased additional ore beds on Louis lsland, British Columbia, for $100,000. Western Steel's monthly payroll climbed to $28,000 while the workers installed a steady stream of new equipment intended to further improve the plant and allow for more efficient production. An electrically operated charging machine, used to fill the open hearth furnaces, cut labor time from three hours of strenuous work to a mere half an hour. In addition, construction of the third open hearth progressed as workers lit drying fires in May.[78]

The large volume of sales and continual improvements gave lrondale the appearance of a successful industrial enterprise. lron and steel workers, as well as local residents, believed in their security, prosperity, and growth. The lrondale News, in a booster campaign, viewed Western Steel's success as an incentive for allied industries to locate on the west side of Puget Sound and predicted the spread of manufacturing activities to all parts of the Olympic Peninsula.[79] Then, on October 12, 1911, Irondale's dreams burst as Metropolitan Trust filed a petition for Western Steel's involuntary bankruptcy at Seattle's United States district court. On October 23, Moore answered the petition by denying Western Steel's insolvency. A federal judge appointed temporary receivers to hold the property until the court made a decision on the bankruptcy proceedings.[80] In the meantime, all lrondale iron and steel production ceased.

Rumors to the effect that the United States Steel Corporation tried to force Western Steel out of business circulated throughout the Puget Sound area. However, regardless of the accusations, Western Steel's failure to

meet the $600,000 repayment deadline caused Metropolitan Trust to foreclose.[81] To avoid a loss in value of the Irondale plant, company creditors voted in December to place the plant on the market for immediate sale and settle outstanding claims against Western Steel. Irondale workers also hoped for an early settlement as Western Steel owed them $27,000 in back wages.[82]

In February 1913, the Port Townsend Weekly Leader announced the federal court's decision for a March 15 sale date for the Irondale property. Metropolitan Trust, using its $2 million of Western Steel security bonds, purchased the plant.[83] The following June, Moore sued the Trust Company, stating that Metropolitan and United States Steel conspired to bankrupt Western Steel. Furthermore, Moore alleged that Metropolitan improperly used its security bonds to bid on the Irondale property. Between June 1912 and February 1913, Moore tried in vain to move the court proceedings to Jefferson County where he enjoyed tremendous support. However, the Washington State Supreme Court denied a change of venue. The corporate battle lasted until February 8, 1913, when a King County federal judge upheld Metropolitan's claim to Western Steel's assets. In April, a federal court dismissed Moore's charge of conspiracy and thereby eliminated his claims on Western Steel Corporation.[84]

By September 1913, Metropolitan settled all outstanding claims, including back pay for the Irondale workers and announced its intentions to sell the plant to Pacific Coast Steel Company of Seattle. The sale, finalized in January 1914 for a net sum of $300,000, once again created an air of speculation in Irondale as residents predicted the plant's reopening. However, to the disappointment of all, Pacific Coast Steel sent 40 of its employees to dismantle and ship the steel plant to Seattle. After three months, only the foundations and empty buildings of the once busy steel plant remained.[85]

The town of Irondale followed a similar fate. In 1911, many residents believed that Moore would eventually win the bankruptcy suit and start the steel plant running again. Support in the press exemplified his popularity among local citizens. As time dragged on, however, many businessmen and residents drifted away. In October 1914, the Seattle Post-Intelligencer reported the scene at Irondale as "gradually going down, little remaining of the residence district but vacant houses." At the same time, a fire swept through Irondale and destroyed the town's main business district. By the end of 1915, Irondale's population decreased from its all time high of 1,400 to a mere 200.[86]

The relative quiet settling over Irondale broke once again in 1917 when high prices for pig iron during World War I led Pacific Coast Steel Company to reopen the iron plant. During the summer, 30 workers completed repairs made necessary by natural deterioration and "marauders" carrying away vital parts of the machinery. The blast furnace, blown in on September 10, used coke and left-over Chinese iron ore from Western Steel days. Pacific Coast Steel turned out 40 to 60 tons of pig iron daily and shipped it to their Youngstown plant in Seattle where steel makers transformed it into finished products.[87]

West Coast shipbuilders, under contract with the federal government, bought the steel and used it to construct warshipa.[88] The furnace shut down for the final time on February 27, 1919, when the company employees exhausted the supply of raw materials. High cost of production combined with a drop in demand for iron and steel at the end of the war made operation of the plant unprofitable. At the end of the year, a dismantling crew tore down the blast furnace and all auxiliary machinery and sold them as salvage.[89]

CONCLUSION

Irondale's dreams of an industrial empire ended after almost 40 years of iron and steel manufacture on the Olympic Peninsula. Its failure can be explained by examining basic considerations which include "iron ore, fuel, fluxes, price of labor, and nearness to markets."[90] The iron ore deposit in the Chimacum Valley proved to be poor quality and in short supply. This necessitated the importation of ore from both British Columbia and China, which added to its price. Fuel problems, also an expensive proposition, continually handicapped the plant throughout Irondale's history. The cost of labor remained high because a lack of skills locally forced owners to bring experienced workers and managers from the East. A limited market further restricted the industry until a growth in population and industrial activity, especially in the 1940's, served to increase demand.[91]

Ironically, even as Irondale fialed, the steel industry on the West Coast, boosted by World War I needs, entered an era of prosperity. By 1922, 20 open hearth furnaces smelted steel in California, Oregon, and Washington. Pacific Coast Steel Company operated four in West Seattle. All the furnaces, however, manufactured steel solely from scrap because of its accessibility and relatively low price.[92] On the other hand, eastern plants, in close proximity to vast iron ore deposits and coal regions, used pig iron as their principal ingredient.[93] Despite eastern manufacturing advantages, a desire in the West for self-sufficiency led to the inauguration of iron and steel production there.

The attempt at Irondale proved premature. Promoters miscalculated the value of local ore and fuel resources as well as the amount of capital needed to maintain a competitive business. Furthermore, the area lacked the population base necessary to support an industry of the size that the owners

envisioned. Irondale, like so many gold and silver mining towns of the previous century, passed into oblivion. Today, where the plant once stood, a mass of brick and concrete foundations hidden by natural growth survives as a monument to those who dared to initiate a western industrial economy.

APPENDIX 1

PIG IRON MANUFACTURE

1. BLAST FURNACE BLOWING IN

A. DRYING: Before the actual smelting process can begin, the blast furnace must be thoroughly dried to evaporate water absorbed by the brick during construction. This initial stage takes several days--if the blast furnace is heated too fast, it could be damaged.

B. FILLING: Placing iron ore (containing approximately 60 percent iron), fuel (charcoal or coke), and flux (limestone) according to a carefully arranged ratio into the blast furnace. The combination of approximately two tons of iron ore, one ton of fuel, half a ton of flux, and four tons of air (hot blast) would produce one ton of pig iron.

C. LIGHTING: Blowing a hot blast into the furnace burns the fuel and begins the smelting process.

D. OPERATING: The actual smelting of iron with the blast furnace, hot stoves, blowing engines, boilers, and pumps all working in unison. The generated heat melts the iron ore and limestone; the iron, being the heaviest, sinks to the bottom of the hearth. The limestone unites with the non-metallic elements of the iron ore to form a slag which floats on top of the molten iron.

1. At Irondale, a single charge required between seven and eight hours; therefore, three charges a day were possible.
2. After a few days running, the operation becomes routine.

II. PIG IRON

A. Pig iron is deoxidized iron ore--it contains between 2.5 and 4.5 percent carbon content received from the fuel charge.

B. Pig iron by itself is not a finished product. It must be re-heated and then rolled or milled into iron products or can be further treated (as in an open hearth) to produce steel.

III. BLAST FURNACE BLOWING OUT

A. When a blast furnace reaches the end of its campaign (firebrick lining worn out), it is usually blown out. This is accomplished either by stopping the charge and allowing the heat to reduce slowly or by adding silica gravel to snuff the fire.

B. The blast furnace is cleaned and the old firebricks replaced with new ones. The blast furnace is then ready to be dried and blown in again.

C. Blowing out is standard practice.

IV. BLAST FURNACE--as described from the top of the furnace down.

A. SHELL: The outer metal lining of the blast furnace which gives it shape and keeps the inner brickwork in place. Workers constructed the Irondale furnaces with boiler plate in "shingle" fashion; that is, the edges of adjacent plates were overlapped and riveted.

B. THROAT: The top of the furnace into which the charge (iron ore, fuel, and flux) is dumped.

C. BELL AND HOPPER: A sealing-type device located in the throat used to keep carbon monoxide gases from escaping.

D. DOWNCOMER: A duct located near the top of the furnace designed to channel carbon monoxide gas under the boiler house and hot stove where it burns as a fuel.

E. SHAFT: The part of the furnace which runs from near the top of the furnace down to the mantle.

F. MANTLE: A heavy steel ring which supports the blast furnace shell and brickwork of the shaft so that the hearth and bosh brickwork may be removed for repair without disturbing the shaft brickwork.

G. BOSH: The inverted conical section of the furnace where melting begins. Water flowing through metal pipe embedded in the fire-brick lining keeps the bosh from melting.

H. HEARTH: The area directly below the bosh where molten iron and slag collect. It is sometimes referred to as the crucible.

I. TUYERE: A nozzle-like casting into which the heated blast (air) enters the furnace.

1. The bustle pipe, which encircles the furnace, distributes the hot blast to the tuyeres.
2. The bustle pipe receives the hot blast from the blowing engine and hot stove.

J. SLAG NOTCH: A hole located a few feet above the iron notch used to rid the furnace of slag (waste) material.

K. IRON NOTCH: A hole located at the bottom of the hearth where the molten iron leaves the furnace on its way to the casting house. The slag and iron notches are plugged with clay during charging.

V. BLAST FURNACE AUXILIARIES

A. CHARCOAL KILN: A heating oven used to reduce wood to charcoal.

1. Charcoal is used as a fuel for smelting in the blast furnace and to supply the chemical reactants (primarily carbon monoxide gas) for reducing iron ore to iron.
2. Irondale had 20 charcoal kilns each 30 feet high and 30 feet in diameter. They were dismantled when Western Steel Corporation decided to use coke.

B. ROASTING PIT: An area where the iron ore is preheated to rid it of any volatile material, especially moisture.

C. ELEVATOR: Used to carry iron ore, fuel, and flux to the top of the blast furnace.

D. BRIDGE: A span over which the iron ore, fuel, and flux are transported in wheelbarrows or wheeled carts from the elevator to the charging floor. The men in charge of this operation are known as top fillers.

E. CHARGING FLOOR: The area immediately surrounding the top of the blast furnace from which the charge is introduced.

F. HOT STOVE: Built of firebrick encased in boiler plate. Its function is to preheat the blast (air) before its admission into the furnace.

G. BLOWING ENGINE: A steam driven machine used to compress air into the hot stove before being blasted into the furnace.

H. BOILER: Used to furnish steam to the blast furnace pump, blowing engine, hoisting machine at the elevator, and the crusher at the roasting pit.

I. PUMP: Used to circulate water in the metal pipes embedded in the bosh and hearth firebrick of the blast furnace. At Irondale, the pump was located in the engine house.

J. WATER LINE: A water pipe running from Chimacum Creek to the blast furnace.

K. CAST HOUSE: Area adjacent to the blast furnace where molten iron runs from the furnace to sand casts known as sows and pigs because of their shape.

APPENDIX 1I

STEEL PRODUCTlON

lNTRODUCTlON: Western Steel Corporation's plant at Irondale employed the basic open hearth method in its steel making process. The charge consisted of a combination of pig iron produced from Western Steel's Irondale blast furnace along with iron and steel scrap obtained from various localities on the Pacific Coast. Employees introduced this charge to the open hearth at its charging aisle. As soon as the charge melted and its carbon and phosphorus content diminished, the workers tapped the open hearth at its pouring aisle, allowing the molten steel to run into a rail mounted ladle which then passed over a line of ingot molds. When cooled, a crane stripped the molds and transported the ingots to a reheat furnace. From the reheat furnace, ingots traveled over an electric conveyor to the 22-inch mill for shaping and then on to the billet shears for cropping. The billet passed back tó another stand of rolls on the 22-inch mill for final shaping or on to the 14-inch or nine-inch mills. Once shaped, the steel bars were cut to length at another set of shears, then moved on to a rolling lathe for dressing or to the cooling bed as a finished product.

I. OPEN HEARTH: The open hearth derives its name from the fact that steel, while melted on a hearth, is accessible through furnace doors for inspection, sampling, and testing. lts process consists in melting by direct flame action a mixture of pig iron and iron and steel scrap. Refined steel contains approximately one percent carbon. Western Steel possessed basiç open hearth furnaces of 25 ton capacities. The term "hasic" denotes the act which permits the charging of

limestone for the removal of phosphorus during the steel making process. The open hearths were lined with basic firebrick and then coated with a layer of burnt dolomite or magnesite.

A. FUNCTIONAL PARTS OF THE OPEN HEARTH

1. BATH: The area of the open hearth where cold pig iron with iron and steel scrap are melted and refined into steel.
2. SLAG POCKETS: Located below and on either side of the bath area. They serve to catch slag and other impurities produced by the steel making process.
3. REGENERATOR CHAMBERS: Located below the hath elevation and behind the slag pockets. They contain a checker work of firebrick which store heat transferred to them from the products of combustion, and subsequently impart the heated gas and air to the hath area. There are two pairs of regenerators for each open hearth.
4. TAPPING SPOUT: Located midway hetween the ends of each open hearth on the pouring aisle side. The tapping spout is plugged with clay while the furnace is charging.
5. CHARGING DOORS: Located at the charging side where steel making ingredients are introduced to the open hearth.
6. FUEL SOURCE: A mixture of hot atomized fuel oil and air burned in the hath area. At Irondale, oil was piped from a 6,000 bbl steel lined concrete storage tank located about 170 feet south of the blast furnace.[94]

B. CHARGING AISLE OF THE OPEN HEARTH

1. CHARGING MACHINE: An electrically operated machine, set on rails and equipped to pick up boxes one at a time from charging buggies. The machine thrust the boxes through the charging doors into the open hearth furnace and turned them to dump their contents onto the hearth (bath). Tracks extended down to the waterfront scrap and pig iron storage beds.[95]
2. Prior to setting up the electric charging machine at Irondale, laborers fed the open hearths by hand.[96]

C. POURING AISLE OF THE OPEN HEARTH

1. LADLE: A large metal container used to direct the flow of molten steel from the tapping spout to the ingot molds. At Irondale, an electrically operated 25-ton ladle mounted on rails spanned a casting pit in front of the open hearth.[97]
2. INGOT MOLD: A steel molding used to give initial shape to the molten steel.
3. ELECTRIC CRANE: Stripped the molds from the ingots and removed them to the reheat furnace to begin the initial step of milling. Irondale's 15-ton crane was adjacent to the ladle tracks.[99]

11. REHEAT FURNACES: The reheat furnace raises the steel's temperature in preparation for hot work or milling. The ingots remain in this furnace until they are sufficiently hot or plastic enough to be rolled to the desired shape.

A. Western Steel built two reheat furnaces in 1909 for the 22-inch mill, each five feet nine inches wide and thirty feet long, with quartz hearths and outside walls and roofs of firebrick. Construction of the 14-inch mill's reheat furnace was similar.[100]

B. The company installed a continuous reheat furnace for the 14-inch mill in October 1910.[101] This new device enabled ingots to pass automatically through the furnace.

C. In April 1911, Western Steel's general superintendent, N.V.F. Wilson, patented a continuous reheat for the 22-inch mill which eliminated the manually operated ones. His furnace featured upper and lower floors. The ingots received heat on one side while pushed automatically through the top floor. As they fell to the second floor, they turned and the furnace heated the other side.[102]

111. ROLLING MILLS: The standard process for shaping steel consists essentially of passing it between two rollers revolving at the same speed and in opposite directions and spaced somewhat less than the object passing through. Due to the basic nature of ingot steel, one pass through the mills is not sufficient to produce the desired shape.

Therefore, the mills are arranged in stands with a specific number of rollers in each. The steel product passes back and forth through rollers of the same stand and then on to the next for further reduction. Roller size reflects the diameter of the rolls, or how large a product the mill will make.

A. IRONDALE ROLLING MILLS

1. TWENTY-TWO INCH MILL: All Western Steel ingots passed through a stand on this mill for billet shaping. The square billets ranged from 2 x 2 to 5 x 5 inches. Mill workers rolled them into angles 3 x 3 x 1/4 to 5/8 inch and 6 x 6 x 3/8 to 7/8 inch; 4 and 6 inch channels; 4 and 6 inch I-beams; and flats up to 8 inches wide and from 1/4 to 1 inch thick.[103]

2. FOURTEEN INCH MILL: Rolled steel from the 22-inch billet stand into rounds 1/4 to 4 x 1 inch; 3 inch channels; angles from 1 1/2 x 1 1/4 x 3/16 inch to 2 1/2 x 2 1/2 x 3/16 to 1/2 inch; and octagons 3/4, 7/8, and 1 inch.[104]

3. NINE INCH MILL: Produced finished merchant bar from 3/16 inch rounds, squares up to 4 inches, and small flats from band size up. This mill had four stands three high, one stand two high, and one stand with two sets of pinions.[105]

B. POWER SOURCE FOR MILLING OPERATION

1. Power to drive the 22-inch mill came from a 36 x 60 1800 horsepower Corliss steam engine with a 40-ton fly wheel.[106]
2. The 14-inch and nine-inch mills derived their power from a 30 x 60 1000 horsepower Corliss steam engine with a rope drum fly wheel connecting the two mills.[107]

IV. AUXILIARY EQUIPMENT

A. BOILER PLANT: A battery of six boilers of 500 horsepower each (three Badenhausen water-tube type designed by John Badenhausen of Seattle), located near the waterfront, supplied energy to the steam engines.[108]

B. POWER HOUSE: Two 30 kilowatt, three 60 kilowatt, and one 75 kilowatt Allis Chalmers engines and motors provided electricity to operate the electric charging machine, cranes, conveyor systems, lifting tables, shears, rolling lathes, grinding machine, and equipment in the machine shop.[109] This equipment was located in the power house near the blast furnace.

C. MACHINE SHOP: Contained a Manning, Maxwell and Moore Lathe (30 x 16), a Pond planer (5 x 6 x 13), steptoe sharper, grinding machinery, forges, and accessory tools to make repairs around the iron and steel plants.[110]

D. ROLLING LATHES: The lathe for the 22-inch mill was a Hogg make with four speed changes driven by a ten horsepower Western Electric motor. The 14-inch mill used a Lewis Foundry lathe with three speed changes driven by a seven horsepower Westinghouse motor.[111] These lathes dressed and shaped rolls for Western Steel and its customers.

E. SHEARS

1. BILLET SHEARS: A Number 6 shears driven by a 20 horsepower motor cut billets to length.[112]
2. FINISH SHEARS: The 22-inch, 14-inch, and nine-inch rolling mills had hot shears of their own used to cut finished products to length.

F. YARDAGE AND WHARF EQUIPMENT

1. WHARF: The wharf was 600 feet in length with a 400-foot frontage and equipped with ore bunkers.[113]
2. ALLIGATOR SCRAP SHEARS: Located near the scrap storage beds, it cut the scrap to fit in the open hearths.[114]
3. SKULL CRACKER: Also near the scrap bed, it crushed large material "too unwieldy for the shears," by dropping a heavy hammer from a high elevation.[115]
4. RAILROAD EQUIPMENT: A four-coupled saddle tank Davenport locomotive, eight Moran dump cars, 15 all-steel Atlas cars, and about three miles of trackage were used to haul raw

material, scrap, and finished products about the plant. By the end of 1910, Western Steel possessed two locomotives and 35 flat ore cars.[116]

5. WEIGHT SCALE: Located on the wharf near the waterline, it weighed incoming ores and scrap and outgoing finished products.[117]

FOOTNOTES

[1] Prospectus of the Puget Sound Iron Mine, 1879, Samuel Hadlock, Superintendent (Port Townsend, Washington Territory: Printed at the Office of the Democratic Press, 1879).

[2] "William Bishop to James Jones and Samuel Hadlock," Liens and Bonds, Vol. 1, 24 July 1879, pp. 108-109 (Jefferson County, Washington Territory); "William Bishop and Wife and Puget Sound Iron Company," Leases and Contracts, Vol. 1, 5 November 1879, pp. 117-120 (Jefferson County, Washington Territory); and "William Bishop, William Eldredge, John Lindley, and Olaff Peterson to Puget Sound Iron Company," Leases and Contracts, Vol. 1, 19 March 1880, pp. 124-125 (Jefferson County, Washington Territory).

[3] "Have We Iron," Washington Standard, 17 October 1879 and "Port Townsend Iron Works," Washington Standard, 17 December 1880.

[4] Letter from Travers Daniel of Clarkville, Tennessee, to James G. Swan of Neah Bay, Washington Territory, published in Puget Sound Weekly Argus, 26 November 1880.

[5] "History of the Industry Since Its Beginning Here," Irondale News, 5 February 1910.

[6] Joseph Daniels, Iron and Steel Manufacture in Washington, Oregon, California and Utah, Engineering Experiment Station Series, Report No. 2 (Seattle: University of Washington Press, 1929), p. 29; Puget Sound Weekly Courier, 4 February 1881; "New Iron Smelter," Seattle Post-Intelligencer, 10 April 1901; Prospectus of the Puget Sound Iron Mine, p. 4; and "On a Big Scale," Puget Sound Weekly Argus, 3 June 1881.

[7] "Mishap," Puget Sound Weekly Argus, 25 March 1881.

[8] "Irondale Items," Puget Sound Weekly Argus, 13 May 1881, and "The Puget Sound Iron Company," Puget Sound Weekly Argus, 3 June 1881.

[9] Joseph Daniels, "History of Pig Iron Manufacture on the Pacific Coast," Washington Historical Quarterly 17 (July 1926):177.

[10] "Puget Sound Iron Company to Puget Sound Iron Company," Record of Deeds, Vol. 7, 21 April 1882, pp. 334-336 (Jefferson County, Washington Territory).

[11] Daniels, Iron and Steel Manufacture, pp. 29-30 and "Irondale," Puget Sound Weekly Argus, 22 December 1883.

[12] Daniels, Iron and Steel Manufacture, p. 29; "New Iron Smelter," Seattle Post-Intelligencer, 10 April 1901; and "Iron Making Soon to Begin Near Port Townsend," Seattle Post-Intelligencer, 13 October 1901.

[13] Daniels, Iron and Steel Manufacture, p. 30.

[14] H.O. Lang, "Iron Ore of the Pacific Northwest," The West Shore 12 (July 1886):203; "Furnace, Mill & Factory," Engineering and Mining Journal of New York 42 (17 July 1886):46; and "Puget Sound Iron Co.," Puget Sound Weekly Argus, 31 January 1889.

[15] Daniels, Iron and Steel Manufacture, p. 30.

[16] Engineering and Mining Journal of New York 47 (30 March 1889):308-309; and Daniels, Iron and Steel Manufacture, p. 30.

[17] Daniels, "History of Pig Iron Manufacture," p. 178; "History of the Iron Industry Since Its Beginnings Here," Irondale News, 5 February 1910; "Tells History of Irondale," Seattle Post-Intelligencer, 10 September 1906; and Solon Shedd, The Iron Ores of Washington, Washington Geological Survey, Volume I, Annual Report for 1901, Part IV (Olympia, Washington: State Printer, 1902), p. 5.

[18] Walther Mathesius, "Raw Materials Problems of the Inter-Mountain and West Coast Areas," paper presented at the Seventh Regional Technical Meeting of the American Iron and Steel Institute, San Francisco, California, 5 November 1948; Daniels, Iron and Steel Manufacture, pp. 19-25, 44-47; and William Pigott, "Basic Open Hearth Furnace Practice of the Seattle Plant of the Pacific Coast Steel Company" (B.S. Thesis, University of Washington, 1921), p. 2.

[19] Engineering and Mining Journal of New York 70 (11 August 1900):151; "Bright Future for Port Townsend," The Morning Leader, 10 November 1900; Daniels, Iron and Steel Manufacture, p. 30; and J.H. Cremer, "Irondale Blast Furnace--Iron Ore and Coal Deposits, Puget Sound Iron Co. Furnace Plant, 17 December 1900," in Pig Iron Manufacture at Irondale, Washington, compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925, pp. 1-18.

[20] "History of Iron Industry Since Its Beginning Here," Irondale News, 5 February 1910; Cremer, "Irondale Blast Furnace," pp. 1-18; and Daniels, Iron and Steel Manufacture, p. 31.

[21] A.W. Clapp, "Iron Making at Port Townsend," Engineering and Mining Journal of New York 73 (25 January 1902);137; "Improvements at Irondale," The Morning Leader, 5 May 1901; and "Much Activity at Irondale Furnace," The Morning Leader, 11 April 1901.

[22] "Making Charcoal," The Morning Leader, 7 July 1901; "Iron Making Soon to Begin Near Port Townsend," Seattle Post-Intelligencer, 13 October 1901; and Clapp, "Iron Making at Port Townsend," pp. 137-138.

[23] "Industrial Future of Port Townsend Bay," The Morning Leader, 28 May 1901; "Still Looking for Iron Ore Property," The Morning Leader, 16 April 1901; "Looking for Iron Properties," The Morning Leader, 30 April 1901; "Ore

Shipments for Irondale," The Morning Leader, 10 September 1901; and Shedd, The Iron Ores of Washington, p. 28.

[24] "Iron in the Olympics," The Morning Leader, 14 September 1901. Despite optimistic reports by discoverers, these deposits never panned out.

[25] "Improvements at Irondale," The Morning Leader, 5 May 1901; "Hotel for Irondale," The Morning Leader, 19 July 1901; "Irondale Wants Postoffice," The Morning Leader, 6 April 1901; and "Iron Making Soon to Begin Near Port Townsend," Seattle Post-Intelligencer, 13 October 1901.

[26] Daniels, Iron and Steel Manufacture, p. 31; "Irondale Furnace is Now Casting," The Morning Leader, 17 December 1901; and "Furnace Lighted at Irondale Plant," Seattle Post-Intelligencer, 17 December 1901.

[27] "Iron Making Soon to Begin Near Port Townsend," Seattle Post-Intelligencer, 13 October 1901.

[28] "Irondale Furnace is Now Casting," The Morning Leader, 17 December 1901; Daniels, Iron and Steel Manufacture, pp. 31-35; Clapp, "Iron Making at Port Townsend," p. 137; "Temporarily Closed," The Morning Leader, 13 February 1903; "Will Not Sell Out the Irondale Plant," The Morning Leader, 5 February 1902; and "Pacific Steel Company Buys Sareta Mine," The Morning Leader, 22 February 1903.

[29] "Giant Furnace and Steel Mills for Seattle," Seattle Post-Intelligencer, 1 March 1903, p. 12; "Heavily Capitalized Corporation is to Absorb Pacific Steel Company," The Morning Leader, 3 March 1903; and Daniels, Iron and Steel Manufacture, p. 33. The Port Townsend Leader publicized Pacific Steel's plans to expand into a steel production plant and solicited citizens in the region to sell land to the company at bargain rates to avoid its erecting the steel mill elsewhere. "Steel Plant for Port Townsend Bay," The Morning Leader, 5 October 1901.

[30] "Plans of the Seattle Iron and Steel Company," The Morning Leader, 13 August 1903; "Will Carry Ore," The Morning Leader, 13 August 1903; "Pacific Steel Sued," The Morning Leader, 12 November 1903; and "Rolling Mill to be Put Up at Irondale," The Morning Leader, 12 December 1903.

[31] "Clallam Founders," The Morning Leader, 10 January 1904; and "M.J. Carrigan Named Receiver," The Morning Leader, 13 January 1904.

[32] Oscar Stromberg, "History of Irondale," Pacific Builder and Engineer 10 (6 August 1910):58; and M.J. Carrigan, "Tells History of Irondale Plant," Seattle Post-Intelligencer, 10 September 1906.

[33] "Jas. A. Moore Buys Irondale Property," Seattle Post-Intelligencer, 7 September 1906, p. 1.

[34] "Visited Irondale," The Morning Leader, 14 January 1902.

[35] "Jas. A. Moore Buys Irondale Property," Seattle Post-Intelligencer, 7 September 1906, p. 1.

[36] "Tells History of Irondale Plant," Seattle Post-Intelligencer, 10 September 1906, p. 1.

[37] "All Machinery Now Delivered at Irondale," Port Townsend Weekly Leader, 15 May 1907; "Irondale Plant Near Completion," Seattle Post-Intelligencer, 26 May 1907; and "Construction News," Engineering and Mining Journal of New York, 83 (8 June 1907):1114.

[38] "Workmen Force Sent to Irondale," Port Townaend Weekly Leader, 24 April 1907; and "All Machinery Now Delivered at Irondale," Port Townsend Weekly Leader, 15 May 1907.

[39] "Steamers are Added to Irondale Equipment," Port Townsend Weekly Leader, 23 January 1907; "Irondale People to Lease Texada," Port Townsend Weekly Leader, 22 May 1907; "Irondale Plant Near Completion," Seattle Post-Intelligencer, 26 May 1907; "Construction News," Engineering and Mining

Journal of New York 83 (8 June 1907):1114; and "Old Barge Here as a Carrier of Ore," Port Townsend Weekly Leader, 12 June 1907.

[40] "Bright Prospects for Irondale," Port Townsend Weekly Leader, 5 May 1909.

[41] "Fires are Started in Irondale Furnace," Port Townsend Weekly Leader, 17 July 1907; "Irondale Will Succeed," Port Townsend Weekly Leader, 26 September 1907; "Furnace Output is Steadily Increasing," Port Townsend Weekly Leader, 9 October 1907; and "Irondale Product is Exceeding Expectations," Port Townsend Weekly Leader, 9 October 1907.

[42] "Irondale Taxes Paid Yesterday," Port Townsend Weekly Leader, 4 December 1907; Daniels, Iron and Steel Manufacture, pp. 33-34; "Repairs are Ordered for Irondale Plant," Port Townsend Daily Leader, 27 August 1908; and "Large Force Employed on Irondale Improvements," Port Townsend Weekly Leader, 21 October 1908.

[43] "Irondale Steel Company to Public," Articles of Incorporation Record, Vol. 1, 14 January 1908, pp. 125-131 (Jefferson County, Washington).

[44] The West Coast steel industry had humble beginnings. Despite Swaney's failure to get his plant started in Seattle, several other companies successfully produced steel prior to World War I. On July 15, 1884, the Pacific Rolling Mill Company of San Francisco manufactured the West Coast's first steel in two small acid open hearth furnaces. In 1899, Union Iron Works of San Francisco erected a two ton steel converter and forged castings for use in its ship building plant. The Columbia Engineering Works of Portland, Oregon, began steel production in May 1903, with a similar converter, later adding a three ton electric furnace and two cupolas. In 1910, the company, now known as Columbia Steel, built a 20 ton basic open hearth at Pittsburgh, California. On July 1, 1907, Pacific Jupiter Steel Company of South San

Francisco made its first crucible steel. Pacific Coast Steel Company of San Francisco constructed two 25 ton open hearths in 1910. It merged with the Seattle Steel Company, and the new Pacific Coast Steel Company began steel production in West Seattle on September 30, 1915, with a 40 ton open hearth. The Southern California Iron and Steel Company made its first steel in a 30 ton basic open hearth in 1915. The Lewellyn Iron Works at Torrance, California, began production with two 40 ton basic open hearths and a five ton electric furnace on October 1, 1916. Daniels, Iron and Steel Manufacture, pp. 27-55; Mathesius, "Raw Materials Problems;" Edward H. Frank, "A History of Bethelhem Steel on the West Coast," paper presented at the Association of Iron and Steel Engineers Western Conference, Stateline, Nevada, 29 June 1974; and Pigott, "Basic Open Hearth Furnace Practice," p. 5.

[45] "Irondale Steel Plant Company Floated in East," Seattle Post-Intelligencer, 27 December 1908, p. 1.

[46] "Contract Let for Monster Furnace," Port Townsend Weekly Leader, 20 January 1909; Wall Street Journal article reprinted in "Irondale Plant Attracts Notice," Port Townsend Weekly Leader, 27 January 1909; "The Inauguration of Steel-Making on the Pacific Coast," The Iron Trade Review (19 August 1909):333-334; Irondale: The Steel City of the Northwest, promotional pamphlet prepared by the Irondale Steel Company, 1909, pp. 3-15; and Daniels, Iron and Steel Manufacture, p. 33.

[47] "Clearing Forces are Working at Irondale," Port Townsend Weekly Leader, 14 April 1909; "Building Boom for Irondale," Port Townsend Weekly Leader, 21 April 1909; and Official plat of Irondale filed for record at the request of the Moore Investment Company, 3 June 1909 (Jefferson County Auditor, Washington).

[48] "Big Excursion is Coming to Irondale," Port Townsend Weekly Leader, 19 May 1909; "Vast Throng at Irondale," Port Townsend Weekly Leader, 29 May 1909; "Worcestor Millionaire Buys Irondale Stock," Port Townsend Weekly Leader, 2 June 1909; "Irondale Will Get Excursion," Port Townsend Weekly Leader, 9 June 1909; "Local Agent for Irondale," Port Townsend Weekly Leader, 30 June 1909; "Whatcom to Carry Party to Irondale," Port Townsend Weekly Leader, 1 September 1909; "Another Excursion is Coming to Irondale," Port Townsend Weekly Leader, 8 September 1909.

[49] "Steel Works on the Pacific Coast," Engineering and Mining Journal of New York, 88 (28 August 1909):419; "Pictures Show Industrial Activity at Irondale," Seattle Post-Intelligencer, 14 August 1909, p. 9; and "Boilers Ordered for Irondale Steel Plant," Port Townsend Weekly Leader, 15 September 1909.

[50] "Western Steel Corporation to Public," Articles of Incorporation Record, Vol. 1, 2 October 1909, pp. 111-118 (Jefferson County, Washington) and "Big Irondale Realty Deal Was Consummated Here Yesterday," Port Townsend Weekly Leader, 1 December 1909.

[51] "Victoria Plant Not an Early Prospect," Port Townsend Weekly Leader, 6 October 1909; "Big Irondale Realty Deal Was Consummated Here Yesterday," Port Townsend Weekly Leader, 1 December 1909; "Company Has Contract for Large Amount of Material," Irondale News, 9 April 1910; "Symington Bros. & Co. Will Soon Select Site Here," Irondale News, 23 April 1910; "Horseshoe Factory to Employ Several Hundred Men to be Built at Once in Irondale," Irondale News, 21 May 1910; "Ready for Installation," Irondale News, 15 October 1910; and Report on the Western Steel Corporation, Irondale, Washington, Seattle, Washington, prepared by J.A. Vandegrift, Engineering Department (Equitable Bond and Certification Co., New York, NY, 17 November 1910), p. 49.

[52] "Two Transcontinental Lines Will he Built to West Side," Irondale News, 19 February 1910.

[53] "Reclaiming of Tidelands is Now Being Prosecuted," Irondale News, 12 February 1910; "Progress at Irondale," Pacific Builder and Engineer 9 (19 March 1910):105; "Moore is Host on Trip to New Irondale Plant," Seattle Post-Intelligencer, 27 March 1910; "Busy Days at Irondale," Irondale News, 9 April 1910; and "Machinery Received--Heavy Work is Progressing," Irondale News, 7 May 1910.

[54] "Slow Wood Fires Lighted Under Furnaces Today," Irondale News, 30 April 1910; "Open Hearth Furnaces--Drying Process Accomplished," Irondale News, 7 May 1910; "Ten Days' Time Required to Prepare Permanent Bottom in Open Hearth Furnaces," Irondale News, 14 May 1910; and N.V.F. Wilson, "Iron and Steel Defined," Pacific Builder and Engineer 10 (6 August 1910):63.

[55] "Development of Project is Most Astounding," Irondale News, 5 February 1910.

[56] Polk's Port Townsend and Jefferson County Directory, 1909-10, Volume II (Seattle, Washington: R.L. Polk & Co., Publishers, 1909); Polk & Co.'s Port Townsend and Jefferson County Directory, 1911-12, Volume III (Seattle, Washington: R.L. Polk & Co., Inc., Publishers, 1911); "Plant to Grow from Profits," Seattle Post-Intelligencer, 24 April 1910; and "Review of Irondale's Progress Shows Record Only Surpassed by One Other Steel City," Irondale News, 31 December 1910.

[57] "Development of Project is Most Astounding," Irondale News, 5 February 1910; "Big Hospital for Irondale," Port Townsend Weekly Leader, 10 November 1909; and "Irondale Hospital is Now Assured," Port Townsend Weekly Leader, 8 December 1909.

[58] "Irondale-Seattle Boat Will Start Wednesday," Port Townsend Weekly Leader, 17 November 1909; "Iroquois Crowded," Irondale News, 18 June 1910; "Everett Business Men's Association Excursion," Irondale News, 13 August 1910; "Excursion Due Sunday," Irondale News, 3 December 1910; "Trained Employees for Steel Mills Coming from Pittsburgh," Irondale News, 30 April 1910; "Large Force of Workmen Arrives from the East," Irondale News, 28 May 1910; and Polk & Co's Directory, 1911-12.

[59] "Irondale's Importance Accented in Announcement," Irondale News, 19 March 1910.

[60] "Progress at Irondale," Pacific Builder and Engineer 9 (26 February 1910):70; and "Steel Making to Commence No Later Than April 15th," Irondale News, 26 February 1910.

[61] The Chinese company is referred to by several similar names in the sources including Hang Yang Steel Company, Han Yang Steel Copmany, Hang Yeh Peh Iron and Coal Company, and Han Yeh Ping Iron and Coal Company.

[62] "Millions of Tons of Chinese Ore are Coming to the Sound," Seattle Post-Intelligencer, 27 March 1910, p. 1; "Ten Thounsand Workmen Will Soon be Required," Irondale News, 2 April 1910; "What Contract With China Means to Pacific Northwest," Irondale News, 28 May 1910; "Str. Riverdale Brings First Shipment of Ore and Iron on Han Yang Steel Contract," Irondale News, 2 July 1910; and "Low Water on China's River," Irondale News, 17 December 1910.

[63] "Manufacture of Steel," Pacific Builder and Engineer 10 (6 August 1910):51; "Properties are Valuable," Irondale News, 1 October 1910; and Report on the Western Steel Corporation, pp. 14-43.

[64] Daniels, Iron and Steel Manufacture, p. 34; and "Test of Furnace Successful Beyond Fondest Hopes of Promoters," Irondale News, 28 May 1910.

[65] "First Day's Work of Rolling Mill Tuesday Produced High Grade Marketable Steel," Irondale News, 25 June 1910; and Stromberg, "History of Irondale," pp. 58-59.

[66] "Rolling Mills Will be Complete and in Operation Next Tuesday at the Latest," Irondale News, 18 June 1910; "Pertinent Questions are Asked and Answers are Self-Evident," Irondale News, 2 July 1910; "Office for Rolling Mill," Irondale News, 2 July 1910; "Twisting Machine in Operation," Irondale News, 6 August 1910; "Steel Corporation Will Install New Nine-Inch Rolling Mill Within Sixty Days Time," Irondale News, 6 August 1910; "Electrically Operated Machinery Will Reduce Present Cost of Producing Steel," Irondale News, 13 August 1910; "Twenty Thousand Tons of Chinese Ore and Pig Iron to Arrive During Month of October," Irondale News, 24 September 1910; "Big Week in Steelmaking," Irondale News, 8 October 1910; "Irondale Steel Plant Will Soon be Increased by Expenditure of Two Million Dollars," Irondale News, 8 October 1910; and "Ore Vessels for November," Irondale News, 12 November 1910.

[67] "Blast Furnaces are Fired, Construction Work Finished," Irondale News, 25 June 1910; Daniels, Iron and Steel Manufacture, p. 34; "Manufacture of Steel," p. 55; "Production of Western Steel Will be Trebled in Near Future," Irondale News, 30 July 1910; and Report on the Western Steel Corporation, p. 55.

[68] "Foundry for Blast Furnace," Irondale News, 10 September 1910; "Foundry Work is Increasing," Irondale News, 15 October 1910; Report on the Western Steel Corporation, p. 49; "Three Hundred Ton Blast Furnace and Three Open Hearths to be Built on Refilled Ground," Irondale News, 19 November 1910; and "Five Thousand Electrical Horse Power Will be Used by Western Steel Corporation," Irondale News, 10 December 1910.

[69] "First Shipment of Finished Steel Bars Has Been Made by Western Steel Corporation," Irondale News, 16 July 1910; "Big Demand for Western Products Will Keep Plant Operating for Entire Year," Irondale News, 23 July 1910; and "First Foreign Steel Shipments," Irondale News, 6 August 1910.

[70] "Production of Western Steel Corporation Will be Trebled in the Near Future," Irondale News, 30 July 1910; "Irondale Steel Approved," Irondale News, 13 August 1910; "Western Steel Sales Large," Irondale News, 10 December 1910; and "Local Steel Wins Prize," Irondale News, 24 December 1910.

[71] "Coming Year Will be a Busy One With the Western Steel Corporation in Irondale," Irondale News, 3 December 1910.

[72] "The Irondale Proposition--The Coming of Steel," Pacific Builder and Engineer 10 (6 August 1910):49; "Pertinent Questions are Asked and Answers are Self-Evident," Irondale News, 2 July 1910; "Ten Million to be Put Into Irondale Plant," Seattle Post-Intelligencer, 13 October 1910; "Two Million Dollars Transferred to Western Steel Corporation by Capitalists," Irondale News, 12 November 1910; and "Big Bond Issue of Western Steel Corporation Has Been Taken by New York Financiers," Irondale News, 15 October 1910.

[73] "A Review of the Past Year Shows a Great Deal of Work Accomplished at Irondale," Irondale News, 17 December 1910.

[74] "Purchases Local Steel," Irondale News, 7 January 1910; "Structural Steel Bought," Irondale News, 25 February 1911; "You Can't Break Irondale Steel," Irondale News, 25 February 1911; "Steel Finds Ready Sale," Irondale News, 21 January 1911; and "Shipments Increasing," Irondale News, 18 March 1911.

[75] Readers should not confuse the Carnegie Trust Company with Andrew Carnegie, the great Eastern steel magnate. In fact, Carnegie reputiated any affiliation with the trust company. "Bond Sale Not Affected by Carnegie

Trust Company," Irondale News, 14 January 1911. However, Moore testified during a civil court proceeding in 1912 that Wall Street bankers, influenced by the United States Steel Corporation, pressured Carnegie Trust into refusing to complete the deal with Western Steel. "Moore Charges that U.S. Steel Killed Irondale," Seattle Post-Intelligencer, 16 June 1912, Sec. 2, p. 6.

[76] "Big Loan Secured," Irondale News, 21 February 1911. Moore later blamed Brayton Ives, president of Metropolitan Trust, with influencing English investors to break their contracts with Western Steel. "Moore Charges that U.S. Steel Killed Irondale," Seattle Post-Intelligencer, 16 June 1912, Sec. 2, p. 6; and "Other Side Made Public," Irondale News, 20 January 1912.

[77] "Outlook is Satisfactory," Irondale News, 15 April 1911; "From Philadelphia," Irondale News, 29 April 1911; "Western Steel Corporation Directorate Insures Strongest Company on the Coast," Irondale News, 13 May 1911; and "Stockholders Meeting," Irondale News, 29 July 1911.

[78] "Millsite Secured," Irondale News, 14 January 1911; "Iron Lands Purchased," Irondale News, 4 February 1911; "Some Things Accomplished," Irondale News, 25 March 1911; "Time Saving Appliance," Irondale News, 29 April 1911; and "Small Mill Starts Work," Irondale News, 13 May 1911.

[79] "Means Very Much," Irondale News, 27 May 1911.

[80] "Regarding Steel Corporation," Irondale News, 28 October 1911.

[81] "Not Making Efforts," Irondale News, 28 October 1911; "Walks Hard on Big Toes," Irondale News, 25 November 1911; and "Other Side Made Public," Irondale News, 20 January 1912.

[82] "Quick Sale is Wanted," Irondale News, 30 December 1911; and "Creditors Hold Meeting," Irondale News, 16 December 1911.

[83] "Will Sell Steel Plant March 15," Port Townsend Weekly Leader, 28 February 1912; "No Decision in Bankruptcy Case," Port Townsend Weekly Leader, 20 March 1912; and "Sale of Steel Plant Confirmed," Port Townsend Weekly Leader, 27 March 1912.

[84] "Moore Charges that U.S. Steel Killed Irondale," Seattle Post-Intelligencer, 16 June 1912, Sec. 2, p. 6; "Suit Against Trust Company," Port Townsend Weekly Leader, 19 June 1912; "James A. Moore Loses on Appeal," Port Townsend Weekly Leader, 9 October 1912; "Court Denies Change of Venue," Port Townsend Daily Leader, 30 October 1912; "Trust Company Title Upheld," Port Townsend Weekly Leader, 12 February 1913; and "Moore Loses Out," Port Townsend Weekly Leader, 16 April 1913.

[85] "Steel Co.'s Affairs Settled," Port Townsend Weekly Leader, 25 September 1913; "Irondale Rumor," Port Townsend Weekly Leader, 13 November 1913; "Irondale Steel Plant Sold," Port Townsend Weekly Leader, 29 January 1913; "Many Men Employed," Port Townsend Weekly Leader, 3 December 1914; Daniels, Iron and Steel Manufacture, p. 42; and "Steel Plant About Moved," Port Townsend Weekly Leader, 11 March 1915. Pacific Coast Steel Company utilized the machinery at its plants in Seattle and San Francisco.

[86] "Irondale Drug Store Moves," Port Townsend Weekly Leader, 2 April 1913; "Flames Wipe Out City of Irondale," Seattle Post-Intelligencer, 14 October 1914; and Polk & Co.'s Port Townsend and Jefferson County Directory, 1915-16, Volume V (Seattle, WA: R.L. Polk & Co., Inc., 1915).

[87] Joseph Daniels, "Operations of Pacific Coast Steel Company 1917-1919," in Pig Iron Manufacture at Irondale, Washington, compiled by Joseph Dnaiels for William Pigott, Puget Sound Steel Co., 30 November 1925, pp. 1-2; "Making Progress," Port Townsend Weekly Leader, 12 July 1917; Daniels, Iron and Steel

Manufacture, p. 35; "Will Operate Soon," Port Townsend Weekly Leader, 6 September 1917; and "Furnace Still Running," Port Townsend Weekly Leader, 28 February 1918.

88 "Irondale Smelter Resumes," Port Townsend Weekly Leader, 11 April 1918.

89 "Furnace Shut Down," Port Townsend Leader, 27 February 1919; Daniels, Iron and Steel Manufacture, p. 35; "Blast Furnace to be Junked," Port Townsend Daily Leader, 18 December 1919; and Karen Russel and Jeanne Bean, Marrowstone (Port Townsend, WA: Port Townsend Publishing Co., Inc., 1978), p. 93.

90 Shedd, The Iron Ores of Washington, p. 39.

91 Mathesius, "Raw Materials Problems."

92 Pigott, "Basic Open Hearth Furnace Practice," pp. 1-7.

93 Solon Shedd, Olaf P. Jenkins, and Hershel H. Cooper, Iron Ores, Fuels and Fluxes of Washington, State of Washington Department of Conservation and Development, Bulletin No. 27 (Olympia, WA: Public Printer, 1922), p. 19.

94 Report on the Western Steel Corporation, p. 33.

95 "Charging Machine," Irondale News, 6 May 1911.

96 Ibid.

97 Report on the Western Steel Corporation, p. 28.

98 "Steel Works on the Pacific Coast," p. 419.

99 Report on the Western Steel Corporation, p. 28.

100 Ibid and "Manufacture of Steel," p. 52.

101 "Irondale Steel Plant Will Soon be Increased by Expenditure of Two Million Dollars," Irondale News, 8 October 1910.

102 "Time-Saving Appliance," Irondale News, 29 April 1911.

103 "Manufacture of Steel," p. 52.

[104] lbid, pp. 52 and 59.

[105] "Steel Corporation Will lnstall New Nine-lnch Rolling Mill Within Sixty Days Time," Irondale News, 6 August 1910.

[106] Report on the Western Steel Corporation, p. 28; Robert Thurston, The History of the Growth of the Steam Engine, (Port Washington, NY: Kennikect Press, 1939); and "First Day's Work of Rolling Mills Tuesday Produced High Grade Marketable Steel," Irondale News, 25 June 1910.

[107] Report on the Western Steel Corporation, p. 28; "New Rolling Mill to be Built by Pittsburgh Machine Company," lrondale News, 29 August 1910; and "Greater Portion of Equipment Already in Seattle," lrondale News, 11 June 1910.

[108] "Steel Works on the Pacific Coast," p. 419.

[109] Report on the Western Steel Corporation, p. 30.

[110] Ibid.

[111] Ibid, p. 29.

[112] Ibid, p. 28.

[113] "Manufacture of Steel," p. 54.

[114] "Twenty Thousand Tons of Chinese Ore and Pig lron to Arrive During Month of October," Irondale News, 24 September 1910.

[115] Ibid.

[116] "Manufacture of Steel," p. 54; and Report on the Western Steel Corporation, p. 33.

[117] Report on the Western Steel Corporation, p. 33.

BIBLIOGRAPHY

"Analyses of Charcoal Pig Iron Made at Irondale, Washington, 1901-1902." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

"William Bishop and Wife and Puget Sound Iron Company." Leases and Contracts, Vol. 1, 5 November 1879, pp. 117-120. Jefferson County, Washington Territory.

"William Bishop to James Jones and Samuel Hadlock." Liens and Bonds, Vol. 1, 24 July 1879, pp. 108-109. Jefferson County, Washington Territory.

"William Bishop, William Eldredge, John Lindley, and Olaff Peterson to Puget Sound Iron Company." Leases and Contracts, Vol. 1, 19 March 1880, pp. 124-125. Jefferson County, Washington Territory.

Carrigan, M.J. "Iron Manufacture on the Pacific Coast, 1904." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

Carrigan, M.J. "Prospectus of the Seattle Iron and Steel Company, 1904." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

Cremer, J.H. "Irondale Blast Furnace--Iron Ore and Coal Deposits, Puget Sound Iron Co. Furnace Plant, 17 December 1900." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

Daniels, Joseph. "History of Pig Iron Manufacture on the Pacific Coast." Washington Historical Quarterly 17 (July 1926):168-189.

Daniels, Joseph. Iron and Steel Manufacture in Washington, Oregon, California and Utah. Engineering Experiment Station Series, Report No. 2. Seattle: University of Washington Press, 1929.

Daniels, Joseph. "Operations of Pacific Coast Steel Company 1917-1919." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

Engineering and Mining Journal of New York (New York, NY), 24 March 1883, 1 August 1885, 8 May 1886, 17 July 1886, 28 January 1888, 30 March 1889, 11 August 1900, 14 September 1901, 23 November 1901, 30 November 1901, 25 January 1902, 26 September 1903, 8 June 1907, 27 July 1907, 17 August 1907, 24 August 1907, 12 September 1908, 1 May 1909, 22 May 1909, 28 August 1909, 3 September 1910, 24 September 1910, 21 October 1911, 28 October 1911, 14 September 1912.

Frank, Edward H. "A History of Bethlehem Steel on the West Coast." Paper presented at the Association of Iron and Steel Engineers Western Conference, Stateline, Nevada, 29 June 1974.

Harbison-Walker Refractories Company, Modern Refractory Practice. The William Feather Co., 1961.

"Historic Resources of Unincorporated Eastern Jefferson County." United States Department of the Interior, National Register of Historic Places Inventory-Nomination Form. Prepared by David B. Stalheim, Office of Archaeology and Historic Preservation, Olympia, Washington, February 1983.

Holdings at Irondale of the Pacific Coast Steel Company Map, 4 April 1922. Part of the Jefferson County, Washington, Historical Society's collection.

Hunt, M.R. "The Manufacture of Charcoal Pig Iron at Irondale, on Puget Sound, State of Washington, December 1904." In Pig Iron Manufacture at Irondale, Washington. Compiled by Joseph Daniels for William Pigott, Puget Sound Steel Co., 30 November 1925.

"The Inauguration of Steel-Making on the Pacific Coast." The Iron Trade Review, 19 August 1909, pp. 333-334.

"Irondale Furnace Company to Public." Articles of Incorporation Record, Vol. 1, 6 November 1906, pp. 119-124. Jefferson County, Washington.

Irondale News (Irondale, Washington), 5 February 1910-27 January 1912.

Irondale: The Steel City of the Northwest. Promotional pamphlet prepared by the Irondale Steel Company, 1909.

"Irondale Steel Company to Public." Articles of Incorporation Record, Vol. 1, 14 January 1908, pp. 125-131. Jefferson County, Washington.

"Irondale, Washington." The Coast 18 (August 1909):89-91.

"James Jones, Samuel Hadlock, E.L. Canhy, and H.L. Blanchard to the Puget Sound Iron Company." Record of Deeds, Vol. 6, 10 September 1879, pp. 453-454. Jefferson County, Washington Territory.

Ludwig, Oswald A. Metalwork: Technology and Practice. Bloomington, Illinois: McKnight and McKnight Puhlishing Company, 1955.

Mathesius, Walther. "Raw Materials Problems of the Inter-Mountain and West Coast Areas." Paper presented at the Seventh Regional Technical Meeting of the American Iron and Steel Institute, San Francisco, California, 5 Novemher 1948.

McGannon, Harold E., ed. The Making, Shaping and Treating of Steel, 9th Edition. United States Steel Corporation. Pittshurgh, Pennsylvania: Herbick and Held, 1970.

The Morning Leader (Port Townsend, Washington), 10 November 1900 - 22 May 1904.

Nichols, Henry W. Models of Blast Furnaces for Smelting Iron. Leaflet No. 2. Chicago: Field Museum of Natural History, 1922.

Official plat of Irondale filed for record at the request of the Moore Investment Company. Jefferson County Auditor, Washington, 3 June 1909.

Pacific Builder and Engineer (Seattle, Washington), 26 February 1910, 19 March 1910, 6 August 1910.

Palmer, Frank R., George V. Luerssen, and Joseph S. Pendleton Jr. Tool Steel Simplified, 4th ed. Radnor, Pennsylvania: Chilton Company, 1978.

Pigott, William. "Basic Open Hearth Furnace Practice of the Seattle Plant of the Pacific Coast Steel Company." B.S. Thesis, University of Washington, 1921.

Polk & Co.'s Port Townsend and Jefferson County Directory, 1911-12, Volume III. Seattle, WA: R.L. Polk & Co., Inc., Publishers, 1911.

Polk & Co.'s Port Townsend and Jefferson County Directory, 1915-16, Volume V. Seattle, WA: R.L. Polk & Co., Inc., 1915.

Polk & Co.'s Puget Sound Directory, 1887, Volume 1. Seattle, WA: R.L. Polk & Co., Publishers.

Pork's Port Townsend and Jefferson County Directory, 1909-10, Volume II. Seattle, WA: R.L. Polk & Co., Publishers, 1909.

Pork's Port Townsend and Jefferson County Directory, 1920-21, Volume VI. Seattle, WA: R.L. Polk & Co., Inc., Publishers, 1920.

Port Townsend Daily Leader (Port Townsend, Washington), 29 March 1908 - 27 August 1908, 30 October 1912, 18 December 1919.

Port Townsend Leader (Port Townsend, Washington), 4 July 1918, 5 September 1918, 20 September 1918, 11 October 1918, 30 October 1918, 7 November 1918, 27 February 1919.

Port Townsend Weekly Leader (Port Townsend, Washington), 12 September 1906 -18 December 1909, 1 January 1912 - 11 March 1915, 24 May 1917 - 30 May 1918.

Prospectus of the Puget Sound Iron Mine, 1879. Samuel Hadlock, Superintendent. Port Townsend, Washington Territory: Printed at the Office of the Democratic Press, 1879.

"Puget Sound Iron Company to Puget Sound Iron Company." Record of Deeds, Vol. 7, 21 April 1882, pp. 334-336. Jefferson County, Washington Territory.

Puget Sound Weekly Argus (Port Townsend, Washington), 6 May 1880, 12 November 1880, 26 November 1880, 14 January 1881, 18 January 1881, 11 February 1881, 25 March 1881, 8 April 1881, 22 April 1881, 13 May 1881, 20 May 1881, 3 June 1881, 2 September 1881, 7 July 1882, 10 May 1883, 16 August 1883, 6 September 1883, 27 September 1883, 22 December 1883, 12 July

1888, 31 January 1889.

Puget Sound Weekly Courier (Olympia, Washington), 21 January 1881, 4 February 1881, 2 January 1883.

Report on the Western Steel Corporation, Irondale, Washington, Offices: Seattle, Washington. Prepared by J.A. Vandegrift, Engineering Department, Equitable Bond and Certification Co., 111 Broadway New York, NY, 17 November 1910.

Repp, Victor E., Willard J. McCarthy, and Oswald A. Ludwig. Metalwork: Technology and Practice, 7th ed. Bloomington, Illinois: McKnight Publishing Company, 1982.

Rusinoff, S.E. Forging and Forming Metals. Chicago: American Technical Society, 1952.

Russell, Karen, and Jeanne Bean. Marrowstone. Port Townsend, Washington: Port Townsend Publishing Co., Inc., 1978.

Seattle Post-Intelligencer (Seattle, Washington), 10 April 1901, 13 October 1901, 17 Decemher 1901, 1 March 1903, 7 September 1906, 10 September 1906, 26 May 1907, 27 December 1908, 14 August 1909, 27 March 1910, 24 April 1910, 13 October 1910, 6 June 1912, 14 October 1914.

Shedd, Solon. The Iron Ores of Washington. Washington Geological Survey, Volume I, Annual Report for 1901, Part IV. Olympia, Washington: State

Printer, 1902.

Shedd, Solon, Olaf P. Jenkins, and Hershel H. Cooper. Iron Ores, Fuels and Fluxes of Washington. State of Washington Department of Conservation and Development, Bulletin No. 27. Olympia, Washington: Public Printer, 1922.

Smith, J. Russell. The Story of Iron and Steel. New York: D. Appleton and Company, 1908.

Steam: Its Generation and Use. New York: Geo. McKibbin and Son, 1955.

Stimpson, William C. and Burton L. Gray. Foundry Work: A Practical Handbook on Standard Foundry Practice, Including Hand and Machine Molding With Typical Problems, Casting Operations, Melting and Pouring Equipment, Metallurgy of Cast Metals, Etc. Chicago: American Technical Society, 1938.

Thurston, Rohert. The History of the Growth of the Steam Engine. Port Washington, New York: Kennikect Press, 1939.

The Town Crier (Seattle, Washington), 3, 10, 17 September 1910.

Washington Standard (Olympia, Washington), 15 August 1879, 3 Octoher 1879, 17 Octobert 1879, 17 December 1880, 10 August 1888.

The West Shore (Portland, Oregon), September 1883, May 1885, July 1886.

"Western Steel Corporation to Public." Articles of Incorporation Record, Vol. 1, 2 October 1909, pp. 111-118. Jefferson County, Washington.