Mantua Lime Kiln
1 mile north of Mantua
Mantua vicinity
Box Elder County
Utah

HAER No. UT-66

HAER
UTAH,
2-MANT.V,
2-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Rocky Mountain Regional Office
National Park Service
U.S. Department of the Interior
P.O. Box 25287
Denver, Colorado 80225

HISTORIC AMERICAN ENGINEERING RECORD
MANTUA LIME KILN

I. INTRODUCTION

Location:	On the west slope of Round Hill in Dry Canyon about one mile north of Mantua, Utah.
Quad:	Mount Pisgah, Utah
UTM:	12/421500/4596710
Date of Construction:	1892
Present Owner:	Earl M. Sheffield, Brigham City, Utah
Present Use:	The lime kiln is abandoned.
Significance:	The Mantua Lime Kiln is a typical late 19th century shaft kiln structure which was built into the side of a steep slope near Mantua, Utah. It was constructed by local businessman James W. Sheffield of Brigham City in 1892 and operated until ca. 1905-1907. The kiln is a typical example of an industrial structure quite common in Utah during the 1890s, just prior to the time when concrete came into widespread use in building construction. This kiln was locally important in supplying much of the lime used for construction of many residential, municipal and commercial structures in Brigham City. It also represents one of only two remaining lime kiln structures in the Brigham City area.
Historian:	Michael R. Polk, Sagebrush Archaeological Consultants, Ogden, Utah. February 1991.
Photographer:	Michael R. Polk, Sagebrush Archaeological Consultants, Ogden, Utah. October 1991.

II. HISTORY

A. NEED FOR LIME

The history of the Brigham City area of Box Elder County in northern Utah began in 1854 with a small settlement of about 60 families of largely Welsh and Danish immigrants. The settlement was headed by Lorenzo Snow who was a member of the Church of Jesus Christ of Latter Day Saints' (L.D.S. or Mormon Church) Council of Twelve Apostles.[1] The city grew rapidly, in large part because of its favorable geographic location. It had good farmland and adequate water supplies from Box Elder Creek and the nearby Bear River. The area was also found to be an excellent location for fruit growing. Perhaps most important, however, was the fact that the town was the last major commercial stop for travelers heading from Salt Lake City to Idaho and the Cache Valley. This factor became particularly important with the opening of the Montana gold fields during the 1860's and 1870's. Because of the proximity of Utah to the gold fields, a large freight trade grew up between Salt Lake City, Cache Valley and Montana during this time.[2] The profit potential for this trade became so great, in fact, that in 1871 construction of the Utah Northern Railroad was begun from Brigham City both north toward Montana and south to a connection with the recently completed Union Pacific Railroad at Ogden.[3]

As Brigham City grew there was a naturally increasing demand for raw materials and manufactured goods to maintain that growth. Some of the most important materials needed to continue the expansion were lumber, stone and brick, materials vital for construction of industrial, commercial and residential structures. During the initial period of pioneer settlement log cabins served as shelters and

work places. Shortly after this time, however, there was a desire to build more substantial buildings of milled lumber, stone and brick. Milled lumber appears to have been used first, as evidenced by the construction of a sawmill near town in 1854.[4] The construction of other mills followed in later years along the mountains and in the canyons near Brigham City.[5]

In addition to the demand for milled lumber, building stone and brick were also desired as construction materials at an early date. The desire for building stone and brick is well-evidenced by the large number of mid to late 19th century houses still extant in Box Elder County which were made of these materials.[6] Part of this popularity may have been due to the abundance of building stone available in Box Elder County.[7] Also in demand for building purposes in the mid to late 19th century were the mortars and plasters which were necessary to bind together the stone and bricks used in construction. These materials were also available locally in the form of lime which was obtained by reducing limestone by burning it in kilns. This was a process undertaken in many communities along the Wasatch Front (western edge of the Wasatch Mountain Range including Salt Lake City).[8] Lime making in the Brigham City area probably began in the 1860s and is known to have continued into the first decade of the 20th century. Cement was introduced into the area in 1909, effectively eliminating the need for manufactured lime.[9]

Lime making operations were probably extant in Brigham City during the 1860s, though such operations are not documented. Lime making operations are not definitely known until the rise of the "United Order" economic system in the 1870s. It was at this time that the Mormon Church encouraged development of a

local economy focusing on a closed system of cottage industries (or "home industries") under the control of a cooperative store. Brigham City was one of the most successful operations of this type in Utah.[10]

During the United Order era an entire "brick department", which included an adobe yard, "lime and lumber department" and "masonry department" operated in Brigham City.[11] The masonry department employed up to 50 persons in the construction of homes, public buildings, and the cooperative's shops and stores. In 1876 and 1877, the department is said to have built 46 homes, plastered 163 rooms, and built four public buildings. In support of this work, the lime and lumber department was said to have produced thousands of bushels of lime per year. In 1876 alone, a total of 4,600 bushels were produced.[12] Stone and brick were often used in construction during this period. Perhaps the most prominent structure of the era which was built by these masons was the Brigham City Tabernacle, a building which still stands.

For a variety of reasons the United Order system failed in the early 1880s allowing private industry to take over its many operations in Brigham City. During and after this economic shift building construction continued and, as a support industry, lime making as well. Unfortunately, there is little known about the use and manufacture of building materials during this time. During the early 1890s, however, building construction in Brigham City appears to have been quite active. During this decade numerous news items appeared in the *Brigham City Bugler* concerning the construction of brick houses and other buildings. Active building construction also appears to have encouraged an increase in local brick manufacturing. During the period between 1891 to 1893 repeated references were made in the local newspaper to the development of brick manufacturing in

and near Brigham City. There was an 1891 report that brick was being manufactured near James Hansen's farm (presumably in or near Brigham City) as well as in nearby Willard.[13] The brick business seems to have increased in 1892 and 1893. Isaac Jensen was reported to have manufactured 200,000 bricks in a factory just north of town in 1892 and sold all of them.[14] At the same time E. J. Hougland of nearby Collinston was producing "a very good quality ...hand-made brick".[15] In 1893 brick manufacturing continued with the company of Dalton and Brunker of nearby Willard. They advertised a stock of 300,000 bricks for sale that year and Isaac Jensen again produced brick in the yard north of town.[16] An active construction industry, coupled with attendant increases in brick manufacturing, obviously would have put pressure on the local lime making industry to produce more mortar and plaster products.

The pressure that the building construction put upon the lime industry is evidenced by the lack of locally produced mortar and plaster products during the early 1890s. This deficiency was questioned by the local newspaper in an 1892 article on the subject of lime making:

> Lime is being hauled all the way from North Ogden [south of Brigham City] to Brigham, a distance of sixteen miles. How is that, when the mountains of this vicinity abound in millions of tons of first-class limestone? That this stone is good has been proven repeatedly by kilns in the neighborhood of Mantua and at different points all along the mountain side from Collinston down to the southern limit of the county at Hot Springs. If lime can be successfully produced at North Ogden, why can it not also be manufactured in large quantities near Brigham? Kilns are now being worked, or have lately been opened, at Mantua, Calls Fort and Deweyville, but only on a small scale. Is it lack of capital, or doesn't the business pay sufficiently well to induce people to persistently stick to this line of occupation?[17]

From this article, it is clear that some attempts were being made at this time to fill the local lime production deficit, but it was obviously not enough.

B. LIME MAKING IN BOX ELDER COUNTY

As noted previously, lime making was carried out in the Brigham City area at least as early as the mid 1870's under the United Order cooperative system. The next known production appears to have been by Elias Jensen who burned lime using marsh gas wells west of Brigham. Though the first known reference to this operation was in November 1891, the article in the *Brigham City Bugler* suggests that the operation was ongoing from earlier times.[18] By early 1892 Jensen, a local Brigham City furniture dealer, had begun another operation just north of Brigham City at Lake Side.[19]

In June and August, the *Brigham City Bugler* reported on the operation of several small lime kilns. A kiln was reported operating north of Mantua (four miles east of Brigham City) as well as at Calls Fort and Deweyville (north of Brigham City).[20] The kiln near Mantua is the "Mantua Kiln" of particular interest in this study.

In 1893 the *Bugler* noted that the lime kilns in Collinston (north of Brigham City) had started up and were producing a good grade of lime and in 1894 it mentioned that Elias Jensen's kiln near Lake Side, which had been clogged up for several weeks, was again operating.[21] It was producing between 30 and 40 bushels of lime a day.[22] Interestingly, the newspaper also reported that local demand for lime should have been enough to keep one kiln burning constantly, suggesting that local production of the product by more than one kiln would probably exceed the demand.

Such comments allude to a possible reason for a sometimes noted deficiency in adequate "home lime" production: the lack of adequate and stable demand for the product. In the 1892 *Bugler* article reflecting upon limited production from the few kilns then in production, the newspaper asked: "Is it lack of capital, or doesn't the business pay sufficiently well to induce people to persistently stick to this line of occupation?"[23] The known operators of kilns in the Brigham City area appear to have conducted those operations on a part time basis, or at least, they continued to pursue other business ventures at the same time. Such a circumstance suggests one of several possibilities. The lime business may not have been very profitable, it was not a commodity in consistent demand, or local demand was only strong enough to support the output of one kiln. Most likely all three contributed to the instability of the business and would have made it necessary for kiln owners to pursue other forms of business in order to survive.

This situation apparently continued through the decade of the 1890's and into the early 1900's when the Mantua Kiln, operated by James W. Sheffield of Brigham City, appears to have been the only remaining local lime making operation.[24] The fact that Sheffield's kiln is the only one listed in the state gazetteers for the period and that his operation is the only one which is mentioned in the *Box Elder News* and *Box Elder Report* in the early 1900's suggests that his business won out in the local lime business competition. All local production of lime for construction appears to have ended before or upon the opening of a local cement factory near Brigham City in 1909.[25]

C. THE MANTUA LIME KILN

The increased demand for local lime production in the Brigham City area in the early 1890s prompted James W. Sheffield to begin operations at a kiln just north of the town of Mantua about 1892.[26] Sheffield's structure was a small, but typical shaft kiln with an internal firebrick-lined hopper, shaft and a cooling chamber. The location for the kiln was apparently chosen to take advantage of a large volume of limestone outcropping on the mountain above the structure.

Other than two news articles which mentioned the existence and operation of Sheffield's kiln in 1892, only a few other references even mention the operation. Several advertisements were found for the business including Sheffield's listing as a lime manufacturer in the state gazetteers for 1900 and 1903-1904[27] and newspaper advertisements in 1903 issues of the *Box Elder News* and *Box Elder Report*.[28] The newspaper advertisements are particularly interesting since Sheffield does not appear to have ever previously advertised his lime business in the local newspapers. The advertisement in the *Report* provided some particularly interesting information: "James Sheffield says that he will be able to furnish all of the lime that can be used in Box Elder County next year..."[29] This notice suggests that his was, indeed, the one remaining kiln operation left in Box Elder County after the turn-of-the-century. The only other item found concerning Sheffield and his kiln was a news article in a 1904 issue of the *Box Elder News* concerning a severe leg injury he suffered in a rock slide on the morning of May 21 while digging out limestone to fill his kiln.[30] This was probably the accident that ended his career in the lime production business.[31] It was at this point that Charles H. Sheffield, James' son, took over the operation at the age of 16.[32] Charles had previously helped his father in the lime kiln business as a boy.

Additional information about the Mantua Lime Kiln operation comes from an interview with Charles Sheffield. As part of a master's thesis project at Utah State University Robert Jensen interviewed Sheffield in the early 1960's about the operation of the kiln:

> He [Sheffield] tells of hauling loads of coal up the canyon with team and wagon and bringing back loads of lime on the return trips. Lime rock located near the kiln was used in making the lime. A grate was located in the arch of the kiln and a large circular chamber extended upward to an opening in the top where the kiln was loaded with alternate layers of coal and lime rock. After being charge[d] properly, the kiln was then fired. Mr. Sheffield stated that when the kiln was burning well it burned with an intense blue flame. While in production it was kept burning continually, the coal and lime rock being loaded into the top of the kiln and the lime being drawn from the bottom. Each day about 2 ½ tons of coal were loaded into the kiln with the lime rock. In return the kiln would produce 50 to 75 bushels of lime, which after cooling was loaded and hauled to Brigham City. Here it was used primarily for mortar for building purposes.[33]

The lime from this kiln was apparently used in the construction of many Brigham City homes and school buildings around the turn of the century.[34] The Brigham Central School building is particularly mentioned.

When and why the operation ended is not known. The state gazetteer published in 1908 fails to list any lime manufacturers in or near Brigham City, indicating that Sheffield's operation had probably ceased operations prior to that date.[35] It is certain that the operation would not have survived the opening of the new Ogden Portland Cement Company factory near Brigham City in 1909.[36] The increasing widespread use of cement in Utah for foundations and mortars early in this century greatly reduced the need for lime. Thus, even if the kiln was still operating in 1909, the decrease in demand for the product would have forced it to close.

III. LIME MANUFACTURING

Knowledge of lime manufacturing has been known for several thousand years and, until the early 20th century, methods for extracting lime from its constituent rock, limestone, were basically the same. Essentially, lime is extracted from limestone rock through the process of heating. When a enough temperature is applied to limestone for a sufficient length of time carbon dioxide is dissociated from the rock and is given off as gas.[37] The quality of limestone varies widely and can have a great effect upon the type of lime produced and the amount of impurities in the finished product.

The decision to build kilns in the late 19th and early 20th centuries was dictated, in large part, by the local market demand and the availability of limestone deposits. It was always preferable to locate the tops of kilns below the limestone deposits to be quarried so that hoisting costs could be avoided.[38] A variety of techniques were used to break limestone loose from its beds and prepare it for burning including drilling, blasting, sorting of the stone to sizes easily handled by one person and eliminating poor quality limestone.[39] Loading was often done with horse and wagon. It is likely that this was the case at the Mantua Lime Kiln where an historic photograph reveals a road leading past the upper rear edge of the kiln. Kilns with hoppers in the upper portion of the structure (which was part of the Mantua Kiln) were usually filled once a day or twice if there was sufficient limestone and kiln capacity. Though it was impractical to store more than two days supply of limestone in a hopper, it was necessary to keep the kiln operating with a continuous fire. With this in mind, it was important to have a steady and reliable supply of limestone available.[40]

Virtually all lime produced in the United States after the turn of the century was made in a kiln. The shaft kiln was used almost universally. The shaft kiln is described by Emley:

> In general, a shaft kiln resembles a short, wide stack, of either square, round, or elliptical cross section. It consists of a casing of steel or stone which is lined with refractory material. The long, vertical chamber formed by this lining may be divided into three compartments by imaginary horizontal planes. The top compartment, called the hopper, is used for storing and preheating the stone. Its sides slope in so that the stone may slide down into the middle compartment, the shaft. This shaft is the place where the lime is burned. It may be of either square, round, or elliptical cross section, independently of the outside of the kiln. ...At the bottom of the shaft the third compartment (the cooler) is used for storing the lime after it is burned. [Processed lime is removed from the cooler section]. ...The fuel used in burning the lime is consumed in the fire boxes usually arranged on two sides of the kiln. They are very similar to the common fire boxes in use under boilers....[41]

Emley states that both coal and wood were used to burn lime, but that wood had long been recognized as a superior material. Wood fuel burns more evenly and, as a result, it gives a better quality of lime. Wood fuel also requires less care in the kiln operation. During the early 20th century when Emley was researching kilns, wood fuel was becoming increasingly costly to use. For this reason, wood was not the preferred choice of most kiln operators. Of the 160 lime kilns that he studied in the United States 65 percent used coal, 17 percent used wood, 10 percent used a mixture of wood and coal and 8 percent used gas.[42] The Mantua Kiln apparently utilized coal exclusively.[43]

There are four basic kinds of shaft kilns. The Mantua Kiln appears to most closely approximate a "Square Kiln with Straight Shaft" noted by Emley,[44] though it was a more primitive version. The Square Kiln has a stone casing, a firebrick lining, an open top, square hopper top and rectangular bottom, straight rectangular shaft, a lined cooler, and four fire boxes. The Mantua Kiln is similar, but has a circular hopper (as described

for the "Round Kiln") and, apparently, no fire boxes. Charles Sheffield indicated that the Mantua Kiln was operated by placing alternating layers of coal and limestone (which was forced down into the shaft by gravity) inside the hopper, charging and burning that mixture in the shaft, and then adding additional layers on the top of the hopper as it burned down.[45] Whether this method was commonly used or was an expedient measure used in small isolated operations is not known.

IV. KILN DESCRIPTION

The Mantua Lime Kiln was constructed ca. 1892 and most closely resembles the square kiln type of shaft kiln described by Emley.[46] The exterior of the kiln has deteriorated to a large extent making physical description partially dependent upon both an historic photograph and upon photographs and description made during an earlier recordation of the structure in 1985.[47]

When first constructed, a wide level platform was cleared at the base of the steep hill and the kiln built against the slope so that wagons could load coal and limestone into the hopper top from a roadway built on the hill behind the kiln. The large level platform at the base of the front of the kiln allowed unloading of processed lime from the cooling chamber into waiting wagons.

The kiln exterior is rectangular in shape and slightly sloping inward toward the top of the hopper. The lower six feet or so of the kiln front is entirely buried in slope debris and kiln remnants making height and width measurement difficult. Based upon field measurements and photographic information it appears to have measured about 22 feet high, 21 feet wide across the base and about 17 feet wide at the top. It was probably 20 feet

deep (into the hill slope). The exterior of the kiln is made of mortared rough cut lime stone. The interior portion of the kiln consisting of the hopper, shaft and cooling chamber is made of a combination of red brick and firebrick.

A high arch opening was built into the front of the kiln in order to allow removal of lime from the cooling chamber after processing. The upper portion of this opening once had three layers of red brick lining. The arch measured about 11 feet high by 8 feet 6 inches wide at its base. Over half of the height of the entrance is now buried in debris and slopes steeply down into a deep filled in wash cut where the loading platform area was originally located.

While the deteriorated condition of the kiln makes measurements and some description difficult, it also exposes engineering detail not often seen in these structures. The upper portion of the kiln, called the hopper, is largely exposed now that much of the external rock covering has fallen away. It measures 6 feet wide at its top. The hopper was made in a conical shape with wedge shaped gauged firebrick laid in a spiral, stair-step pattern giving the hopper a larger opening at the top and thus forcing the limestone and coal layers into the smaller shaft portion of the kiln beneath the hopper. The firebrick was mortared together with, what appears to be, a mixture of mortar and finely crushed brick. Much fused, green glassy slag has formed on the interior of the hopper from a chemical reaction between the burning limestone and brick. Much brick and rock debris now fills a portion of the hopper so that a portion of its interior and the entire shaft are not visible.

The cooling chamber at the base of the kiln is largely clogged with large boulders and fine debris. There is a wall of shaped, mortared native rock located at the rear of the chamber, however, and the top portion of another, smaller arched entrance into the shaft. This arched area is lined with firebrick and measured more than 2 feet wide.

Several types and shapes of bricks were used to construct the kiln. Wedge-shaped firebrick was used to form the hopper. The bricks are only slightly different in size from each other. One measured 4¼-by-3¼-inches by 8½-by-2½-inches thick. Red bricks found in the cooling chamber are standard, rectangularly-shaped, and measure 8¼ inches long by 3½ inches wide by 2½ inches thick. Neither of these brick types possess manufacturer's marks, though it is likely that the red bricks were made in local Brigham City area yards which were active during the early 1890's. Another rectangular shaped firebrick type was also found in the kiln area with several different maker's marks imprinted on them including "LACLEDE" and "LACLEDE CROWN". Both of these brick types were identified as products of the Laclede-Christy Clay Products Company of St. Louis, Missouri. The "LACLEDE" bricks were manufactured between 1857 and 1921 and the "LACLEDE CROWN" bricks between 1889 and 1942.[48]

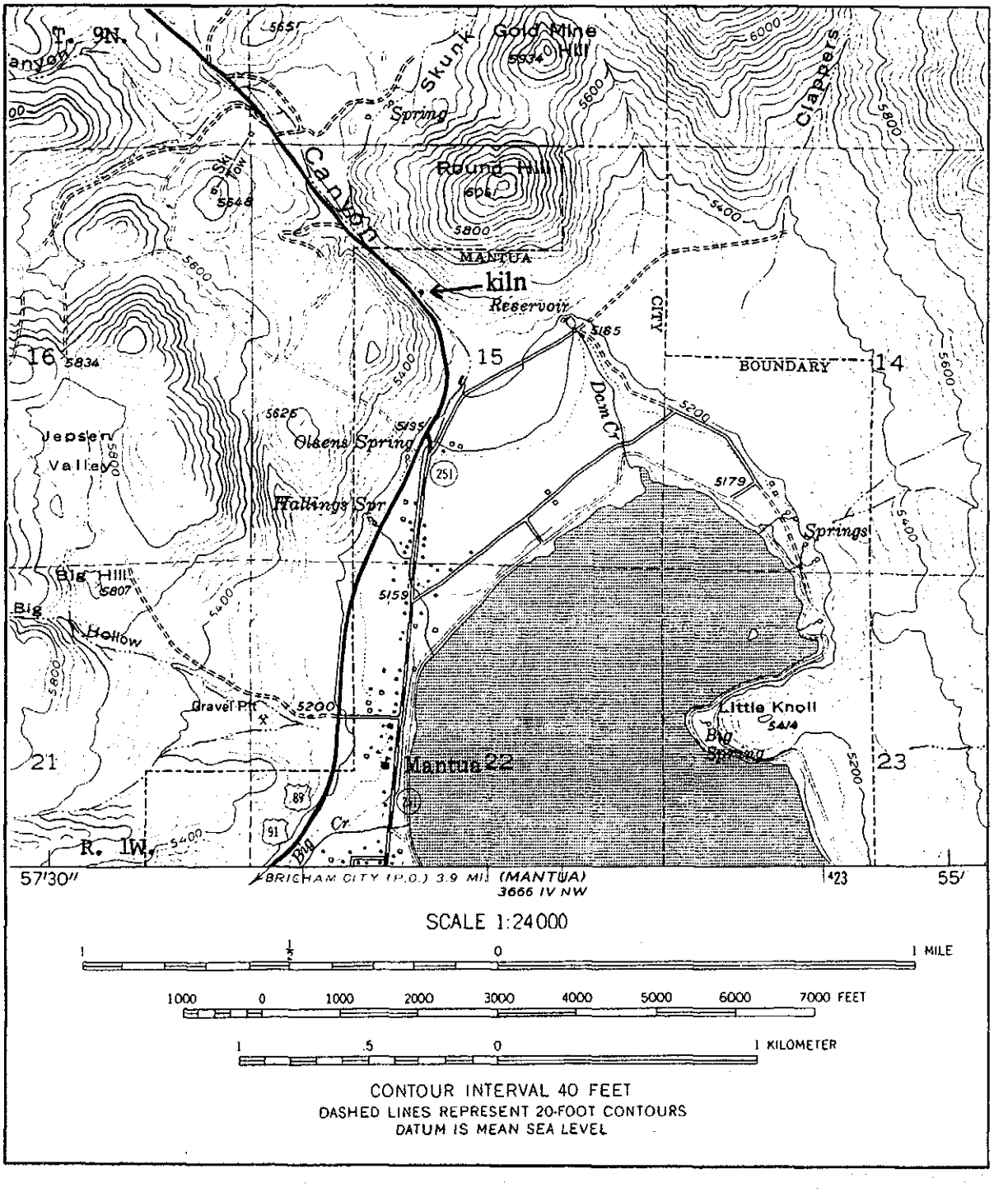
There were no known alterations made to the kiln structure. Its condition, however, has deteriorated rapidly since the middle 1960's and even more so since it was first recorded in 1985. The recent stabilization of a deeply cut wash below the structure by the Utah Department of Transportation has helped slow this deterioration.

V. BIOGRAPHICAL MATERIAL

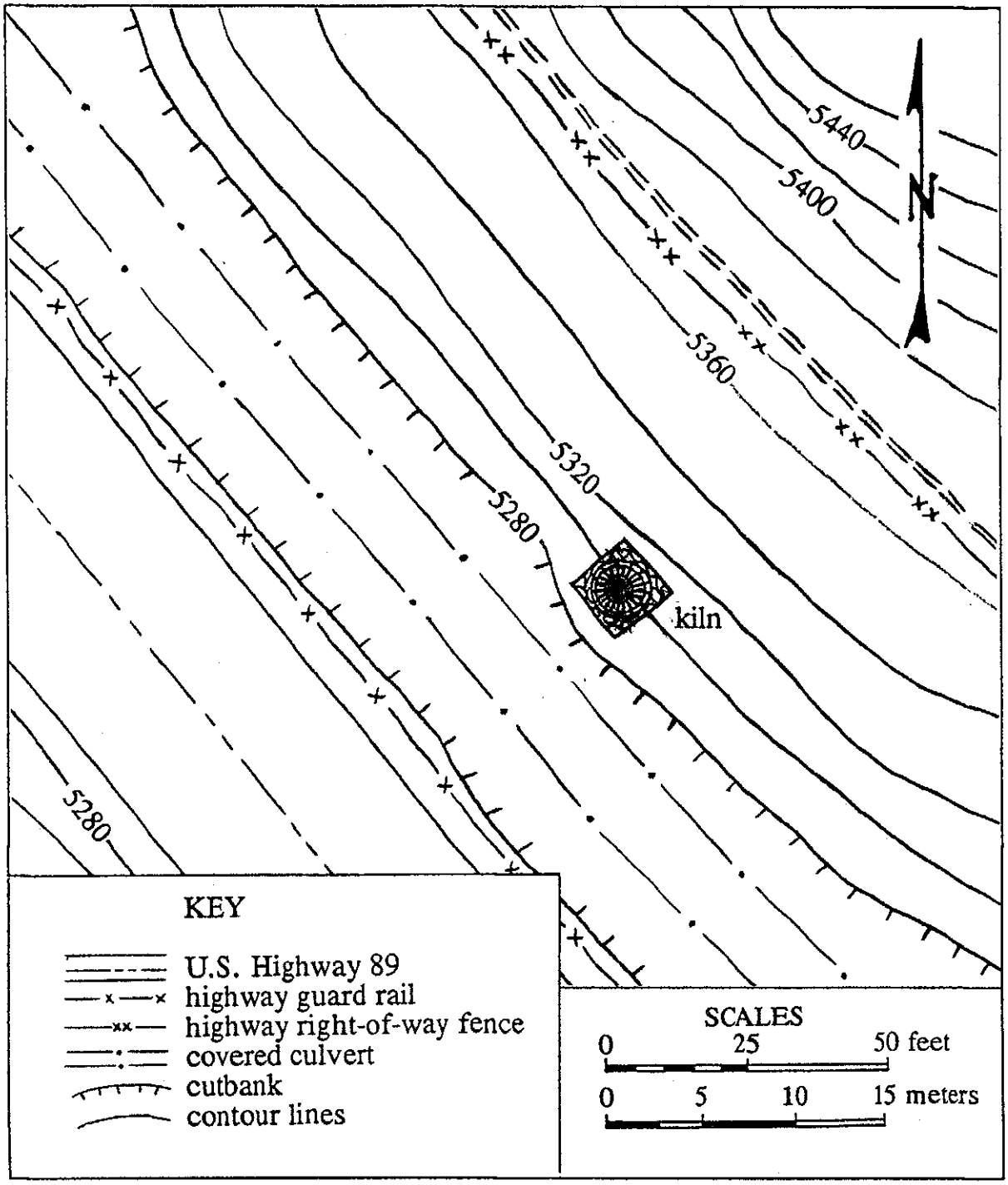
The builder and operator of the Mantua Lime Kiln was James W. Sheffield (and later his son Charles Sheffield), a local businessman from nearby Brigham City, Utah. A convert to the Mormon Church, Sheffield came to the United States from England in 1873 and began apprenticing in boot and shoemaking under the direction of Charles Kelly, pioneer shoemaker in Brigham City.[49] His shoemaking career ended temporarily in 1883 when he lost his hand in a Fourth-of-July cannon firing accident. Following this accident, Sheffield opened several businesses and worked at various jobs.

Soon after his accident he operated a wagon freight line and, in 1891 seems to have gone back into the shoe repair business. He opened a store at the corner of Box Elder and South Streets in Brigham City which seems to have continued in operation until at least 1895.[50] In 1892 he began his lime production business. Also in the 1890's Sheffield operated a hide business and was the city assessor and water tax collector for a period of time.[51] After the turn-of-the-century he appears to have focused his attention on his lime making business until the rock slide accident in 1904. He later took over custodianship at Central Elementary School, State Security Bank and the L.D.S. Box Elder Seminary, all in Brigham City.[52] He died January 6, 1948 in Brigham City at the age of 91.

Sheffield does not appear to have owned the land that his kiln is on until 1900. In that year on February 7 he purchased 12-37/100 acres of land including the kiln and adjacent limestone deposits from Sören Hansen of Mantua City for $40.00.[53] The land has continued to pass down through the family and is currently owned by Earl M. Sheffield of Brigham City, grandson of James W. Sheffield through James' son William.



Location of Mantua Lime Kiln. Taken from: USGS Mount Pisgah, Utah Quadrangle 7.5' (1955).



Plan view of Mantua Lime Kiln and surrounding area.

Mantua Lime Kiln under construction in 1892. Owner and builder James W. Sheffield is standing on corner of kiln. Photograph taken by A. W. Compton from collection of Robert E. Jensen.

VI. ENDNOTES

1. Leonard J. Arrington, "Cooperative Community in the North: Brigham City, Utah", *Utah Historical Quarterly*, 33, 1964, p. 200.

2. Charles S. Peterson, "The Valley of the Bear River and the Movement of Culture Between Utah and Idaho", *Utah Historical Quarterly*, 47, 2, 1979, pp. 199-200.

3. Merrill D. Beal, *The Utah and Northern Railroad Narrow Gauge*, Idaho State University Press, Pocatello, Idaho, 1980, pp. 5 and 7.

4. L. W. Forsgren, compiler, *History of Box Elder County*, Daughters of the Utah Pioneers, Salt Lake City, 1937, p. 125.

5. Ibid., pp. 126-127.

6. Peter L. Goss, "The Architectural History of Utah", *Utah Historical Quarterly*, 43, 3, 1975, pp. 213-214.

7. Utah Mining Association, *Utah's Mining Industry: An Historical, Operational and Economic Review of Utah's Mining Industry*, Salt Lake City, 1967, p. 29.

8. Miles P. Romney, "Utah's Cinderella Minerals: The Non-metallics", *Utah State Historical Quarterly*, 31, 3, 1963, p. 226.

9. L. W. Forsgren, *History of Box Elder County*, p. 130.

10. Leonard J. Arrington, "Cooperative Community in the North: Brigham City, Utah", pp. 201-206 and 217; *Great Basin Kingdom: An Economic History of the Latter-day Saints, 1830-1900*, University of Nebraska Press, Lincoln, 1966, p. 325.

11. Mark Riddle, *Lorenzo Snow and the Brigham City Cooperative*, on file at the Brigham City Library, Brigham City, Utah, n.d. pp. 15, 17 and 20; Leonard J. Arrington, "Cooperative Community in the North: Brigham City, Utah", p. 205.

12. Mark Riddle, *Lorenzo Snow and the Brigham City Cooperative*, p. 20.

13. *Brigham City Bugler*, 24 October 1891, p. 4, col. 2.

14. Ibid., 27 August 1892, p. 1, col. 5.

15. Ibid., 3 September 1892, p. 1, col. 3.

16. Ibid., 11 February, 1893, p. 4, col. 3; 17 June, 1893, p. 4, col. 4; 12 August 1893, p. 1, col. 3.

17. Ibid., 20 August 1892, p. 1, cols. 1 & 2.

18. Ibid., 14 November 1891, p. 4, col. 3.

19. Ibid., 21 May 1892, p. 1, col. 4.

20. Ibid., 25 June 1892, p. 1, cols. 5 and 6; 20 August 1892, p. 1, cols. 1 and 2.

21. Ibid., 27 May 1893, p. 4, col. 1.

22. Ibid., 28 April 1894, p. 4, col. 1.

23. Ibid., 20 August 1892, p. 1, cols. 1 and 2.

24. *R. L. Polk & Co's Utah State Gazetteer and Business Directory*, 1900, Vol I, First Edition, Salt Lake City, p. 596; 1903-1904, Vol II, Second Edition, Salt Lake City, p. 726.

25. L. W. Forsgren, *History of Box Elder County*, p. 130.

26. Robert E. Jensen, *A Photographic Record of Selected Industries of Box Elder County*, M.S. Thesis, Department of Industrial and Technical Education, Utah State University, Logan, Utah, 1967, p. 12; Francis Christensen, "Lime Kiln near Brigham City", *SUP News*, Sons of the Utah Pioneers News, Salt Lake City, 12, 3, 1965, p. 8; *Brigham City Bugler*, 20 August, 1892, p. 1, cols. 1 and 2.

27. *R. L. Polk & Co's Utah State Gazetteer and Business Directory*, 1900, Vol I, First Edition, Salt Lake City, p. 596; 1903-1904, Vol II, Second Edition, Salt Lake City, p. 726; the *Stenhouse & Co's Utah Gazetteer*, 1892-1893, Salt Lake City was also checked, but did not list Sheffield.

28. *Box Elder News*, 8 October 1903, p. 1, col. 6; 22 October 1903, p. 8, col. 1; *Box Elder Report*, 1 March 1902, p. 1, col. 2.

29. *Box Elder Report*, 1 March 1902, p. 1, col. 2.

30. *Box Elder News*, 26 May 1904, p. 1, col. 1.

31. Francis Christensen, "Lime Kiln near Brigham City", p. 8.

32. Ibid.

33. Robert E. Jensen, *A Photographic Record of Selected Industries of Box Elder County*, pp. 11 and 13.

34. *Salt Lake Tribune*, "Brigham City Business Leader Dies", 7 January 1948, p. 6, col. 1; L. W. Forsgren, *History of Box Elder County*, p. 94.

35. *R. L. Polk & Co's Utah State Gazetteer and Business Directory*, 1908-1909, Vol III, Third Edition, Salt Lake City, p. 778.

36. L. W. Forsgren, *History of Box Elder County*, p. 130.

37. Warren E. Emley, "Manufacture of Lime", *Technological Papers of the Bureau of Standards No. 16*, Government Printing Office, Washington D.C., 1913, p. 7.

38. Ibid., p. 19.

39. Ibid., pp. 23-24.

40. Ibid., p. 26.

41. Ibid., p. 27.

42. Ibid., p. 50.

43. Robert E. Jensen, *A Photographic Record of Selected Industries of Box Elder County*, p. 13.

44. Warren E. Emley, "Manufacture of Lime", p. 31.

45. Robert E. Jensen, *A Photographic Record of Selected Industries of Box Elder County*, p. 13.

46. Warren E. Emley, "Manufacture of Lime", p. 31.

47. Michael R. Polk, *A Cultural Resources Survey of a Portion of U.S. Highway 89, Box Elder County, Utah*, Sagebrush Archaeological Consultants, Archaeological Report No. 132, Ogden, Utah, 1985, pp. 5-7; *A Cultural Resources Survey of the U.S. 89/91 Highway Corridor Study Area, Box Elder and Cache Counties, Utah*, Sagebrush Archaeological Consultants, Archaeological Report No. 294, Ogden, Utah, 1989, pp. 12-14.

48. Karl Gurcke, *Bricks and Brickmaking, A Handbook for Historical Archaeology*, The University of Idaho Press, Moscow, Idaho, 1987, pp. 256-257.

49. *Salt Lake Tribune*, "Brigham City Business Leader Dies", 7 January 1948, p. 6, col. 1; Noble Warrum, *Utah Since Statehood, Historical and Biographical*, Vol. II, S.J. Clarke Publishing Company, Chicago, 1919, p. 627.

50. *Brigham City Bugler*, 7 February 1891, p. 1, col. 1; 2 April 1892, p. 4, col. 2; 6 April 1895, p. 1, col. 3.

51. Ibid., 6 May 1893, p. 4, col. 3; 11 August 1894, p. 4, col. 4; 6 July 1895, p. 1, col. 3; 3 November 1894, p. 1, col. 4.

52. *Salt Lake Tribune*, "Brigham City Business Leader Dies", 7 January 1948, p. 6, col. 1.

53. Box Elder County Warranty Deeds Book S, County Recorder's Office, Box Elder County, Brigham City, Utah, Warranty Deed No. 8388, p. 325.

VI. BIBLIOGRAPHY

A. BOOKS AND PUBLISHED SOURCES

Arrington, Leonard J. *Great Basin Kingdom: An Economic History of the Latter-day Saints, 1830-1900.* Lincoln: University of Nebraska Press, 1966.

Arrington, Leonard J. "Cooperative Community in the North: Brigham City Utah", *Utah Historical Quarterly*, 33, pp. 198-217.

Beal, Merrill D. *The Utah and Northern Railroad Narrow Gauge.* Pocatello, Idaho: Idaho State University Press, 1980.

Christensen, Francis. "Lime Kiln near Brigham City", *SUP News.* Salt Lake City: Sons of the Utah Pioneers News, 12 (3): p. 8.

Emley, Warren E. "Manufacture of Lime", *Technological Papers of the Bureau of Standards No. 16.* Washington, D. C.: Government Printing Office, 1913.

Forsgren, L. W., compiler. *History of Box Elder County.* Salt Lake City: Daughters of the Utah Pioneers, 1937.

Goss, Peter L. "The Architectural History of Utah", *Utah Historical Quarterly*, 43 (3): pp. 208-239.

Gurcke, Karl. *Bricks and Brickmaking, A Handbook for Historical Archaeology.* Moscow, Idaho: The University of Idaho Press, 1987.

Peterson, Charles S. "The Valley of the Bear River and the Movement of Culture Between Utah and Idaho", *Utah Historical Quarterly*, 47 (2): pp. 194-214.

R. L. Polk & Co's Utah State Gazetteer and Business Directory, 1900, Vol. I, First Edition. Salt Lake City.

R. L. Polk & Co's Utah State Gazetteer and Business Directory, 1903-1904, Vol. II, Second Edition. Salt Lake City.

R. L. Polk & Co's Utah State Gazetteer and Business Directory, 1908-1909, Vol. III, Third Edition. Salt Lake City.

Romney, Miles P. "Utah's Cinderella Minerals: The Non-metallics", *Utah State Historical Quarterly*, 31 (3): pp. 220-234.

Stenhouse & Co's Utah Gazetteer, 1892-1893. Salt Lake City.

Utah Mining Association. *Utah's Mining Industry: An Historical, Operational and Economic Review of Utah's Mining Industry.* Salt Lake City, 1967.

Warrum, Noble. *Utah Since Statehood, Historical and Biographical*, Vol. II. Chicago: S. J. Clarke Publishing Company, 1919.

B. NEWSPAPERS

Box Elder News. 8 October 1903, p. 1, col. 6.

_____. 22 October 1903, p. 8, col. 1.

_____. 26 May 1904, p. 1, col. 1.

Box Elder Report. 1 March 1902, p.1, col. 2.

Brigham City Bugler. 7 February 1891, p. 1, col. 1.

_____. 24 October 1891, p. 4, col. 2.

_____. 14 November 1891, p. 4, col. 3.

_____. 2 April 1892, p. 4, col. 2.

_____. 21 May 1892, p. 1, col. 4.

_____. 25 June 1892, p. 1, col. 5 & 6.

_____. 20 August 1892, p. 1, cols. 1 & 2.

_____. 27 August, 1892, p. 1, col. 5.

_____. 3 September 1892, p. 1, col. 3.

_____. 11 February 1893, p. 4, col. 3.

_____. 6 May 1893, p. 4, col. 3.

_____. 27 May 1893, p. 4, col. 1.

_____. 17 June 1893, p. 4, col. 4.

_____. 12 August 1893, p. 1, col. 3.

_____. 28 April 1894, p. 4, col. 1.

_____. 11 August 1894, p. 4, col. 1.

_____. 3 November 1894, p. 1, col. 4.

_____. 6 April 1895, p. 1, col. 3.

_____. 6 July 1895, p.1, col. 3.

Salt Lake Tribune. "Brigham City Business Leader Dies", 7 January 1948, p. 6, col. 1.

C. DOCUMENTS AND REPORTS

Box Elder County Warranty Deeds Book S, Warranty Deed No. 8388, County Recorder's Office, Box Elder County, Brigham City, Utah.

Jensen, Robert E. *A Photographic Record of Selected Industries of Box Elder County*. M.S. Thesis, Department of Industrial and Technical Education, Utah State University, Logan, Utah, 1967.

Polk, Michael R. *A Cultural Resources Survey of a Portion of U.S. Highway 89, Box Elder County, Utah.* Sagebrush Archaeological Consultants, Archaeological Report No. 132, Ogden, Utah, 1985.

Polk, Michael R. *A Cultural Resources Overview of the U.S. 89/91 Corridor, Brigham City to Wellsville, Utah.* Sagebrush Archaeological Consultants, Archaeological Report No. 294, Ogden, Utah, 1988.

Riddle, Mark. *Lorenzo Snow and the Brigham City Cooperative*. On file at the Brigham City Library, Brigham City, Utah, n.d.

D. HISTORIC PHOTOGRAPHS

A. W. Compton, Photographer. View of Mantua Lime Kiln under construction circa 1892. Located in collection of Robert E. Jensen, Brigham City, Utah.