

DELAWARE SURVEY 1975

EASTBURN-JEANES LIMEKILNS

NEAR NEWARK, DELAWARE

NEWARK EAST QUAD 18.438100.4399280
18.438800.4399060

c. 1820-1850

PRESENT OWNERS: HUGO POPPY, JOHN L. BRILL, PAPER MILL ROAD, NEWARK
CARL HERBER, PIKE CREEK ROAD, NEWARK

SIGNIFICANCE: The limestone/marble deposits in the Pike Creek Valley of New Castle County are the largest in the State of Delaware. During the first third of the 19th century they became the center of an extensive commercial lime-burning industry which continued over 85 years. By the 1830's, the Jeanes and Eastburn families had opened two quarries and erected a number of limekilns. The rapid growth of demand for lime as fertilizer and mortar made the Eastburn enterprise a profitable one until eclipsed by larger, more efficient suppliers after 1900. The site reflects the growth and organization of lime burning from a supplementary agricultural pursuit to a commercial operation. Eight of the original limekilns remain, as do the quarries and a number of auxiliary structures which comprised the Eastburn-Jeanes lime-burning complex in the early 19th century.

RAYMOND W. SMITH, Supervisory Historian

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THE EASTBURN-JEANES LIMEKILNS

During the 19th century burnt lime, or calcium oxide, was a commodity valuable because of its numerous industrial applications. As a building material, lime mixed with water was used as interior plaster. Lime had also been recognized as an essential ingredient in the making of mortar and hydraulic cement since Roman times.¹ The quality of Delaware limestone as a building material was recognized early in the 19th century. A geologic survey of the state published in 1841 noted, "The limestone found in the upper part of the state, yields an excellent mortar, when well burned and freshly slacked; and with proper care, one bushel of burnt lime will more than double its bulk".² It was as an inorganic agricultural fertilizer, however, that burnt lime achieved its greatest importance before the Civil War.

The early impetus to fertilize using lime was provided by Southern agriculturist Edmund Ruffin. As early as 1818 Ruffin began experiments with the application of marl to depleted, "acid" soils in his native Virginia. At harvest time, Ruffin's marled lands yielded a crop 40% greater than fields which had not been thus fertilized. Ruffin correctly discerned from these spectacular results how alkali helped neutralize accumulated vegetable matter, restoring balance and fertility to farmland. In 1821 he published his findings in the American Farmer and, in a form subsequently revised and expanded, Ruffin's Essay on Calcareous Manures went through 5 editions by 1852.³ Ruffin's advocacy of lime as fertilizer anticipated by 2 decades the appearance of Justus Liebig's classic Chemistry and its Application to Agriculture and Physiology in an American edition (1841). Liebig encouraged liming of fields to replace needed soil constituents and, together with Ruffin's earlier published work, exerted profound influence upon American Agriculture in the ante-bellum era.

Lime burning in early America began as one of the farmer's late winter tasks. Limestone was "burned", or calcined for several reasons. By slowly heating the stone, carbonic acid was driven off, leaving a rather pure calcium oxide as an end product. The burning of limestone likewise reduced the bulk of the calcium as its impurities were removed, allowing the lime to be transported and applied more efficiently.

The use of lime as fertilizer was widely known and rapidly expanding by the 1830's. Initially, farmers used lime far in excess of its real efficiency, understanding little of its chemical action. Soon those beyond the immediate vicinity of lime deposits began to recognize the value of agricultural lime, and many farmers turned to lime burning to supplement their incomes. It is in this context of growing interest in lime and its uses that the Eastburn-Jeanes lime-burning enterprise expanded to commercial scale in the first half of the 19th century.

Growth of a Local Industry

The commercial lime-burning industry which developed in Pike Creek Valley began in 1816. In that year a prosperous landowner, one Abel Jeanes, began the quarrying and burning of lime on the site. The Jeanes farm occupied an extensive tract of land along Pike Creek, on which were located the largest outcroppings of native limestone in Delaware. On the property Jeanes erected a large dwelling house of brick and stone, a massive barn, a double tenant house, springhouse, and a combination warehouse and gristmill, using limestone quarried on the farm to construct these outbuildings.⁶

Abel Jeanes was joined in his large-scale farming operations sometime after 1812 by David Eastburn. In 1800, Eastburn had emigrated to Milltown, Delaware from Bucks County, Pennsylvania. On 3 December 1801 he married Elizabeth, sister of Abel Jeanes. Soon after the War of 1812, Eastburn purchased land adjoining the Jeanes property on Pike Creek, where he established a farm of his own. Little is known of David Eastburn's agricultural activities in Pike Creek Valley. He died in 1824, leaving a widow and 14 children. It was his eldest son, Joseph Eastburn, who recognized the full potential of the limestone quarries, and under his management the lime-burning activities soon evolved from an agricultural task into a profitable commercial venture.⁷

Conditions in Pike Creek Valley favored the growth of the Eastburn-Jeanes lime-burning enterprise. Geologically, the stone of New Castle County was the finest obtainable in the state for processing commercial and agricultural lime. A contemporary assessment of 1841 observed:

(Limestone) . . . occurs in . . . abundance at Jeanes' and Eastburn's on Pike Creek, and in smaller quantity at Klair's, 2 miles W. of Centreville, and at Bullock's, near the crossing of the state line by the Brandywine. It is a pure marble, essentially composed of lime, magnesia, and carbonic

acid, with a small amount of foreign matter. It is a coarse and fine-grained crystalline mass, with a white color of greater or less purity, presenting at times a bluish tinge from the presence of carbonaceous matter. It lies in heavy beds, generally disintegrated in its upper layers, and giving rise to a calcareous sand near the surface of the ground. ⁸

Calcareous stone of this bluish type found in Pike Creek Valley was the stone preferred among experienced limeburners as yielding the highest quality of commercial burnt lime. ⁹

A second major advantage lay in the abundance of wood available on the Eastburn farm as fuel for the limekilns. To supplement his own extensive timber holdings, Joseph Eastburn acquired cutting rights to large adjoining tracts of timber, perhaps in return for supplying neighboring farmers with burnt lime. Firewood was hauled from the woodlots using horses and oxen. ¹⁰

Thus having available an abundant supply of raw materials, Joseph Eastburn and Abel Jeanes proceeded to open additional quarries, and to erect numerous stone kilns during the 1820's and 1830's for the burning of limestone. A local historian noted that during this period, 7 kilns were in operation on the Eastburn farm; between 10 and 12 limekilns on the Jeanes property. Supplementing this already large capacity were a number of scattered limekilns operated by individual members of the numerous Eastburn family. ¹¹ The constant burning of lime in so many kilns allowed the business to be conducted on an industrial scale.

The magnitude and rapid growth of the Eastburn-Jeanes lime operations in the early 1830's is discernible from data on Delaware manufactures compiled and reported to Congress in 1832. The lime industry in Pike Creek Valley as managed by Abel Jeanes and Joseph Eastburn had a total capital investment of \$70,000 in buildings, grounds, and machinery. Jeanes employed between 25 and 30 men; Eastburn, 14. Since 1816, the combined operation had annually produced 85,000 bushels of burnt lime from 95,000 bushels of quarried limestone, a very high yield of product from the raw material. The kilns were kept in constant operation throughout the year, and sale of their product was brisk. ¹²

The rapid growth in demand for agricultural lime in the late 1830's met major obstacles in the lack and prohibitive cost of land transportation for such a bulk commodity. These factors were a major impediment to the expanded use of lime in

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agriculture outside the immediate vicinity of the kiln for many years.¹³ In order to take fullest advantage of the lucrative agricultural market for his product, Joseph Eastburn recognized the need to bring his lime from the kilns to the farmer. Toward this end the enterprise began to maintain its own pool of horse and ox-drawn wagons for hauling burnt lime. In 1832 there were 38 draft horses and 10 or 11 yoke of oxen available for this work.¹⁴ As the undertaking achieved a commercial scale, Joseph Eastburn erected several supporting structures at the growing Pike Creek Valley complex. These included a wheelwright's shop, office and storeroom, and wagon shed, all build of native limestone, and all still extant. The kilns at first supplied only local needs, but Pike Creek Valley lime was soon being delivered as far south as Middletown, Delaware, and Chesapeake City, Maryland (western terminus of the Chesapeake & Delaware Canal); and as far to the north as Lancaster, Pennsylvania, where German farmers were leading innovators in the application of lime as fertilizer.¹⁵

Just as the company's wagon drayage facilitated delivery of bulk lime, so economies of scale appear to have affected the price of the commodity as well. In 1835, burnt lime in southeastern Pennsylvania sold for 25-35¢ per bushel (approximately 80 pounds) at the kiln. A similar price situation existed in Delaware. Abel Jeanes reported that prior to 1822, his lime sold at a cash price of 30¢ per bushel; after that date the price fell to 20¢ at the kiln. As the quarrying operation grew, new kilns were erected, production of burnt lime increased, and the price per bushel decreased. In 1832 Eastburn himself noted a constant decline in the costs of labor and materials since his lime-burning business was established in 1816.¹⁶ There is no evidence of a barter system between the Eastburn-Jeanes interests and consumers of their product; all sales were on a cash basis.

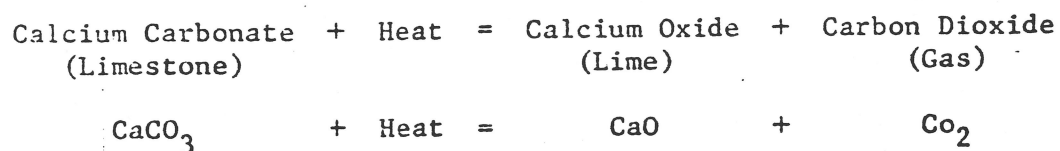
With the bulk of its trade in agricultural lime, the Eastburn-Jeanes business continued throughout the 19th century, continuing to prosper despite a backlash against liming of fields by many farmers prior to the Civil War. With understanding of soil chemistry and the function of agricultural lime, a steady demand for the product of the kilns grew out of the postwar era.

In hopes of increasing its output and efficiency, the Pike Creek lime enterprise

partially converted to coal as the fuel for its kilns by 1850. Ultimately, however, the local industry was eclipsed by the development of modern blasting and quarrying techniques, which facilitated the opening of the large limestone quarries of Pennsylvania, Western Maryland, and the Shenandoah Valley of Virginia by 1900.¹⁸ The rationalization of the lime-burning process using large banks of commercial kilns and coal fuel likewise gave large firms the advantages of economies of scale over localized operators such as Eastburn. Finally, rail transportation from the above-mentioned quarry regions facilitated the hauling of bulk lime to the consumer, thereby eliminating the major cost factor in the lime industry. It was the combination of these factors which ultimately brought an end to the Eastburn lime-burning industry in Pike Creek Valley. Eight limekilns and 2 abandoned quarries, together with the stone buildings erected by Abel Jeanes and Joseph Eastburn stand as reminders of an extensive local lime industry which ceased its operations during the first decade of the 20th century, a victim of technological and economic change.

The Limekiln: Function and Construction

In the lime industry, the term limestone is applied to a class of rock containing above 80% of the carbonates of calcium and magnesium. The "burning" of lime is actually a heat-induced reaction wherein the chemical bond between calcium oxide and carbon dioxide is broken. Using chemical notation, the process which occurs when limestone is "burned", or calcined becomes:



It is this chemical change within the limekiln which yielded quicklime. Depending upon its intended use, quicklime was sometimes "slaked", or "slacked" by the addition of water at its final destination. Quicklime was thus converted to slaked lime, or calcium hydroxide, Ca(OH)_2 .¹⁹ Slaking increased by upwards of 1/3 the bulk of the lime, thereby rendering it more efficient for use in mortar or as plaster. For agricultural use as fertilizer, however, newly burned quicklime was essential. A contemporary treatise advised farmers, "Care should always be taken to procure this article as fresh and as perfectly burnt as possible before it is made use of, as lime

when only just taken from the kiln can be said to be pure, for immediately on its removal it begins to absorb the carbonic acid gas of the atmosphere, and to resume its original state of carbonate of lime.²⁰ Here, the value and importance of rapid, efficient transportation from kiln to farm becomes readily apparent.

The effect of lime burning in the kiln is to drive off water and carbon dioxide, yielding a pure calcium oxide. Initially, the kiln fire liberates the water and some carbon dioxide; however, prolonged burning at sustained heat is necessary to drive off the remaining carbonic acid (a red heat is sufficient).²¹ Hence it was essential that the limekiln be designed and built to incorporate the desired characteristics for slow, sustained burning while consuming minimum fuel.

Limekilns were generally erected near either the limestone quarry or near woods where fuel was obtained. The location of the Eastburn-Jeanes kilns in Pike Creek Valley was a fortunate one on both counts, and contributed to the success of the enterprise by limiting internal transportation to short distances for both raw materials. The earliest type of limekiln was the stack, or field kiln, in which broken stone was merely piled on a stack of wood, perhaps sealed over with mud or caly, and ignited. More permanence was achieved early in the 19th century with the emergence of the intermittent kiln. Square or circular retaining walls of fieldstone were erected, and an arched charge of limestone placed inside over a pile of wood fuel. While a slight advance over the stack kiln, the disadvantages of the intermittent kiln were several. It was heavily dependent on cheap and abundant fuel and labor. It was also wasteful of fuel and heat, being allowed to burn out with each charge. Not until the lime cooled inside the kiln could it be raked out and the kiln refired.²²

The most efficient limekiln to appear in the early 19th century was the perpetual kiln, and it is this type which was erected in a number of minor variations on the Eastburn and Jeanes farms during the period 1816-1850. The perpetual kiln was so named because once ignited, it could be continually recharged at great savings in fuel over the intermittent kiln. Lime could likewise be "drawn" from the kiln periodically as slow burning converted charge after charge of limestone into quick-lime.

A perpetual kiln was generally built into a hillside so that the reverse slope would facilitate charging the kiln with cartloads of limestone and fuel from above.

The hill further served as a windbreak, preventing crosswinds and sudden drafts from interfering with the burning process inside the kiln.²³ Often the front walls of the kiln were extended to follow the contour of the hill, thereby acting as a retaining wall for the earth alongside the hearth.

The Eastburn-Jeanes limekilns vary in size and outward appearance, but all are similar in structure and function. The perpetual kiln appears circular in plan. The diameter of the "pot" or kiln shaft is approximately 8 feet at the top. In vertical section, the pot appears as an ellipse, truncated at top and bottom, and tapering downward to a diameter of 5 - 6 feet at the hearth. The elliptical shape utilized reverberatory hear, and the "boshes", or curved kiln walls facilitated downward settling of the lime as it burned.

The hearth or "thimble" is an opening 6 to 10 feet high, and of nearly equal width, arched or capped by a large lintel stone. Several shaft-type apertures extended horizontally from the hearth into the kiln shaft. These "eyes" or flues regulated the draft and rate of burning within the kiln. A larger horizontal shaft beneath the draft holes facilitated the removal of burnt lime.

Behind the hearth at the bottom of the vertical kiln shaft was a lattice or grate of iron bars. This grate supported the weight of the stone and fuel charge while burning slowly took place.²⁴

The kilns at the Eastburn-Jeanes site were all constructed of rough-hammered limestone quarried on the premises, with mortar applied between the stones. The 2 largest kilns appear to have a refractory lining of red sandstone in lieu of firebrick. the lining of late 19th century limekilns. The kilns were built to heights of between 15 to 23 feet. Most interesting of the kilns is a bank of 6 adjoining hearths fronting on Pike Creek Road. No. 2 of these 6 kilns are identical, and as the lime burning operation expanded, it is apparent that kilns were simply added to this group as needed, each perhaps an experiment toward achieving optimum efficiency.

Roofs were common on limekilns in the 19th century, though no traces remain on the Eastburn-Jeanes kilns. On a bank of several commercial kilns it was common practice to construct a lean-to or shed roof across the front to protect attendants from the elements as they maintained their long vigil over the burning process.²⁵ Supporting columns for

such a shed roof are evident at the Eastburn 6-kiln group, spaced across the front of the kilns at regular intervals. In addition to shed roofs on the front, many kilns also had plank roofs across the top of the kiln shaft. These roofs kept out rain and snow which would otherwise interfere with the burning process. They were removed when the kiln fire reached the top of the shaft. No evidence of such roofs on the Eastburn kilns remains,²⁶ but they were common to kilns of this type in the early 19th century.

The Lime-Burning Process

The lime-burning process described below is typical of that which Eastburn and numerous small local operators practiced throughout the 19th century. Only after 1900 and the rise of large-scale quarries and kilns were these methods superseded.

Limestone was quarried on the Eastburn-Jeanes farms using sledges, hand drills, and presumably an occasional charge of black powder. Stone from depths below ground level proved the best for calcining. Large rocks were broken easily, and reduced to stones no longer than 10 cubic inches. Occasionally, underground springs were uncovered, with resultant flooding of the quarries.²⁷ Wagonloads of limestone and cut firewood were hauled to the kiln from quarry and woodlot, respectively.

Charging the kiln involved first placing a layer of "lightwood", or kindling at the bottom of the shaft below the iron grate. Next came a cord or more of larger softwood, then a layer of limestone, loaded from the top of the kiln. Small stone was placed toward the outer perimeter of the kiln shaft, with a larger stone toward the center to facilitate draft and even burning. Alternate layers of fuel and limestone were then piled upward through the boshes to the top of the kiln, the layers of wood becoming heavier and those of stone lighter as the charge reached the top. Often stone was piled above the top of the kiln shaft and plastered over with mud or clay except for a center flue or draft hole. An elderly limeburner noted that it took 2 men 1½ weeks or longer to charge a kiln the size of those on Pike Creek.²⁸

Once fully charged, the kiln was ignited from beneath the iron grate at its base. As the limestone slowly "burned", or calcined, the contents of the kiln settled, whereupon new layers of stone and wood could be added to the perpetual kiln from the top. Once the limestone at the bottom of the kiln was fully burned (approximately 6 to 8 hours), "drawing" of quicklime began. Burnt lime was raked out through the shaft

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below the iron grate using a long hook-shaped iron rake. Drawing was repeated approximately every 6 to 8 hours for as long as the fires continued to burn.²⁹

The work of the limeburner was arduous at times. The kilns were kept burning continually throughout most of the year, and the job of tending them demanded the worker's fullest attention. The draft entering the kiln required constant regulation as winds shifted, and limeburners took turns tending the flues around the clock.³⁰ The lower the temperature and the longer the "burn", the better would be the quality of quicklime produced. Hence, a key determinant of success was the skilled craft knowledge of the experienced limeburner.

The yield of burnt lime from each kiln varied according to the capacity of the pot and the quality of the limestone as it came from the quarry. Generally, the lime raked out of the kiln was equal to approximately 60% of the charge of limestone by weight.³¹ Though the perpetual kiln represented a saving in fuel over the intermittent kiln, perpetual kilns still consumed vast quantities of firewood. Burnt lime was sold by the bushel, and according to best estimates, a cord or more of wood (128 cubic feet) was required to burn 60 bushels of lime (each full bushel weighing approximately 80 pounds).³² A kiln the size of those in Pike Creek Valley held a limestone charge sufficient to make a total of 525 bushels of lime. Once started, the burning process might be expected to produce 300 bushels every 24 hours.³³

Immediately upon cooling after being raked from the kiln the lime was packed in sealed casks of 3-bushel capacity to await shipment. Quicklime for immediate, local agricultural use, however, was frequently delivered by wagons in bulk.³⁴

The Eastburn-Jeanes lime-burning industry served the needs of builders and farmers in northern Delaware and its environs for over 85 years. Though the enterprise was abandoned shortly after 1900, the limekilns of Pike Creek Valley remain as vestiges of this industry's important place in the economy of the region.