CHAPTER 8

RESEARCH GOALS

AND CONTEXT

Introduction

This chapter reviews GAI's research design for conducting archeological investigations at the Cubbage Mill Site (7S-C-61). The initial goal of Phase I archeological investigations was to collect information to better define the function, size, date, and overall integrity of the site. Information gathered during this phase warranted the completion of Phase II testing to determine the site's National Register eligibility. At this time, it was determined that Cubbage Mill likely represented one of the best-preserved archeological examples of a mill in the State of Delaware. Since the bridge replacement project could not avoid this significant, i.e., National Register-eligible resource, Phase III investigations were conducted to mitigate the adverse effects of proposed construction through archeological data recovery.

The *Management Plan for Delaware's Historic Archeological Resources* (*Management Plan*; DeCunzo and Catts 1990) developed concepts (geographic zone, time period, research themes and domains, and property type) that provide a context for developing research questions. The *Management Plan* separates the state into several geographic zones and provides an overview of site types and periods by which to evaluate the historic context and significance of a given archeological site. The Cubbage Mill Site falls within the Lower Peninsula geographic zone within Sussex County. Following Ames et al. (1989:20), the *Management Plan* (DeCunzo and Catts 1990:119) defines five temporal components to Delaware's historic framework (with the periods of import for Cubbage Mill in bold):

1630-1730: Exploration and Frontier Settlement

1730-1770: Intensified and Durable Occupation

1770-1830: Early Industrialization

1830-1880: Industrialization and Early Urbanization

1880-1940: Urbanization and Early Suburbanization

(For a more detailed historic context, refer to Volume I, Chapter 3)

The periods are organized around a list of property types and research themes, including domestic economy, manufacturing and trade, landscape, and social group identity, behavior and interaction. Cubbage Mill is a gristmill property type or agricultural processing industry, i.e., manufacturing and trade research theme.

These research themes and domains for the state are interrelated to provide for greater flexibility in their applications. In many sites, including Cubbage Mill, more than one theme or research domain may apply. Cubbage Mill was an industrial or manufacturing site that served as a gristmill but, for a short period of time, also functioned as a sawmill. Broad research issues apply to industrial sites, including 1) the interrelationship between

the landscape (and environment) and the industrial process (physical location), 2) the effects of the industry on the community, including its economic impact, and 3) the evolution of the process and technology of the gristmill industry, including the equipment. An overview of these research issues based on archival research (Chapter 3, Volume I) provides a context for the site study.

Research Goals

Archeological investigations can contribute to the study of Delaware's industrial heritage. The research questions discussed below were designed to examine research problems for a gristmill in the Lower Peninsula in Sussex County, circa 1770-1940, as identified in the *Management Plan* (DeCunzo and Catts 1990). Cubbage Mill archeological investigations have the potential to make a significant contribution to the manufacturing and trade and landscape themes based on Phase I and Phase II studies. Research undertaken for archeological investigations can also provide insights on the economy and social group identity, behavior and interaction research domains.

The gristmill property type has not been well studied in the region. A gristmill includes more than just the mill building itself; it also includes the water source (millpond), water system (headrace, tailrace, penstock, etc.), power supply (waterwheel, turbine, steam engine, etc), and a variety of mechanical equipment. These features are sometimes grouped together under the more encompassing term "mill complex."

The mill seat (location of the mill) and its setting fall under the landscape research domain since a water-powered mill is intimately tied to the surrounding landscape. The key to economic success for a water-powered mill is *location* (natural environment), *location* (customers/demand for services), and *location* (transportation networks). This gives rise to a series of research questions.

Was the mill placed in a beneficial environment for a mill seat?

Was there enough need within the local community for these services?

Was there adequate transportation to the mill?

The manufacturing and trade research domain examines the technology and manufacturing process and how it has changed over time. Architectural remains are the most common type of artifact found on a gristmill site and are useful for providing information on technology and the manufacturing process. Based on Phase I/II results, archeological investigations at Cubbage Mill can provide data on mill construction methods, water delivery system (s), and power technology. Several research questions arise from this observation.

What parts of the mill complex have been documented?

How has construction methods at the site changed over time?

How was the water delivery system modified over time?

How has the power source at the mill changed over time?

Does the site show evidence of technological innovations?

Cubbage gristmill operated for over 150 years. This gives rise to the question about the economics of the mill.

> Was it owner operated or tenant operated?
>
> Did the mill owners adapt to changing trends in agriculture, transportation, and industrial development?

To address these questions, the study will review information gleaned from both documentary research and archeological investigations.

A final research goal is to discuss whether or not the archeological investigations of Cubbage Mill made a contribution towards our understanding of a gristmill, during the period 1770-1940, and the research domains selected as appropriate for this site.

Context

To provide a context for this site, we present a general overview of the history of the region, followed by a discussion on mill seat environmental settings focusing on Cubbage Mill, the technology of water-powered mills, and a brief overview of other mills in the region. In some instances, information from Cubbage Mill is included to illustrate a particular point. The chapter ends with a discussion of the mill dam as a property type. This context enables us to discuss the results of investigations at Cubbage Mill within the broader context of mill studies and historic archeological sites in the region.

Historical Perspective of the Region

The American Revolution and extensive political unrest in Sussex County, an active Loyalist/Tory region, characterized the period of Early Industrialization (1770-1830). During this time, Maryland and Delaware resolved a boundary dispute, making Sussex County the largest in the state. Corn agriculture dominated in the Lower Peninsula (including Sussex County) with gristmills concentrated in the Piedmont and Upper Peninsula to the north. DeCunzo and Catts (1990:61) reference the importance of mills within the Lower Peninsula as centers of commerce including their role in the local transportation network:

> Both the transportation network and the settlement pattern focused on gristmills, sawmills, and mill dams. The mills provided nodal points for the surrounding population, and other services, such as taverns, shops, and stores were erected in their vicinities. The mill dams often provided the easiest means of crossing low, swampy ground and of crossing the mill ponds, thus serving as ready-made causeways across streams and creeks in the area. These mill seats and crossings sometimes expanded into larger towns…

Sussex County had an agriculturally based economy. Before the late 19th century, residents practiced subsistence farming, relying on corn, lumber, meat, fur, and textile production. Small-scaled industries, with individual owners, such as sawmills, gristmills, and tanneries, sold their products to the local market. Farmers producing excess grain generally sold it to markets in the form of flour. Water-powered mills (i.e., gristmills, sawmills, and woolen mills) were scattered across the landscape along dependable

streams (Bomberger and Sisson 1991). Sawmills were frequently paired with gristmills. Most communities also had a tannery where leather used for shoes, saddles, and harnesses, could be made from hides obtained from farmers.

Between 1830 and 1880, Industrialization and Early Urbanization increased across Delaware, especially with the introduction of the first railroads, which could more efficiently transport crops to markets. Corn agriculture continued to dominate. In addition, the Lower Peninsula of Delaware was responsible for much of the peach production in the eastern United States. Both agricultural production and manufacturing increased during this period, the latter especially so in the northern counties. Sussex County remained primarily agricultural, however, typified by a large number of gristmills and sawmills in the late 19th and early-mid 20th centuries. As one might expect, prior to the Civil War, Sussex County contained more than half of the slaves in Delaware (DeCunzo and Catts 1990:75).

Transportation improvements throughout the 19th century made it easier for farmers to send their products to market. By the latter part of the 19th century, truck, orchard, and strawberry farming replaced subsistence farming. Excess grains were made into flour and excess milk made into butter and sent to the various markets. Expansion of larger commercial industries, such as canning factories, and the development and growth of railroad town centers contributed to urbanization.

By the 1880s, many of the water-powered gristmills and sawmills were no longer in operation due to competition from large roller mills or steam-powered mills in larger centers. However, eastern Sussex County continued to be more rural in character with more of an emphasis on local markets (Bodo and Guerrant 1996). A few of the local gristmills, like Cubbage Mill, continued to operate into the 20th century.

During the period from 1880-1940 (Urbanization and Early Suburbanization) there was a general decline in corn production as cornfields were gradually replaced with hay. Many wheat fields were replaced with buckwheat, rye, or barley crops by the latter part of this period. Sussex County experienced an enormous growth of Type I farms, which are less than 100 acres in size (DeCunzo and Catts 1990:79). Lumber manufacture also increased in economic importance. Truck gardens, fruit crops (especially peach farming), and cannery crops continued to play an important a role in agricultural production within the Lower Peninsula. The large-scale poultry industry also had its origins during this period.

This was also a time of major changes in the transportation system (DeCunzo and Garcia 1993:308). During the preceding period, rail lines were used to move goods to markets. The development of the automobile and the accompanying expansion of road networks made it easier to both buy and sell goods and produce outside of the local markets.

Mill Seats and the Natural Landscape

The location of a water-powered mill is tied to the natural landscape placed along waterways where conditions are most favorable. A typical mill complex or mill seat included the mill, as well as, a dam, bridge, pond, headrace and/or penstock, and a tailrace. The dam and pond created the water source to power the mill. The headrace

delivered the water from the dam and entailed the construction of a channel or flume from the dam to the mill location. At the end of the headrace, water was delivered to the waterwheel by the penstock, which usually had a gate to direct the water to the appropriate location on the wheel. The water exited the mill by way of the tailrace which directed the water back into the stream below the mill.

Level Building Surface

One attribute of a good mill seat is a relatively level area close to a stream for the mill structure. At Cubbage Mill, the actual mill foundation was cut into a natural escarpment located near the north side of the creek valley. The headrace, penstock, and tailrace were located within the North Fork of Cedar Creek on the south side of the mill.

Adequate Water Supply

The second attribute for a good mill seat is a location that permits the miller to create an adequate flow and fall of water for powering the mills. Flow refers to the amount of water that can be used to generate power. Fall refers to the vertical drop in water that can be created to produce energy. The higher point on the wheel that the water is delivered the more weight that is applied to spin the wheel, generating more power.

Constructing a dam across a stream and creating a pond of water were one common way to create adequate waterflow and fall. Dams were constructed to increase the 'head' of a mill seat, with the head being the potential energy of the water itself (i.e., waterpower). Dams were located upstream of a mill, with the pond creating enough water to operate the mill for a certain period of time—usually a few hours for a small mill to several days for larger commercial mills.

There were factors to be considered in selecting the location for the mill dam. Areas with a wide stream valley or locations with a low stream bank were generally not favorable for building a mill dam and were not considered a good location for a mill seat. In addition, laws forbid mill owners from creating a mill pond that would infringe on the rights of other landowners (water rights, flooding, etc.) along the stream.

In Delaware, many mill dams were wide enough to accommodate a road on the dam which crossed the stream. These were encouraged by the state to improve transportation and benefited the millers, since it provided a convenient way for customers to access their establishment. Roads were constructed atop the mill dams at Clendaniel, Cubbage, and Swiggetts ponds.

At Cubbage Pond, the mill dam was built across the Cedar Creek Valley and had two water outlets: an outlet for the South Branch of Cedar Creek and an outlet for water to flow into the mill's power system on the North Branch of Cedar Creek. The outlet leading to the mill could be closed when the mill was not in use. One of the problems with a mill pond was that over time sediments would build up in the pond, diminishing water storage capacity and consequently reduced the time that a mill could operate before the water needed to be replenished.

Avoidance of Flood-prone Locations for the Mill Structure

A beneficial location for the mill building was generally high enough above the stream to avoid frequent flooding. Mills could be subjected to flooding from the upstream side and were generally built, in part, to release more water from the mill pond during times of high water to reduce flooding problems. Mills were built with extra support features on the upstream side of the foundation to minimize the effects of these floods.

One of the most overlooked problems with flooding at mill seats was the impact of water backing up from the downstream side. While most mill dams and buildings were constructed with extra protective measures from the upstream side, they were relatively defenseless from the type of flooding that could easily undermine timber and earthen dams on the unprotected downstream face. The water could also undermine parts of the mill foundation and basement. Finally, water could create a temporary pond in the tailrace area. This could result in the deposition of silts and sand (clogging the waterway) which would then have to be cleared away before the mill could operate properly. This problem was evident during excavations at the Cubbage Mill when several storms created a large pond in the tailrace section of the site that covered the base of the penstock (Photograph 8.1). This occurred despite the fact that the cofferdam around the excavation prevented water from Cubbage Pond from entering site excavations from the upstream side. The mill could not have operated under these conditions.

Photograph 8.1

Nor'easter during excavation demonstrates historical mill ponding and flooding aftermath experienced by Delaware millers. (View of penstock and brick foundation.)

Technology of Water-powered Mills

Waterwheel mills convert the hydropower of active streams and impounded bodies of water by channeling flow against a rotating and circulating wheel that is articulated to drive shafts and gears that turn a grinding stone and other devices. A technology dating to the time of the Roman Empire, there are four basic waterwheel types represented by; 1) overshot waterwheels, 2) breast waterwheels, 3) undershot waterwheels, and 4) horizontal waterwheels (Figure 8.1). The main differences between waterwheel types were in their diameter, breadth, and direction of rotation.

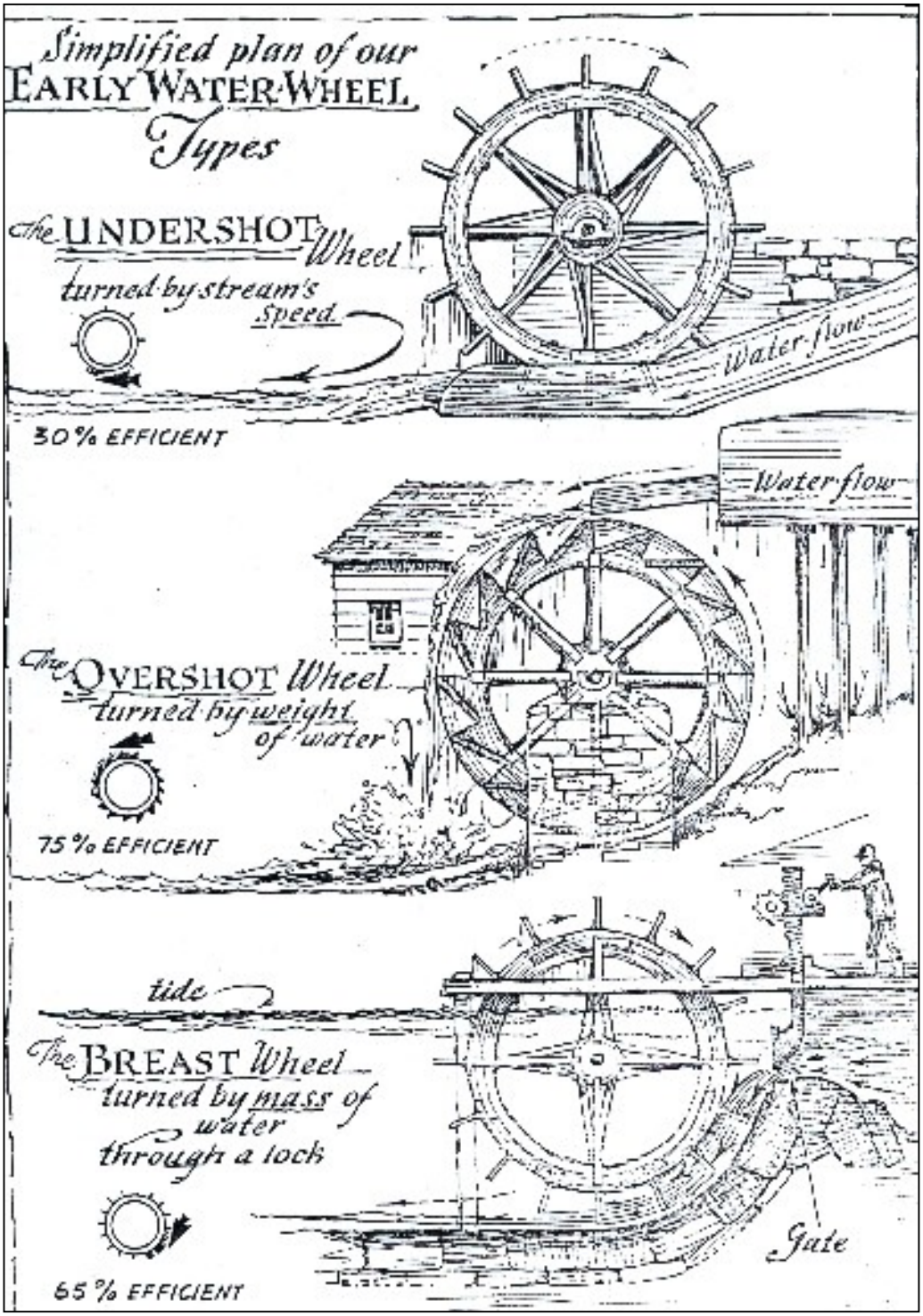

Figure 8.1

Early Vertical Waterwheel Types (after Sloane 1954:44)

The energy generated by waterwheel mills is closely related to the characteristics of the "head" and "flow" of the available water source. Head refers to the vertical distance that water drops to the point of impact with the wheel and has significant bearing on energy potential. In flat coastal areas characterized by low head, millers often impounded rivers and streams to create a mill pond that would ensure a predictable water supply with an increased flow. The dam on Cubbage Mill pond confirms that the builders were cognizant of this need for a reliable water source. Mill ponds typically afforded sufficient water to run the mill for only a limited period of time before the mill pond ran low on water, limiting the head available. Once the head was exhausted, the miller had no other option but to close the dam gate and allow stream water to replenish the pond. This meant that only a limited number of jobs could be accomplished at one time.

Adjustable floodgates at the dam enabled millers to fill penstocks--channels designed to impound water--which led to a gated sluiceway and constricted the final watercourse striking the wheel. Penstocks were usually constructed with trash racks designed to filter out debris that would otherwise impede or damage the waterwheel, as identified during excavations at the 18th-19th century Middleford Mill, Sussex County, Delaware (Crane et al. 2002: 80). As a larger safeguard measure, the miller and his staff had to spend ample time maintaining the dam and gates to ensure that breaches did not occur. Such accidents did occur, however, often destroying the immediate site and threatening mills that might be located downstream.

Waterflow through the sluices and penstocks was closely monitored by the miller when grinding was underway. Insufficient waterflow resulted in slow wheel rotation, which often failed to grind grains to a satisfactory meal consistency. By contrast, excessive waterflow sped the wheel, which in turn increased the friction of the grinding stones. As a result, customers often complained about the "burned" taste of the produced meal.

While undershot or "flutter" waterwheels were the easiest to construct and maintain and, as the name suggests, were struck by flowing water at their base (Goggin n.d: 2), any wooden waterwheel had a limited use-life and required constant maintenance. Generally, the wood wheel rotted and had to be replaced within 20 years. Typically constructed to the same vertical height as the head of the pond, undershot wheels generally exhibited a series of horizontal paddles or boxes separated along the arc of the wheel at the same distance as their dimensional width. Despite the ease in construction, undershot varieties were the least energy efficient waterwheel type. When the head or fall of the water is only 2-3 ft then the mill must use either an undershot wheel or a horizontal or "tub" wheel. [Although no one knows for sure, oral historical evidence (Jane Waples Serio, pers. comm. 1998) and analysis of the site suggest that Cubbage Mill may have employed an undershot wheel.] These wheels did not produce as much power as the breast or the overshot waterwheel types. The horizontal wheel did not produce enough power for most commercial mills. One of the few undershot waterwheels in operation in this area during the early 19th century, it is also not surprising that historic documents suggest that the waterwheel system was discontinued at Cubbage Mill and replaced with a turbine in the mid-19th century (as was the case at other mills in the region), as more efficient mechanized technologies became available.

The excavations at Site 7S-C-61 focused on the archeological remains of a water-powered gristmill. Water-powered gristmills were generally two to three story structures that were divided into three work levels: basement, first floor, and second floor (Herman 1987:76). The basement contained the drive system, which provided the power to operate the mill. The gears and machinery in the basement converted the vertical power of the waterwheel to horizontal power used to rotate the grinding stones. In addition, the wood gears, which were mounted on a husk or hurst frame, converted waterwheels eight to twelve revolutions per minute to the millstone's 100+ revolutions per minute. The hurst frame is a massive wooden frame with its base on the basement and its upper reaches extended to the first floor where it supports the grinding stones.

The first floor or grinding floor housed the grinding stones (Figure 8.2). The upper part of the husk frame held the set of grinding stones in place. A set of stones included a top or capstone and a bottom or bed stone. The top stone turned while the bottom stone remained stationary. Grain was poured into the hole in the top stone and as it turned, the grains were sheared or ground into smaller and smaller pieces. Centrifugal force carried the ground grain out towards the edge of the stones where the ground flour dropped into a barrel shaped device.

The second floor held the bolting machinery that was used to sift the flour. A bag hoist used to lift the sacks of grain was also located in the top floor.

When archeologists encounter the remains of gristmills during archeological excavations, usually all that remains is evidence from the basement of the structure. This is the case at Cubbage Mill. Therefore, the site evidence and interpretation tends to focus on the mill elements like the power system, evidence of the gears and machinery found in the basement, and mill building construction. The location of the mill, as discussed above, is also important for the analysis and interpretation of this site type.

Mills in the Region – A Comparative Sample

As stated in Volume I (Chapter 3), the majority of available mill seats were occupied in southern Delaware by the early 19th century because of the expanding role of buckwheat flour and corn meal production in the area (local use and export). As of 1997, 13 of these gristmills and/or dammed ponds remained standing in Sussex County, five of which were listed on the National Register of Historic Places (NRHP): Chipman's Mill, Hearns and Rawlins Mill, Warren's Mill, Baltimore Mills and Abbott's Mill. These latter two sites are described below.

Baltimore Mills, Sussex County

One of the best examples of an extant gristmill in southern Sussex County is Baltimore Mills located along Vines Creek. This mill complex consists of five structures and four archeological sites arranged in a typical mill seat grouping. Baltimore Mills possesses the foundation for the gristmill, a wheelpit, dam/bridge abutments, a roadbed, tailrace, mill pond, a dump, two house sites, and a sawmill site. In 1996, the mill complex was listed on the National Register of Historic Places (Bodo and Guerrant 1996). No archeological research has been conducted at the site.

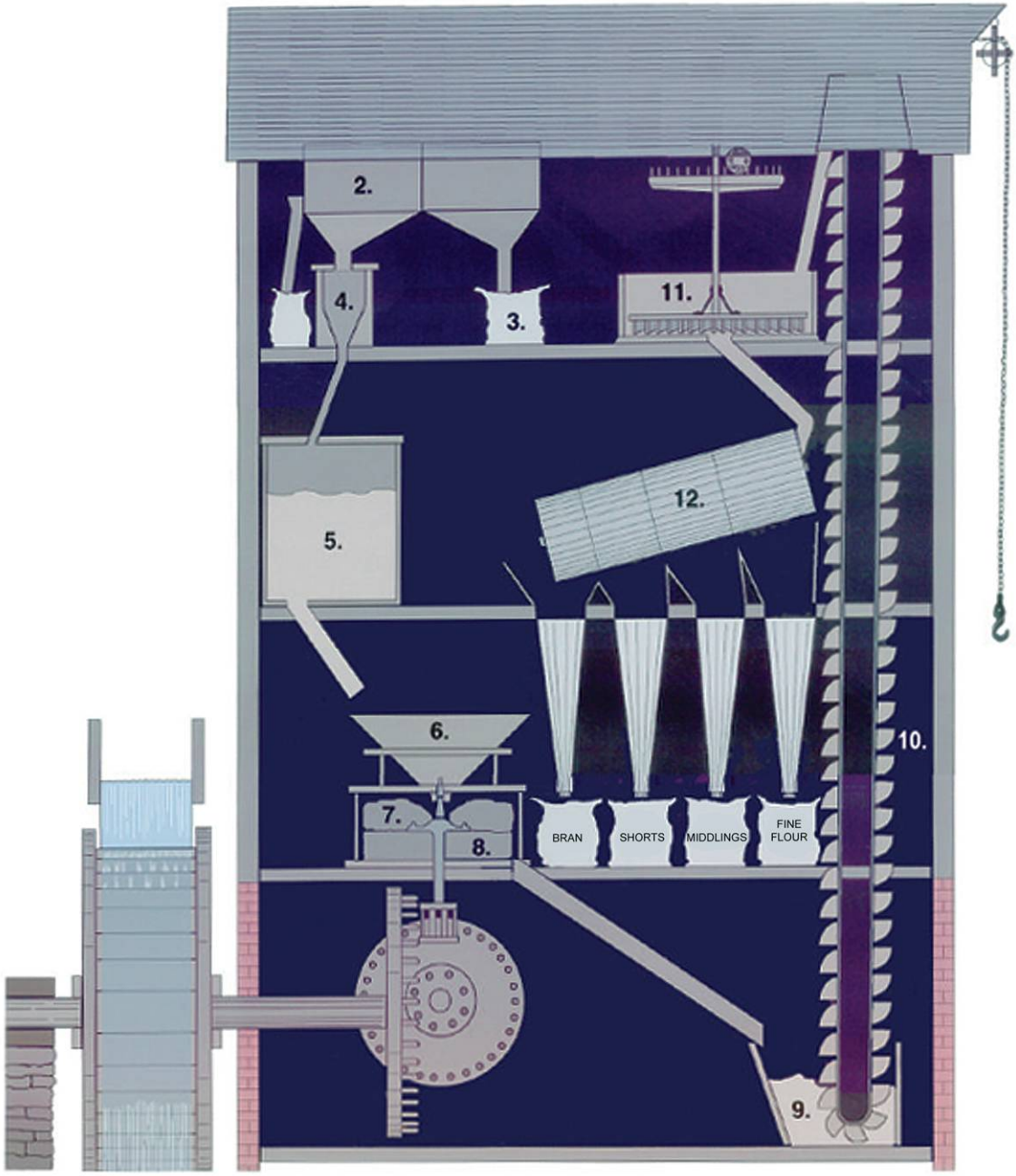

Figure 8.2

How a Gristmill Works

HOW A GRISTMILL WORKS

The *sack hoist (1)* lifts incoming loads of grain to the top story. Emptied into the *dirty grain bin (2),* the grain passes through a circular screen that whirls dust and mold from the grain and into...the *sack (3)* below.

Heavier grain falls through the screen mesh to the *smutter (4).* The smutter cleanses the grain of a fungus (smut), and scours off any remaining dirt. Once cleansed of smut and dirt, the grain drops to the *wheat garner (5),* a wheat storage bin. The wheat garner allows wheat to be fed to the *hopper (6)* at a rate that suits the millstones.

The *runner stone (7)* is turned by a gear train that transmits power from the waterwheel.

Ground flour falls through a chute below the (stationary) *bed stone (8)*...into a *bin (9)* from which...an *elevator (10)* carries it back up to the top floor...where the flour is cooled by the *hopper boy (11).* This rake-like machine with splayed wooden teeth sweeps freshly ground grain toward the center, cooling it.

Fresh grain is fed by the hopper boy, down a central chute, to the slanted *bolter (12).* From the bolter, flour passes through increasingly coarse mesh--finest flour through closely meshed silk, then middlings, shorts, and bran drop into the second, third, and fourth bags, respectively.

Abbott's Mill, Sussex County

Another example of a typical late 18th-early 19th century mill seat is the NRHP-listed Abbott's Mill located within Cedar Creek Hundred near Milford, Sussex County (Photograph 8.2). The mill was built in 1795 and operated until 1963, producing mainly buckwheat flour and cornmeal within the four-level structure.

Photograph 8.2 Abbott's Mill, Sussex County, Delaware

Abbott's Mill likely used an overshot-type waterwheel until its replacement by a water-powered turbine sometime in the mid-late 19th century.

A diesel engine was subsequently introduced during the early 20th century to provide a more consistent source of power at the site. The Delaware Nature Society presently operates Abbott's Mill as a visitor's site. Much of the original mill seat is still extant, including the original mill building, mill pond, dam/bridge, and the grain elevators (Goggin n.d.). No archeological studies have been conducted at Abbott's Mill.

Noxontown Mill, New Castle County

Another excellent example of a well-preserved early-19th century gristmill complex is the NRHP-listed Noxontown Mill located near Middletown, New Castle County (Lankton 1976). This mill was built in 1740 and continued in operation until the 1940s, when it was converted to a store. The mill seat consists of a mill pond/dam, a short millrace, and mill building. Noxontown was a typical Colonial Period (small) mill, with its primary focus being flour processing.

Photograph 8.3 Noxontown Mill, New Castle County, Delaware, ca. 1740

Noxontown Mill's production peaked in the late 19th century prior to a switch in focus to cornmeal production by the early 20th century, a pattern seen at Cubbage and other area mills. Similar to Abbott's and Cubbage Mills, Noxontown Mill relied upon waterpower until this time when a gas engine was introduced as an auxiliary power source. By the mid-1940s, the mill ceased operation. As of the mid-1970s, the 3-story mill remained standing with much of its late-19th century machinery intact.

In addition to these NRHP-listed mills, two other Sussex County mills have been recorded by the Historic American Engineering Record (HAER), including Houston-White Company Mill and Basket Factory (1905-1930s) in Millsboro and Wagamon Pond Dam and Bridge in Milton (ca. 1815-1915) (see discussion below).

Five other mill complexes have been recorded by HABS/HAER in New Castle and Kent Counties. These include Duck Creek Mill (unknown age) in Smyrna (Kent County), and four in New Castle County, including John England's Gristmill (1789-early 1900s); Alexander Foster Gristmill (1795-early 1900s); Greenbank Mill (1767-early 1900s); and the Alexander Wilson Agricultural Works Complex and Gristmill (1849-1983). The following section focuses on a brief review of several mill sites that have been the focus of archeological field investigations. With the exception of Greenbank, archeological studies have not been conducted at any of these sites.

Archeological Mill Studies in Delaware

The archeological remains of mills can provide important information regarding the "social and economic context of the industrial revolution, as well as the processes of production and the evolution of technology" (DeCunzo and Catts 1990:145). To understand the archeological significance of Cubbage Mill better, it is useful to describe features uncovered at similar sites in the region. In so doing, the results of the Cubbage archeological study (presented in the following chapter) can be placed within a broader context of other mill projects. In general, only a handful of mills have been subjected to detailed archeological investigations in Delaware and the surrounding region, and even fewer that have uncovered significant mill remains at these sites. As such, work at Cubbage Mill has the potential to provide important information regarding the settlement, construction, operation, and evolution of an early manufacturing site in Delaware's Lower Coastal Plain.

Wagamon Pond Dam

Wagamon Pond Dam, near Milton (Sussex County) represents one of the few examples in Delaware of an extant mill complex that has experienced some degree of archeological investigation. Wagamon Pond Dam, a mill complex used mainly from 1815 to 1915, was the subject of Phase I-II cultural resources studies by Heite Consulting (Heite and Blume 1991).

These investigations revealed the original waste gate and bridge structure, which were determined eligible for listing on the NRHP. Non-contributing portions of the mill complex included the former mill site (low integrity), remains of the former earthen dam (lacks historical significance), and the hydraulic system (no mill association). Archeological investigations were restricted to 10 machine-cut trenches which revealed the remains of a circa 1944 mill. No traces of earlier mills were identified as they were all constructed on the same site. These were likely removed during use of the area as a borrow pit. Heite and Blume (1991:33) adds, "Few remains of the 1815 mill can be expected to have survived two fires and three rebuildings at the site."

Middleford Mills Archeological District

The Middleford Mills Archeological District (Crane et al. 2002) is located along S 46 over Gravelly Fork in Middleford (Sussex County) and consists of a mill seat with multiple mill-related features. This area was known for milling and iron production during the 18th and 19th centuries. Parsons excavated a portion of the Middleford Mills complex prior to the replacement of Bridge 238 by the Delaware Department of Transportation. Beginning in the early 1800s, a gristmill and sawmill were present approximately 600 ft. northwest of the bridge. Research determined that the gristmill was built between 1805 and 1807 and operated until the late 19th century. Other mills in the area included a sawmill, a carding mill, and a planing mill built in 1864. All of these mills were situated in the same general location, approximately 600-800 ft. northwest of Bridge 238. The gristmill ceased operations in the 1890s; it was purchased and used as a machine shop in the early 1900s.

Bridge 238 carries S 46 over what is thought to be a tailrace for mill buildings located to the northwest (Crane et al. 2002:21). Archeological survey by Parsons in the late-1990s identified the remains of undefined wooden features, including pilings and posts, beneath recent floodplain deposits under Bridge 238. Data recovery studies further exposed these features, determining them to be the probable remains of low bulkheads or footers for a former bridge/dam and waste gate structure over the stream. The bulkheads appeared to have associated wooden wing walls (Crane et al. 2002:92). Circular saw cut marks on timbers, below Bridge 238, indicate that they date to the latter portion of the 19th century, likely representing a period of repair of the original waste gates for the mill complex. Vertical posts identified beneath the bridge are interpreted as supports for a superstructure for raising and lowering the waste gates, thus controlling water levels in the pond. The authors refute an alternative hypothesis that the wooden remains were the foundation for a mill's wheel box. No wheel-pit flooring was identified during excavations and no such wheel features are known to have ever been present at this location.

The extensive background research and archeological excavations at Bridge 238 indicated that the Middleford Mills Archeological Complex was eligible for listing on the National Register of Historic Places. Due to the completion of data recovery excavations, the replacement of the bridge was determined to have a no adverse effect on these resources. The study also recommends that additional archeological investigations be conducted at Bridge 237, and at the locations of the former mills (to the northwest) to provide a better understanding of the history and function of the overall mill complex.

Cantrell Warehouse and Enterprise Mill Site

Cantrell Warehouse and Enterprise Mill in Seaford (O'Connor et al. 1985) represents one of the few mills in Sussex County to be investigated archeologically. This study entailed the excavation of shovel test pits within three main areas near the warehouse and mill. Excavations failed to identify any remains of the 19th century mill. The only archeological remains uncovered were associated with the recent use of the site; as such, the site was determined ineligible for listing on the NRHP.

Rockland Mills Site

Small-scale archeological investigations were conducted at Rockland Mills (New Castle County), Pike Creek (New Castle County), and Moore's Lake (Kent County). Phase I and II studies at Rockland Mills identified the remains of several worker row houses associated with a nearby, mid-late 19th century mill complex (Hoffman and Zebooker 1995). These row houses retained low integrity due to prior demolition and were not NRHP-eligible. Unfortunately, no remains of the mill structures were identified.

Pike Creek

Also in New Castle County, excavation of six backhoe trenches for the Pike Creek project (Burrow and Liebeknecht 2000) uncovered the remains of a 19th century textile mill, the Woodward/Trump/Broadbent/Taylor Mill (7NC-D-202). Built in 1819 as a textile mill, it operated as a carpet factory by 1843. Unfortunately, only a portion of the (northern) mill wall, which was rebuilt, was situated within the project right-of-way. In addition to the wall, remains of portions of the waterpower system were identified, including an upper millrace and footers for a possibly elevated flume.

Archeological remains within the area of the mill indicate that it may not have been used after the 19th century. The remains of the mill and water control features were "too fragmentary for any substantial conclusions to be drawn about the development of waterpower technology at the site" (Burrow and Liebeknecht 2000:i) (Figure 8.3).

Figure 8.3

Mill Locations on Pike Creek: 1796-1891

Moore's Lake

Archeological studies at Moore's Lake, or Mt. Vernon Mills, in Kent County by Heite (1992) identified a National Register-eligible mill complex. This includes several structures associated with the late 18th to late 19th-century mill including the mill dam, headrace, a portion of the mill structure, mill pond, footbridge, and dwelling (Heite 1992:1, 13-16). The narrow area of potential effect from the road-widening project, however, limited the archeological studies to only three shovel test pits, failing to identify any associated archeological remains.

East Creek Sawmill

Archeological investigations have been conducted at several mill sites outside of Delaware in the greater Middle Atlantic region, including the East Creek Sawmill (Cape May County) in southern New Jersey (Morin et al. 1988) (Figure 8.4).

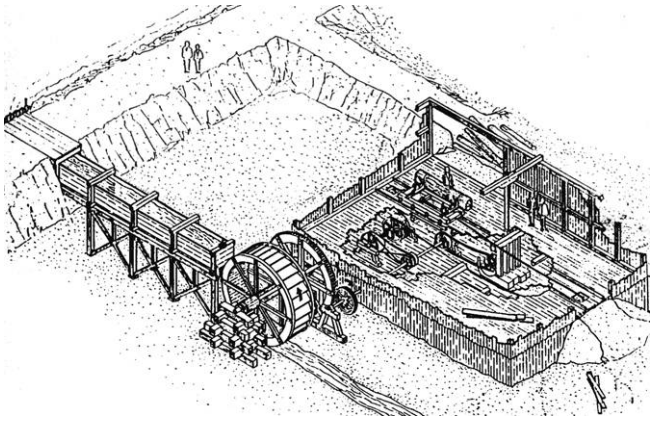

Figure 8.4

East Creek Sawmill Illustration, 1782-circa 1913 (after Morin et al. 1988)

There are several similarities between East Creek Sawmill and Cubbage Mill, including the period of use and the excellent preservation of subsurface mill features. East Creek Sawmill, consisting of a tailrace and mill/dam, operated between 1782 and 1913. Archeological excavations occurred in three stages, including the excavation of 21 test units intended to expose the wooden remains of the tailrace.

Investigations at the site identified 45 well-preserved archeological features, including a wooden tub of unknown function and numerous beams, pilings, and planks, many of which had clearly been recycled from former structures. As at Cubbage, the excellent condition of many of the wood beams and planks was due to their submerged location, within the stream channel. Excavations identified three stages of mill construction, indicating that mill owners adapted to new technologies over time. East Creek Sawmill used waterwheel technology until circa 1880, when a shift was made to a water-powered turbine and, finally, steam engine, post-1894. This is not unlike the evolution in technology that occurred at Abbott's Mill, Baltimore Mills, and Cubbage Mill during this same period.

Hopper Mill Site

In the mid-late 1980s, archeological excavations were conducted at the National Register-listed Hopper Mill Site on the Ramapo River in Bergen County, New Jersey, prior to a U.S. Army Corps of Engineers (USACOE) flood control project. Archeological fieldwork identified the locations of a gristmill, a sawmill, a wing dam, headrace, and a tailrace. The Hopper gristmill was established in 1764 and continued in use until the 1870s. Unlike other mill sites, the Hopper Mill did not employ a dammed pond as a water source, but instead controlled the flow of water from the river itself via a boulder wing dam and headrace.

Excavations included 10 small machine trenches, one of which successfully identified the remains of the waterwheel pit containing an intact mid-19th century horizontal waterwheel. This feature was carefully exposed, mapped, and subsequently reburied for preservation purposes. The horizontal waterwheel was fabricated entirely of wood and wrought iron with dimensions of 4.5 ft. (diameter) by 13 inches (height). The wheel

contained a solid circular base plate surrounded by eight wooden blades--the cast iron shaft that turned the wheel, remained intact at its center.

Other features identified during machine trenching included two foundation walls to the gristmill, the headrace, the boulder wing dam, and tailrace. No evidence of the Hopper sawmill was identified during excavations. Because impacts to other areas of the site were minimal, no additional test excavations were conducted at the site. (The waterwheel remains in situ for future study.)

Eberhart Gristmill and Timber Dam

During the mid-1990s, the USACOE (Pittsburgh District) conducted data recovery excavations at Site 36Fa428, a mill complex located in New Geneva (Fayette County), Pennsylvania (ca. 30 miles south of Pittsburgh). The mill complex contained four main areas: a timber dam, a sawmill, a bridge anchor, and the Eberhart gristmill (Workman and Davis 1995). The site is situated along Georges Creek, approximately 0.5-mile from its confluence with the Monongahela River.

Surface reconnaissance indicated that the gristmill was located along the west side of the creek, the sawmill on the east, with the timber dam directly between the two (Workman and Davis 1995: 8, Figure 4.3). The bridge anchor was immediately south of the sawmill and was likely associated with a late-18th and early-19th century pedestrian bridge spanning Georges Creek. Background research indicated that the sawmill was in operation between 1795 and the 1870s; the timber dam was likely built around 1807; and the gristmill dated between 1837 and 1920.

Hand excavations exposed a significant portion of the sawmill foundation, which measured approximately 27 by 7 ft. and built of squared timbers (Frye et al. 1995). Whereas historical research established a date of ca. 1795 for sawmill construction, dendrochronological analysis (Appendix A) of mill timbers produced dates of 1741 and 1745. Similar to the results at Cubbage Mill, this discrepancy likely relates to the recycling of timbers from an earlier mill. Excavations apparently were unsuccessful in revealing details regarding sawmill technology, as the location of the waterwheel (nor the types of saws) was not identified.

The gristmill was investigated during relocation of S.R. 3003 by Christine Davis Consultants (CDC 1993) revealing most of the mill's sandstone foundation and a waterwheel pit, as well as squared timbers and wood planks associated with the nearby timber dam. The gristmill rested upon a bedrock floor, approximately 6 ft. above the stream (Workman and Davis 1995: Appendix III, Page 2-3). The configuration of the wheelpit and the [wooden] dam indicate that an overshot waterwheel powered the mill.

Between 1845 and the 1870s, the sawmill and gristmill operated simultaneously. The wooden dam contained gates for both the sawmill and gristmill, with water diverted to the respective mills as necessary. With the introduction of steam power in the mid-late 1800s, the gristmill's wheelpit and headrace were in filled and, by the early 1900s, the gristmill ceased operation.

Background research indicated that the sawmill and timber dam were "clearly associated with Albert Gallatin" (Workman and Davis 1995:78), one of the earliest settlers of Fayette County and a major early-19th century political figure within Pennsylvania. As a result of this and the presence of well-preserved mill remains (gristmill, sawmill, dam), the site was considered eligible for listing on the National Register of Historic Places under Criteria B and D.

Angle Mill

Phase I and II archeological studies were conducted at the Angle Mill Site (44Fr140) near Rocky Mount (Franklin County) in southern Virginia (Browning 1986). The gristmill operated between 1772 and the early 1950s, focusing mainly on buckwheat and cornmeal processing. To a lesser extent, sawmilling also occurred at the site. The mill was destroyed by fire in the 1980s. The project was largely restricted to background research, documenting mill function and ownership through time. Although surface survey identified the mill foundation, waterwheel pit, possible sluiceway, and a wooden (strongback) dam, no subsurface excavations were conducted. The site was found to be ineligible for listing on the National Register of Historic Places.

Newlin/Downs Mill Site

Investigations by the Maryland Department of Transportation identified the Newlin/Downs Mill Site near Brookey (Montgomery County) in west-central Maryland (Fehr et al. 1997). This site includes the remains of a gristmill/sawmill, in operation between 1800 and 1887, a miller's house, and millrace. No excavations of the mill complex were conducted as the consultant recommended avoidance of the site.

Summary

As described above, several historical and archeological studies of mills have been conducted in the greater Middle Atlantic region. However, in most cases, these projects involve only a cursory background study of these sites, with little in the way of subsurface investigations. With the exception of the Middleford Mills Archeological District in Sussex County, none of the data recovery investigations occurred in Delaware. Moreover, other than Middleford Mills, East Creek Sawmill (New Jersey), and the Eberhart Gristmill (near Pittsburgh, Pennsylvania), none of these archeological investigations employed systematic hand excavations to identify subsurface features and deposits. And it is only the latter two projects that produced well-preserved, subsurface features that contributed to the reconstruction of the mill's history.

As with Wagamon Pond Dam (Sussex County), mills were, more often than not, converted repeatedly over time for multiple purposes, essentially disturbing if not destroying former remnants of construction. This has led to the generally poor preservation of mill features at many of these sites. As noted above, mills often became a focal point of population growth, increasing the chances of mill destruction over time.

Clearly, identification of mill remains at Cubbage Pond, in conjunction with their exceptional integrity, provides a rare opportunity to supplement our limited inventory of archeological studies of such sites in the Middle Atlantic region. This includes the collection of significant new information on the history, construction, production, and

evolution of technology at a late 18th to early to mid-20th century mill. From a management perspective, the Cubbage Mill Site has reoriented our thinking concerning the archeological potential of bridge replacement projects, and provides a baseline for this site type by which to measure the National Register significance of future mill sites throughout the state. Moreover, it highlights the importance of mill dam/bridge crossings as an important property type. It is expected that, as a result of the analysis of the Cubbage Mill Site, specific changes will be recommended to the state's existing management plan for historic archeological resources.

MillDams/Bridges as a Property Type

Roads over mill dams were common in Delaware. Heite (1991) notes the importance of mill dams as local thoroughfares:

> Combination dam-bridge structures were the rule, rather then the exception, in Delaware, because of a state law that required the county to build and maintain bridges over mill spillways crossed by public roads. It was therefore in a miller's interest to build such combination structures.

During the archeological investigations at Cubbage Mill, it became apparent that the mill dam/bridge crossings could be considered a distinct property type. As so often happens today, transportation networks are designed for the needs of area residents, and businesses, such as industries. In the past, mill dams were designed to be of sufficient construction and width to accommodate the placement of an overlying road. Having a mill dam/bridge crossing benefited the mill owners by providing easier access for local consumers and benefited local transportation because it provided a more cost effective bridge design. The Cubbage Mill Site illustrates the preservation of early industrial remains beneath these mill dam/bridge crossings. To highlight their importance to the archeological record, it is recommended that mill dam/bridge crossings be added to the property types for Delaware historic archeological sites (see DeCunzo and Catts 1990).