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Evolution of mill settlement patterns in the Antietam drainage, Washington County, Maryland

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EVOLUTION OF MILL SETTLEMENT PATTERNS IN THE ANTIETAM DRAINAGE, WASHINGTON COUNTY, MARYLAND

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TO MY PARENTS

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ABSTRACT

Waterpowered flour mills were once a common feature on the American landscape. This study examines the location of flour mills in one small area, the Antietam Creek drainage in Washington County, Maryland, to determine factors that influenced mill location and production. The factors concentrated on in this paper are economic in nature. These economic factors are studied by looking at mill production in relation to proximity to major transportation networks. Changes in the relationship between these two variables through time revealed some of the influences upon flour mill placement.

Two types of flour mills existed in the Antietam drainage. The custom mill provided flour and meal for the local community; these mills were not an integral part of a larger regional economic system. Merchant mills, on the other hand, produced flour for the market and were closely tied to larger economic systems. This study revealed that flour production at the merchant mills was tied to shifts in regional and national market centers, but that production at custom mills tended to be stable through time.

EVOLUTION OF MILL SETTLEMENT PATTERNS

IN THE ANTIETAM DRAINAGE,

WASHINGTON COUNTY, MARYLAND

CHAPTER 1
INTRODUCTION

For two and one-half centuries, waterpowered flour mills existed as a common feature on the American landscape. These mills formed an integral part of seventeenth to nineteenth-century lifeways and were found on virtually every stream within reach of settlers. Few of these tens of thousands of mills that once blanketed the countryside have survived, however. A few old mills have been converted into museums of early technology; others have survived as ruins along overgrown creek banks. The majority, however, have simply disappeared, leaving little or no traces behind.

Waterpowered mills represent the nation's largest and most familiar rural industry prior to the turn of the twentieth century. Although scant physical remains of these mills exist today, documentary evidence noting their locations and what they produced survive in most instances. Central to this thesis is the belief that cultural change will be revealed through the study of mill placement and mill production over time. For this reason, attention on the following pages focuses on economic change as reflected by changes through time in mill placement and production.

Settlement Patterns in Archeology

The study of mill placement also may be termed the study of mill settlement patterns. Patterning is a central concept in archeological theory. Lewis Binford (1972:23-24) verbalizes this idea when he argues that an object produced by a culture encompasses all of the elements of that culture—technological, social, and/or ideational—and that these elements are revealed through patterning. It follows that "past cultural systems are examined through archeological methods of pattern recognition. From delineated patterns, behavioural laws are formulated to describe the observed regularity" (South 1977:2). Stanley South (1977:2) argues that when patterns become apparent, one then must look for explanations, or theories, behind these patterns. Theories then should be tested against the archeological record "to build better theories, [which] is the major goal of archeology."

Settlement patterns are an aspect of cultural patterning that often is revealed through the archeological record. Bruce Trigger (1970:237-238) defines settlement patterns as "those classes of factors that interact with each other to produce the spatial configuration of a social group." The factors that influence settlement patterns—natural, technological, and social—generally do not carry equal weight in any given situation (Trigger 1970:255).

Archeologists value settlement patterns because they reflect the natural, technological, and social institutions that shaped these patterns (Trigger 1970:238). If studied diachronically, changes in settlement patterns exhibit changes within these institutions (Adams 1965:174; Trigger 1970:259). Mill spatial patterns therefore should reveal the factors that formed them. In addition, changes in institutions also should be reflected by changes in mill settlement patterns.

Problems exist when using archeological settlement patterns to study trends in natural, technological, and social institutions. A primary difficulty arises from differences in fieldwork intensity. All sites in a region must be recorded, or a statistically sound sampling of them completed, before spatial patterning can be studied accurately. For example, sites may show a clustered distribution in a given region simply because those areas in which the clustered sites lay have been the only ones intensively surveyed. Erosion and site destruction also distort site patterning on the landscape. Because of differences in fieldwork intensity and site destruction, "the archaeologist has to work with an imcomplete map, and he can rarely put much reliance on the picture such a map gives" (Hodder and Orton 1976:19). Gordon R. Willey (1968:216) adds:

> The total landscape distribution, or the macropattern, is the most difficult of all to comprehend. For one thing, it can be brought into focus only after considerable archaeological research has been carried out in a zone, region, or area, and after conclusions have been reached about the size and borders of the territorial unit under consideration.

Fortunately, historical archeology often can circumvent problems inherent in prehistoric settlement pattern studies. The presence of written records frequently allows the historical archeologist to fill in gaps created by differences in field survey intensity, erosion, and site destruction (Langhorne 1976:73). William T. Langhorne (1976:73) contends that the historical data bank allows for hypothesis formation that can be tested against the archeological record to a degree unknown in prehistoric archeolgy. Robert Paynter (1982:5) adds that "using an historical setting avoids some of the circularity found in methodological studies based on prehistoric data." In this study, in fact, documentary research totally replaces fieldwork as the means of locating and ranking flouring mills.

Settlement pattern studies divide into two groups. The first--identified as microsettlement pattern studies—concentrates on relationships within a site (i.e. between compounds, houses, artifacts). Macrosettlement patterns, on the other hand, emphasize a wider regional perspective by looking at relationships between sites. The latter has been viewed largely in an ecological and economic context, whereas the sociocultural context generally has been reserved for microsettlement studies (Willey 1968:215). This paper will examine economic and technological change on a macrosettlement level.

Information on site size usually is collected in settlement pattern studies. "By ranking sites according to some criterion such as size, the spatial relationship of settlements of different rank can be examined" (Hodder and Orton 1976:18). Since field survey, by which mill site size can be determined, is not conducted here, production figures taken from census schedules are used in its place. The assumption here is that mills that produced more flour and/or meal are larger in size than those that produced less flour and/or meal. The two primary variables in this study, therefore, are mill location and mill production, with a focus on the changing relationship between the two through time.

Spatial configurations may be clustered, dispersed, or random. Clustering appears primarily as a result of localization of resources or of sites generated from nearby parent sites (Hodder and Orton 1976:85; Earle 1976:197). In contrast, regular distributions generally result from competition for resources. Randomness, of course, denotes no apparent patterning. Hodder and Orton (1976:9) argue, however, that random settlement patterning does not reflect random behavior:

> We expect non-random spatial patterns because we know that individual behavior is not random but is constrained and determined by, for example, kinship factors in the exchange of goods and physical factors in the location of sites. However, it

> will be found that non-random behavior is often not apparent in the spatial patterns. Many of the observed archaeological patterns have a form which is similar to patterns produced by a random process. If the form of the pattern is similar to the end result of a random process, this does not necessarily mean that the process which produced the observed pattern was random.

Identification of structure within a settlement pattern is only the first step. Pattern recognition is simply an aid in the interpretation of the spatial process which produced that pattern (Hodder and Orton 1976:31). Discovering the settlement system, or the set of "rules" or factors that generated the pattern, is the goal. Kent Flannery (1976:162) notes that these rules cannot be empirically derived, but at least some of them can be deduced by computer simulation or statistical probability.

This paper will attempt to go beyond simple mill pattern recognition towards identifying reasons for mill placement and changes over time. This represents a tentative step towards discovery of a system behind mill settlement patterns. Although mill settlement patterns should reflect changes in the economic and technological factors that influenced mill placement, such patterns will not explain why these factors changed. Studies of mill settlement in other regions also must be accomplished before a system for mill patterning can be discerned.

Only one published work on mill settlement patterns—William T. Langhorne's (1976) paper "Mill Based Settlement Patterns in Schoharie County, New York: A Regional Study"—is known to the author. Langhorne postulates that resource exploitation is a fundamental factor in mill placement, and that different mill types will vary in their settlement patterns based on differential exploitation of resources. He uses gristmills and sawmills as examples to examine this proposition. Langhorne contends that sawmills, a material oriented industry, will be dispersed in a frontier area, whereas gristmills, as a market oriented industry, will be clustered near their markets.[1] Because of their material orientation (i.e. requirement for supply of wood close at hand), sawmills will be built away from settlements; conversely, gristmills will be found within settlements since they require nearby markets. Many problems exist with Langhorne's work, although most are not pertinent to this study. When appropriate, however, discussion of his study in relation to this work will be noted.

Although Robert Paynter (1982) does not directly examine mills in his book Models of Spatial Inequality, he does examine settlement patterns in the context of historical archeology. Paynter believes that settlement patterns result from socio-cultural stratification. Such stratification leads to core/periphery relationships among various subareas within a larger system. A core area is one where surplus is accumulated; a peripheral area is one where wealth is paid over to the core areas. "By studying the settlement pattern," Paynter contends, "one can determine if the study area was part of a large or small-scale system, and if the former, have some idea if the study area was part of a core or the periphery" (Paynter 1982:4). As change occurs in the political economy, concomitant change is expected in the settlement pattern due to alterations in long-distance relations of surplus circulation (i.e. trade) (Paynter 1982:33).

Paynter's basic research question, therefore, is to identify characteristics of an area's settlement organization that reflect the impact of long-distance processes. Paynter's approach has heavily influenced the course of this paper, for the history of milling in Washington County is one of continuous interaction with external marketing and technological forces.

The study of mill settlement patterns should be considered an aspect of the subdiscipline of industrial archeology. Up to the present, however, those labelled as "industrial archeologists" have been reluctant to examine spatial relationships among industrial sites. Perhaps because industrial archeology is a young field and a pressing need exists, its practitioners have concentrated attention on recording standing structures.[2] In fact, R.A. Buchanan (1972:20), popular spokesman for the discipline, defines industrial archeology as "a field of study concerned with investigating, surveying, recording and, in some cases, with preserving industrial monuments," with the aim of "assessing the significance of these monuments in the context of social and technological history." Therefore, in industrial archeology today, little or no emphasis is given to the search for patterning among industrial sites.

Economic geographers, on the other hand, have pioneered the study of patterning in industrial location. According to Peter Lloyd and Peter Dicken (1972:1), "economic geography is essentially a behavioral science . . . There has been a major shift of emphasis away from the particular question of how economic phenomena are located to the more general question of why such phenomena are located and arranged as they are." For answers to this question, geographers focus primarily on the effects of supply and demand upon industrial placement. Any investigation of supply and demand also necessitates a study of transportation. Transportation, in fact, is an important feature of any settlement pattern study, for changes in means of transport create major changes in patterns of human life (Morrill 1970:111). An emphasis here will be on correlating changes in patterns of mill production with changes in transportation patterns.

Economic historians also have begun studying long-distance trade relations in a manner similar to Paynter. Although economic historians do not use the terms "core" and "periphery" and do not look at relationships in terms of stratification, they are investigating city-hinterland relations. Economic historians believe that most studies of large cities have concentrated on the individual city without regard for its relationship to the surrounding countryside (Pratt 1976:35-36). The new emphasis focuses on a regional approach in which the study unit includes both cities and their rural hinterlands.

Some economic historians contend that industries producing for broader markets outside a region have greatly influenced regional development (Pratt 1976:37). Others stress the development of a division of labor between city and countryside. For example, urban areas manufacture industrial equipment utilized in rolling and slitting mills, flouring mills, and distilleries—industries located in areas away from cities because waterpower and/or supplies of raw materials are available in rural districts (Soltow 1976:57).

Economic historians, like their counterparts in geography, also are examining closely the cultural and transport networks that linked rural areas to market cities. Viewing the eastern seaboard during the eighteenth and early nineteenth centuries, Julius Rubin (1967:20) contends:

> In the economies that grew up on the coasts of the Atlantic, geographic conditions favored the development of a dense trade and communications network which produced commercial and urban characteristics in rural and urban dwellers alike . . . The migrants from these town economies found that conditions in the interior stood in the way of the dense communications networks required to maintain their particular culture, but two factors permitted a rapid modification of these conditions. The first was the commercial character of the settlers themselves; the second was the rapid secretion by the port cities of primitive transportation lines and long-range commerical networks.

The rate of growth of the seaport cities during this period was dependent "not only on the physical size, population, and fertility of their hinterlands but also on the extent to which these hinterlands were commercialized, industrialized, and linked to the ports" (Rubin 1967:8).

Examination of settlement patterns has become an integral component of archeology. Settlement patterning potentially offers insights into decision-making processes of people of the past. Such studies particularly are promising within the field of historical archeology, for documentary evidence provides additional data that can yield a more accurate and complete assessment of site patterning. Practitioners in other fields, as discussed above, indirectly have furnished concepts about historical settlement patterns that may be tested within an archeological framework.

Conceptual Framework

Incorporating the ideas of Paynter and the economic historians and geographers discussed above, it is the contention that mill settlement patterns in an area are affected by decisions made outside that area. As a rural-based industry, flour milling takes on peripheral characteristics and is directed by marketing forces in more core-like commercial cities. Through time, changes in mill settlement patterns should indicate the growing dominance of regional marketing systems in rural Washington County. As a corollary, one could predict that as mills increasingly become integrated into a regional and then national economy, mills will cluster around the predominant transportation network of the era.

Several types of data were gathered to test the thesis that mill settlement patterns were heavily influenced by external forces. Initially, the location of all flour mills within the Antietam drainage was plotted. Second, production figures for these mills were recorded. This procedure allowed ranking by mill size. Third, the distance from each mill to predominant transportation forms was measured.

In addition to external marketing forces, mill settlement patterns also are influenced by natural constraints and by milling technology.[3] Louis Hunter (1979:114-115), an authority on waterpowered industries in the United States, asserts:

> The physical limitations of topography, geology, and meteorology restricted waterpower to use at sites adjacent to falls and rapids; it was transportable by mechanical means only for quite short distances. Within the potential of a given stream site the power capacity was fixed in amount; unlike steam power, it could not be increased by adding more engines and boilers and firing more fuel . . . The burden of these geographic limitations . . . was approximately in inverse ratio to the level of economic and industrial development.

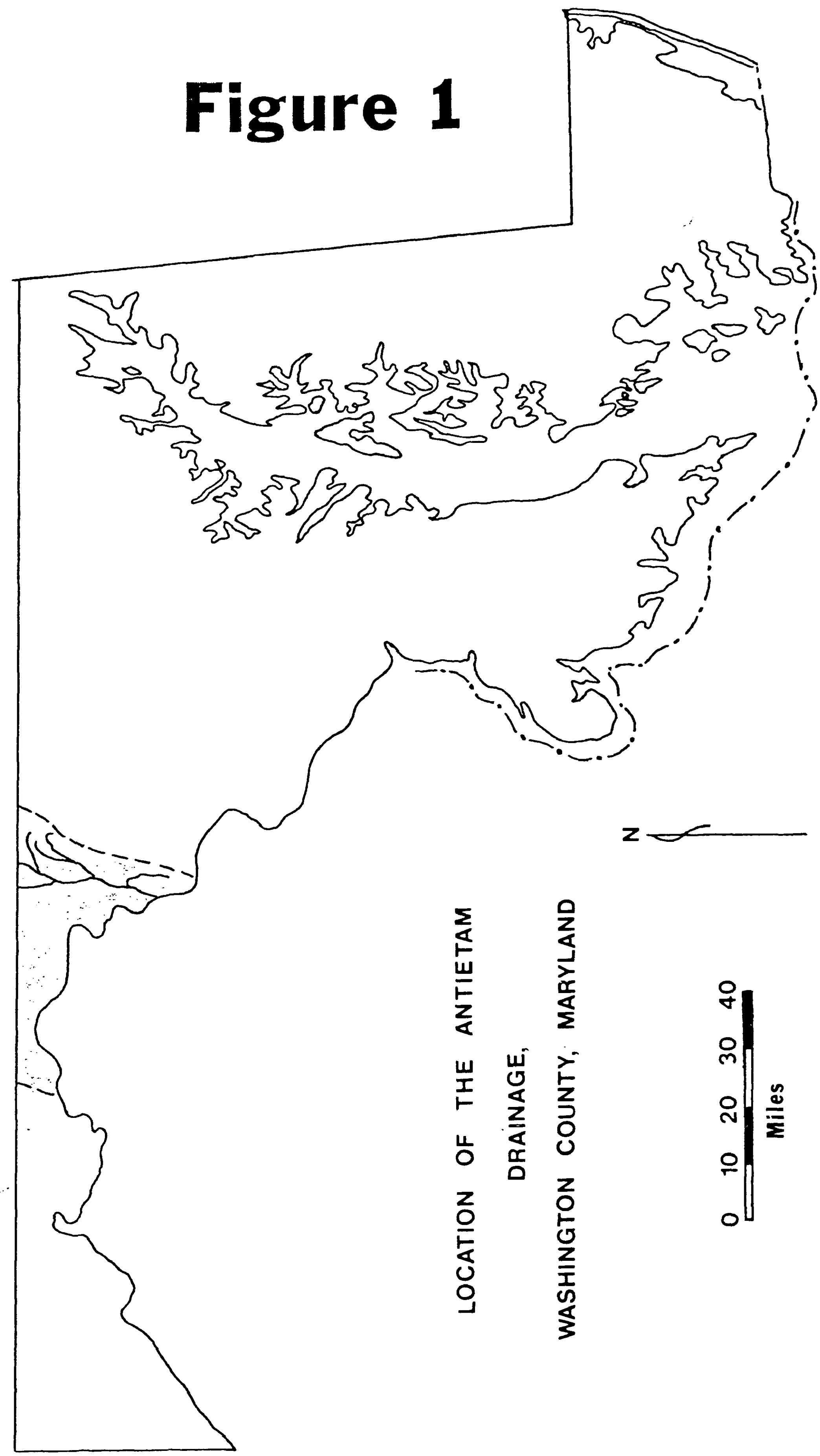
Technological innovations circumvented these limitations to a degree, for advancements in milling technology allowed increasingly effective use of stream flow. The larger revolution within industry, however, negated the effectiveness of innovations in waterpower by the second half of the nineteenth century.

The basic pattern of a drainage system is similar to a tree, with trunk, limbs, and branches. The larger the stream, the greater the amount of capital and technological skill necessary to harness it. The first mills in an area most likely concentrated on the smaller "branch" streams, with later mills constructed on the larger "limb" and "trunk" streams as capital and technology permitted. This notion will be tested in the Antietam drainage through plotting changes over time in mill placement in relation to stream size.

Investigating changes in mill settlement patterns by studying economic and technological aspects is justified on several grounds. First, the flour milling industry and its patterning on the landscape is greatly influenced by economic and technological factors. Second, most extant documentary data on the flour mills of the area under study are economic and technological in nature. Third, economic factors may have had the most influence on culture change in American society (Kasson:1976). This will not, however, be an economic study per se, but an examination of archeologically defined settlement patterns emphasizing the economic and technological factors behind these patterns. This paper does not intend to convey the idea that economics and technology are the <u>only</u> explanations of mill settlement patterns, but these will be the primary factors addressed here.

In sum, two aspects of mill settlement patterns will be investigated. The first covers the influence of external marketing forces--or economic behavior—upon the development of mill placement. The influence of external marketing will be examined through correlating changes in mill placement and/or production with the evolution of transport networks. The second area of inquiry concentrates on the importance of natural and technological forces in defining mill settlement. Placement of mills relative to each other and in relation to their physical surroundings will be reviewed for insights into natural and technological influences on changes in mill patterning.

Figure 1



LOCATION OF THE ANTIETAM
DRAINAGE,
WASHINGTON COUNTY, MARYLAND

Definition of the Study Area

The Antietam Creek drainage basin lies within Franklin County, Pennsylvania, and Washington County, Maryland. Headwaters of the creek arise in Pennsylvania, but the majority of the stream flows through the eastern half of the Great (also known as the Hagerstown or Antietam) Valley of Maryland (Figure 1). The Antietam shares this valley with one other major watercourse—the Conococheague—which lies in the western half of the valley.

Antietam Creek forms a part of the Potomac River drainage, which covers roughly 14,500 square miles (Tenth Census 1885:39). The Antietam drains approximately 343 square miles, at least two-thirds of this in Washington County. This compares with the drainages of other streams in the area: Monocacy River—1,010 sq. mi., Conococheague Creek—493 sq. m., Licking Creek—185 sq. mi., and Sideling Creek—121 sq. mi. (Tenth Census:1885).

Four major tributaries empty into the Antietam. Of these, three rise on the east side of the stream within South Mountain. From south to north these three are Little Antietam Creek, Beaver Creek, and Forbush's Branch (Figure 2). On present-day topographic maps, Forbush's Branch also is labelled Little Antietam; to prevent confusion the historical name is used here. Beaver Creek, the largest of the tributaries, has a large branch of its own—Little Beaver Creek. One major stream, Marsh Run, rises on the west side of Antietam Creek.

The Tenth Census (1885:50) describes Antietam Creek as draining "a rolling and fertile country," but possessing a uniform slope uninterrupted by falls and rapids. In addition,

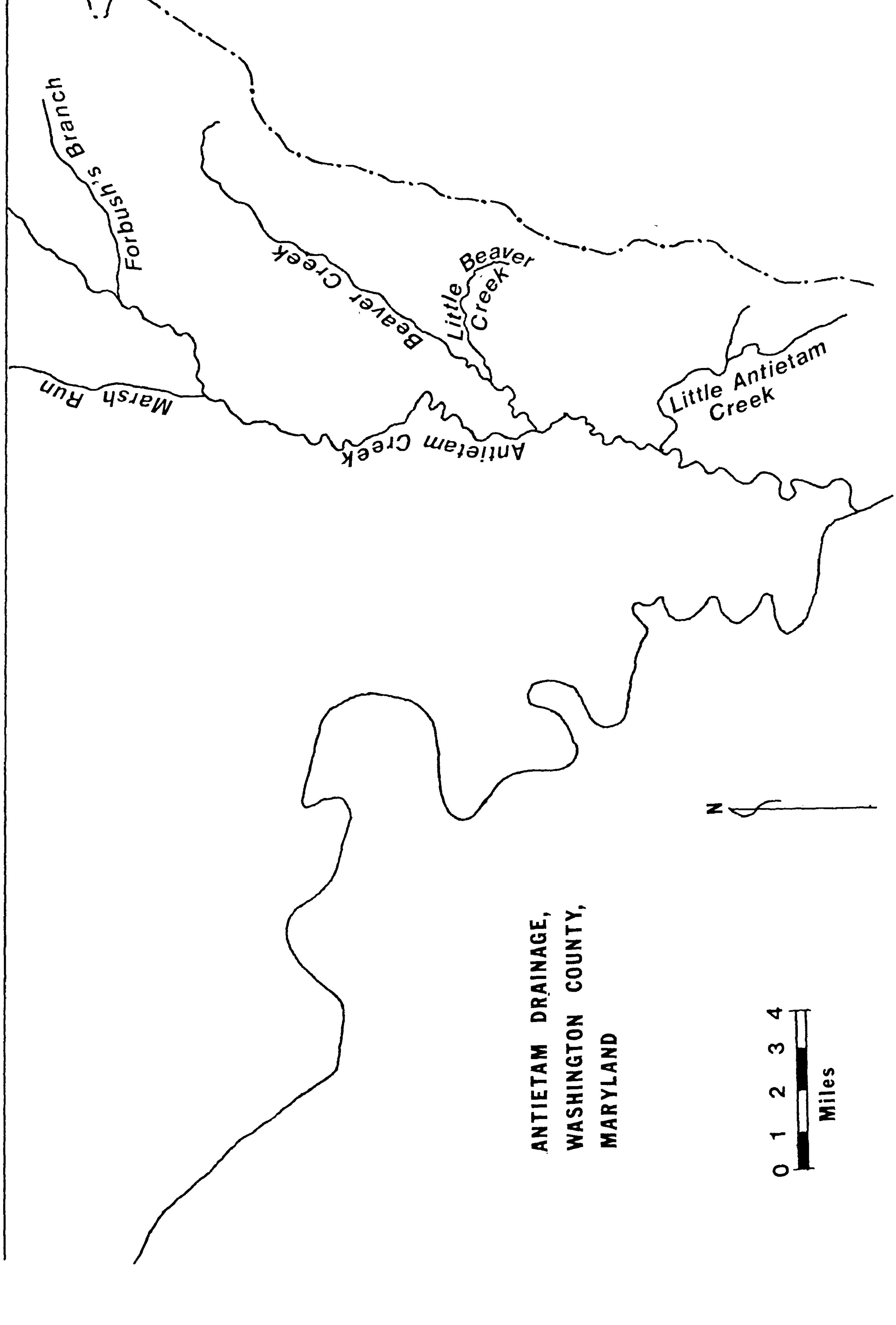
> [Antietam Creek] is utilized to a considerable extent, together with its tributaries, to run principally grist-, flour-, and paper mills,

> and there are said to be no sites of importance unimproved, though some of the improved powers are at present idle. The flow of the stream is very variable, the freshets sudden and quite violent, and the powers small as a rule.

Thomas J. Scharf (1882:35-36) disagrees with this assessment, believing that the Antietam is not subject to fluctuations, but instead "furnishes a very large amount of never-failing water-power." Whoever is correct, it is apparent that throughout the history of the Antietam Valley, the Antietam and its tributaries have supported numerous milling establishments of all types.

For the purposes of this paper, only those sections of Antietam Creek and its tributaries that flow within the boundaries of Washington County are included in the study area. Several reasons exist for using the Antietam drainage as the focus for this study and for including only those areas that lie within Washington County. First, most of the drainage area lies in one county—Washington County. This facilitates documentary research and allows for a more complete picture than the study of a stream system scattered over several counties. Second, the necessary records are complete in Washington County. Third, the Antietam Valley is an agricultural area where milling has been pre-eminent until the recent past. Fourth, the Antietam Valley, although a rural area, is situated close to large market centers and their effect on the flour milling industry in this area can be readily assessed. Fifth, the use of a closed drainage area presents a wide variety of stream types and terrain that can be used as variables. Finally, the author has a personal interest in and some background in the general history of Washington County.

Figure 2



Forbush's Branch
Beaver Creek
Little Beaver Creek
Marsh Run
Antietam Creek
Little Antietam Creek
N
ANTIETAM DRAINAGE,
WASHINGTON COUNTY,
MARYLAND
0 1 2 3 4
Miles

Primary Documents

Primary documents furnished the majority of the data used in this project. These documents included land, will, and chancery court records at Frederick County and Washington County courthouses, a wide array of maps, and contemporary newspapers.

As the first step in locating flour mills and defining a rough time span for their operation, the excellent maps produced of Washington County at various points in its history (1794, 1808, 1859, and 1877) were consulted. It is believed, based on other research described below, that these maps probably document most, if not all, flour mills operating in the Antietam Valley after the Revolutionary War.

Land ownership was traced next for each of the mills displayed on the maps. As census schedules were recorded by mill operators, owners' names were needed to enable the matching of census data with particular mills. Also, the land records in many cases provided additional information on the mills, such as dates of operation and additional waterpowered industries associated with the property. Wills and chancery court records especially were useful in this respect.

In some cases problems were encountered tracing mill ownership. The farther back a title search was followed, the more confusing it became, especially for records prior to 1800. Additional hurdles were encountered when chains of ownership occasionally were disrupted by law suits or by unrecorded deeds. At times a title may have been divided into several different shares, all following individual chains of ownership. The problems outlined above were resolved through time-consuming and painstaking "detective work"; thus, these problems rarely obstructed clarifying mill owners and listing census data for the mills.

Once the land records search had been completed, Washington County schedules for the manufacturing censuses of 1820, 1850, and 1880 were investigated.[4] Although other manufacturing censuses were enumerated, these dates best suited the overall research strategy. These censuses contained the most complete data for their respective eras and also were spread evenly over time allowing greater identification of trends.

Using the census schedules proved more complicated than first believed. For example, apparently not all manufacturing establishments were enumerated, especially in the 1820 and 1850 listings. By 1880, however, the schedules were much more complete. In addition, the questionaires sent out with the enumerators differed from census to census. Even within the same census, data were recorded differently by individual enumerators. As a result, comparisons of the census returns, both within the same census and between different censuses, was difficult. Grain consumption per year per mill was the only constant that tied the censuses together; therefore, out of necessity, grain consumption was chosen as the comparative base for a large part of this research.

The greatest problem, and the most difficult to resolve, was the fact that the proprietor listed on a schedule was not necessarily the owner of the mill being enumerated. This complicated matching census data with a mill as deeds rarely referred to mill leases or hired millers. As a result, for the 1820 and 1850 censuses, there were several census schedules from the study area that could not be paired with specific mills and thus could not be included in the analysis. It is not known what effect this may have on the statistical results (problems with the individual censuses are discussed in succeeding chapters).

Secondary Sources

Several excellent books document the history of milling and milling technology. The best overview is provided by Louis C. Hunter (1979). Hunter furnishes an outstanding account of developments in waterpower useage from the colonial era to the turn of the present century. He concentrates on the evolution of waterpowered mills from small, isolated rural establishments to huge milling factories employing hundreds of workers. Of special importance is Hunter's use of census data, from which the author acquired the idea of examining manufacturing schedules for a small, defined area. Additionally, Hunter's contention that milling changed partly as a result of increasing market integration and his documentation of developments in milling technology greatly aided this research.

Additional works on watermilling include John Reynolds (1970) and Charles Howell and Allan Keller (1977). Both concentrate on mill technology of the colonial era and provide basic introductions to mill operations. Several books describe milling history and technology of the latter half of the nineteenth century. These include Charles B. Kuhlmann (1973), Herman Steen (1963), and John Storck and Walter Dorwin Teague (1952).

No recent work has been published on the history of Washington County. In fact, two of the three major sources, Herbert C. Bell (1898) and J. Thomas Scharf (1882), were written during the latter decades of the nineteenth century.

The third, Thomas J. C. Williams (1906), was published the first decade of the twentieth century. Bell, who unfortunately covered only a small part of the county, appeared the most accurate of the three. Both Scharf and Williams should be read with caution and viewed as a starting point, rather than as final sources of information. For lack of other sources, however, Scharf and Williams have been used extensively in some places, particularly in the chapters tracing the development of flour milling in Washington County.

Introduction to the Text

Chapter Two provides a brief summary of milling history within the United States as culled from secondary sources. These pages will emphasize economic and technological influences on milling history. Chapters Three and Four document the development of the flour milling industry in the Antietam drainage of Washington County, Maryland. These chapters also place the history of milling in the county within an economic and technological framework.

Chapters Two through Four provide the background for Chapter Five, a description and interpretation of statistical analyses that use mill location, mill production, and transportation networks as variables. Finally, conclusions and further hypotheses about the role of external marketing forces and natural constraints on the development of flour milling within Washington County will complete this paper.

CHAPTER 2
A SHORT HISTORY OF MILLING

Milling has always been an essential component of grain cultivation. The first farmers pounded their grain between two stones. The saddle quern eventually replaced this crude process and thus supplied the first true grinding method—the movement of a stone backwards and forwards across a saddle-shaped stone base. From this procedure evolved the rotary quern, a circular top stone mounted on a central pivot which revolved on a stationary base stone. The rotary quern represents the forerunner of the rotating millstone of traditional gristmills (Reynolds 1970:10-11).

Watermilling was first recorded circa 85 B.C. The initial mills were simple "Norse" or tub mills. In the tub mill, the top grindstone was attached to a vertical shaft which passed through an opening in the center of the stationary stone. Wooden blades were secured to the base of the shaft and furnished a crude horizontal wheel. Tub mills required no gearing as the force of the water against the blades turned the spindle and thus turned the upper wheel (Reynolds 1970:12; Howell and Keller 1977:22).

The Roman architect Vitruvius recorded a second type of mill circa 15 B.C. He depicted a simple vertical water wheel attached by one-step gearing to the horizontal grindstones (Reynolds 1970:11; Howell and Keller 1977:30). Technologically, the introduction of gearing marked a great advance over the tub wheel as it increased power through the transmission of energy from one plane to another (Reynolds 1970:11). From this simple beginning arose the later advancements of the integrated factory system which heralded the Industrial Revolution.

Milling in America to 1750

Little development in milling technology occured from the time of Vitruvius to the arrival of the first settlers in North America (Howell and Keller 1977:30). When these initial settlers debarked, they found an abundance of small streams ideal for the traditional vertical mills and tub mills used to grind the wheat, rye, and oats they had brought with them from Europe.

> Inescapably, the technology of colonial America in this as in most other respects was simply an extension of the technology prevalent in the Old World, reflecting in its details usages characteristic of the countries of emigrant origin . . . In their cultural baggage [the settlers] brought a fund of knowledge, skills, and experience related to Old World water-milling design, construction, and use (Hunter 1979:52).

The first mills were constructed within a few years of settlement. A waterpowered mill erected at Jamestown in 1621 may have been the first in North America. In 1631 a mill was built in Massachusetts, and in 1634 the first mill was established in Maryland at St. Mary's City (Steen 1963:27).

Each westward advancement of the frontier witnessed adapatation to varying stages of milling technology. These adaptations were made necessary by the immediate needs of the settlers and the resources available to them:

> Because the process of colonization is repetitive in nature, it is also evolutionary in the sense that the sequential pattern of change that once occurred in the center of a newly settled frontier region tends to be repeated along its periphery as settlement within the region expands (Lewis 1977:150).

Initially, the frontiersmen depended on crude, time-consuming, hand-operated devices such as the quern to grind the small amounts of grain raised for personal consumption. The inadequacy of such a method is revealed in numerous accounts of settlers traveling great distances—up to fifty miles—along primitive trails to have their grain watermill ground. Indeed, construction of gristmills in many regions took precedence over erection of schools and churches, a testimony to the relative importance of food for the body over food for the mind and soul (Hunter 1979:3).

The first mills established in a community, like the first houses, were generally primitive and small. These mills usually were located on small streams, "often a branch," where a rough pile of stones and timber filled in with brush and stone served as the dam to divert the water. Ditches sufficed as raceways to carry water to the wheel (Storck and Teague 1952:148; V. Clark 1949:175).

The earliest mills may have been tub mills, for their uncomplicated design allowed quick and inexpensive construction (Hunter 1979:73; Howell and Keller 1977:24; Reynolds 1970:64). On the other hand, the motive power may have been supplied by vertical undershot wheels which required only a small head of water and could operate without a dam and raceway through the force of the current alone (Weiss and Sim 1956:27).[1] These simple mills were slow in operation, low in output, and ran intermittently as circumstances required or as streamflow allowed (Hunter 1979:10). Sometimes they served individual families or were jointly owned by several (Hunter 1979:110).

John Muir's (Hunter 1979:549) description of southern Appalachian mills, although written in 1916, conveys an impression of what mills were like in early settlements:

> Grist mills, in the less settled parts of Tennessee and North Carolina, are remarkably simple affairs. A small stone, that a man might carry under his arm, is fastened to a vertical shaft of a little home-made, boyish-looking, back-action water-wheel, which, with a hopper and box to receive the meal, is the whole affair. The walls of the mill are of undressed poles cut from seedling trees and there is no floor, as lumber is dear. No dam is built. The water is conveyed along some hillside until sufficient fall is obtained, a thing easily done in the mountains.

Writing during the same time period, Horace Kephart (1976:132-133) adds:

> When you travel in our southern mountains, one of the first things that will strike you is that about every fourth or fifth farmer has a tiny tub-mill of his own. Tiny is indeed the word, for there are few of these mills that can grind more than a bushel or two of corn in a day; some have a capacity of only half a bushel in ten hours of steady grinding . . . The appurtenances of such a mill, even to the very buhr-stones themselves, are fashioned on the spot . . . A few nails, and a country-made iron rynd and spindle, were the only things in it that he had not made himself, from the raw materials.[2]

As communities became increasingly settled and advanced beyond subsistence level, mills evolved into more substantial and permanent structures operated by a professional miller. These mills remained relatively small and continued to satisfy the needs of the local community for flour and meal. Known as 'custom mills,' they averaged small outputs of three to four bushels an hour and ground the product to customer specification. The miller kept a percentage of the ground meal for himself as a toll or fee. This toll ranged from one-twelfth to one-fourth of the ground meal and was set by ordinance or custom (Hunter 1979:4).

Custom mills, like the earliest mills, usually were built on small streams where the capital required to construct the associated dams and millraces did not exceed the means of the miller (Storck and Teague 1952:48; V. Clark 1949:175). Generally, the mill foundation and the wheel pit were constructed of stone; the mill and its machinery were fashioned almost entirely of wood until the end of the eighteenth century. According to Hunter (1979:105-106), these mills continued to be driven by impact wheels of the tub and undershot types throughout the colonial period. Hunter admits, however, that information on mill construction during this era is scanty at best.

Often paired with custom mills was another waterpowered enterprise—sawmilling. Combination grist- and sawmills were common in many if not most areas of colonial America (Hunter 1979:5). In fact, sawmills usually entered a newly settled territory earlier than gristmills and tended to be more numerous throughout the colonial period (Hunter 1979:21). Other industries also became associated with grain milling in the late eighteenth century (see below).

Custom milling prevailed as long as communities remained isolated and transportation systems primitive. Flour mills continued as small and dispersed industries on the many small water powers that blanketed the east coast, serving farmers within their limited range. Gristmilling, therefore, made little progress toward commercialization before the middle of the eighteenth century (Hunter 1979:42).

About mid-century, however, and perhaps even earlier in more densely settled areas of the colonies, millers began to experience increased demand due to population growth and expanding markets. It is likely that more mills were built to meet this demand, but also that existing mills expanded to satisfy new needs. Increased production resulted as larger and more powerful water wheels (such as the overshot wheel) were installed and as gearing systems were adopted that permitted the operation of more than one pair of stones by a single water wheel (Howell and Keller 1977:59-60). In addition:

> Sooner or later the point was reached where, transport conditions permitting, market outlets were sought for the mounting surplus of

a growing community. It was a short and natural step for the millowner to supplement custom operations by the purchase of raw materials to process and market on his own account (Hunter 1979:41).

Development of Merchant Milling

In the mid-1700s, flour exports from ports along the eastern seaboard burgeoned. Originating in New York City at the end of the seventeenth century, this flour trade made New York City the world's largest wheat market and milling center during the first decades of the eighteenth century. From about 1750 on, however, the region around the Chesapeake Bay and the Delaware River eclipsed New York. Philadelphia initially provided the chief market outlet, with Baltimore, Wilmington, and Richmond close behind (Storck and Teague 1952:149-151). The leading flour marketing centers remained in the central colonies throughout the remainder of the eighteenth and into the nineteenth centuries, as Pennsylvania, Maryland, and Virginia became the foremost grain producers during this period.

Flour was exported to three principal markets. The West Indies, particularly Barbados, received the largest share of the export market. Large quantities were shipped to colonies outside the wheat belt—New England, the Carolinas, and Georgia (Kuhlmann 1973:34). Markets also extended as far as Portugal and the Madeira Islands (Steen 1963:29-30). The export trade was largely in the hands of merchant middlemen who received the flour on consignment from mills within the city and from mills in outlying regions (Kuhlmann 1973:34).

The rapid expansion of the flour trade caused and was supported by an increase in the number and capacity of large flour mills during the latter half of the eighteenth century (Hunter 1979:110-111). Known as 'merchant mills,' these establishments catered almost exclusively to market production. Rather than grinding for a set toll, the miller purchased grain from farmers in the surrounding district and in turn sold the flour to merchant middlemen in the port cities.

The location of merchant mills reflected their close relationship with the export market. Because few roads existed, water transport to exporting centers was a necessity. Therefore, at locations where a conjunction of wheat supplies, waterpower, and ready access by water to markets existed, milling concentrations emerged (Kuhlmann 1973:31). Such concentrations were most numerous on the larger streams with outlets on the tidewater between Philadelphia and Richmond (Hunter 1979:110-111).

Merchant mills did provide some custom work, often setting aside special stones for this purpose. No doubt in many instances this was done under compulsion, for most colonies had statutes forcing merchant mills in areas of heavy commercial milling to set aside certain stones and days for custom work (Steen 1963:30; V. Clark 1949:64; Kuhlmann 1973:35). Outside areas of commercial influence, however, mills continued trade on a custom basis, perhaps buying some wheat on the side to produce flour for the market.

Although merchant mills essentially used the same machinery as custom mills, commercialized milling was accompanied by an increasing scale of operation. Generally, this consisted of expanding the number of sets of grinding stones and adding bolting equipment to refine the flour into various grades. These additions necessitated an increased power supply, gained through selecting mill seats with greater power capacity and/or adopting more powerful water wheels (Hunter 1979:110). Adding additional water wheels to an establishment to drive more stones was not uncommon. Before the American Revolution, a mill that ground 100 bushels a day was considered a fair sized operation (V. Clark 1949:179).

Little similarity existed between custom mills and merchant mills outside the machinery and the supporting facilities of dams and raceways they both utilized. The former served a noncommercial, agricultural economy and was identified closely with household manufactures. Custom mills also located within the community they served. Merchant mills, on the other hand, more closely aligned with other rural-sited but market oriented industries such as iron-works (Hunter 1979:37). Due to the need to be near wheat growing centers and waterpower, merchant mills generally were located outside the market city.

In sum, the custom mill and the merchant mill represented different points along an industrial continuum: the former served an agricultural and essentially subsistence-oriented community; the other served an emerging industrial and market-oriented economy. As will be shown, both continued in existence almost side by side until the beginning of the twentieth century.

Oliver Evans' Contributions to Milling Development

With the exception of the actual grinding process, most work in any mill, whether custom or merchant, was accomplished through heavy physical labor before the Revolutionary War and in the years immediately succeeding it. Oliver Evans, who revolutionized milling technology in the 1780s, described the milling methods of the time in a rather biased but thorough manner:

> If the grain be brought to the Mill by land carriage, the Miller took it on his back, a sack generally 3 bus., carried it up one story by stair steps, emptied it in a tub holding 4 bus., this tub was hoisted by a jack moved by the power of the Mill which required one man below and another above to attend to it, when up the tub was moved by hand to the granary, and emptied. All this required strong men. From the granary it was moved by hand to the hopper of the rolling screen, from the rolling screen by hand to the Millstone hopper, and as ground it fell in a large trough, retaining its moisture, from thence it was with shovels put into the hoist tubs which employed 2 men to attend, one below, the other above, and it was emptied in large heaps on the meal loft, and spread by shovels, and raked with rakes, to dry and cool it, but this necessary operation could not be done effectually, by all this heavy labour. It was then heaped up over the bolting hopper, which required constant attendance, day and night, and which would be frequently overfed, and cause the flour to pass off with the bran, at other times let run empty, when the specks of fine bran passed through the cloth, which with the great quantity of dirt constantly mixing with the meal from the dirty feet of every one who trampled in it, trailing it over the whole Mill and wasting much, caused great part to be condemned, for people did not even then like to eat dirt, if they could see it (Bathe and Bathe 1972:12).

Astounded by this tremendous amount of physical labor and the magnitude of waste, Evans in 1784-85 constructed a waterpowered automatic system of milling. Evans' system reduced the amount of manual labor by over half and improved the amount and quality of the flour produced (Steen 1963:33; Weiss 1956:80-81).

In Evans' procedure the grain and its flour were not touched by human hand once it entered the mill:

> Beginning with its removal from vessel or wagon, the grain underwent a series of treatments, starting with the action of the rubbing stones, which removed dirt, and passing to a rolling screen, which eliminated loose dirt, other foreign matter, and broken and immature grain. The grain then passed to the millstones, which reduced it to meal. The meal was elevated to an upper floor, where it underwent a spreading, cooling, and gathering process by means of a revolving rake known as the 'hopper boy.' Finally it passed through the bolting reels, which

> separated the fine flour from the bran and middlings, and in large commercial operations was packed, with power assistance, in barrels for shipping. In the course of this series of operations the grain, meal, or flour was conveyed from floor to floor and from place to place automatically by several types of devices, termed by Evans the elevator, the conveyer, the drill, and the descender (Hunter 1979:421-422).[3]

Comparison of these two quotes reveals the sustantial amount of manual labor Evans eliminated with his procedures.

Evans offered to install his improvements free to the first miller in each county who accepted them. Initially, millers were slow to step forward as Evans' ideas were unfamiliar and difficult to grasp. Storck and Teague (1952:169) claimed that after this initial period of reluctance, however, Evans' devices were introduced rapidly, even into small mills, everywhere in the United States. Hunter (1979:100), in writing of Evans' inventions, disagreed:

> The small output and frequently intermittent operation of most one-run gristmills producing meal for a community on a custom-toll basis offered no market for the elaborate and costly milling equipment so zealously promoted by Evans.

As scant research has been conducted on the adoption of Evans' inventions, an answer is not forthcoming at this point to either assertion.

Evans' inventions had a tremendous impact on the development of the flour milling industry. The trend towards merchant milling on a large scale, already strong, gained additional momentum with Evans' mechanisms. In the early years of the Republic, flour milling became the leading industry in scale of operation and degree of mechanization (Hunter 1979:102).

Although probable that Oliver Evans' improvements increased the disperity in size and production between merchant mills and custom mills, his system did not signal the demise of the neighborhood custom mill. On the contrary, the majority of flour mills continued operating on a custom basis into the 1850s, to a lesser or greater extent purchasing and grinding small amounts of grain to sell in the market as a sideline (Hunter 1979:1; Steen 1963:14). Custom mills continued to be necessary due to the lack of good overland transportation networks in most rural areas well into the nineteenth century. Capacities for most custom mills in the early nineteenth century ranged between 20 and 100 cwt.; few merchant mills exceeded 200 cwt.[4]

Industries Associated with Flour Milling

The difficulties and expense of transport in the pre-railway years promoted small, dispersed waterpowered industries that operated alongside the rural-based flour mills. Circa 1800, flour and grist mills together comprised about one-third of the total number of waterpowered mills in the nation. Sawmills, in fact, outnumbered grain mills by a substantial margin. Other manufactures included fulling, carding, paper, linseed oil, gunpowder, cotton, wool, and bark mills, plus iron-works (Hunter 1979:101). These industries served small and highly localized markets and, like most flour mills, were located on secondary streams (Hunter 1979:540).

Commonly paired with flour mills were three of these industries--the sawmill, fulling mill, and carding mill. "A sawmill and a gristmill under the same roof was so common as almost to be expected, in some parts of the country, wherever there was a dam" (V. Clark 1949:181). Much less widespread than sawmills, but for home manufactures hardly less necessary, were fulling mills:

> Fulling was the traditional finishing process in making woolen cloth. In a prolonged operation combining pounding with washing, fulling freed the rough-woven cloth from the natural grease in the fibers and the oil used in carding and spinning wool. The pounding

> action of heavy wooden stocks or beaters in soapy water had the even more important effect of compacting the cloth, increasing its strength and durability, a process accompanied by a reduction in dimensions (Hunter 1979:21-22).

The carding machine was introduced into this country during the 1790s. It was often an adjunct to a gristmill, a fulling mill, or both (Hunter 1979:25).

Other small waterpowered establishments occasionally were associated with flour mills. These industries—paper, powder, oil, plaster, and small textile—generally operated on a market rather than community or custom-toll basis. The majority of these industries developed during the latter two decades of the eighteenth century after the Revolutionary War ended British restrictions on manufactures (Hunter 1979:49).

Transportation Improvements and the Flour Milling Industry

As previously emphasized, transportation was primitive during the first quarter century of independence outside the coastline and navigable rivers. Waterway improvements were confined to short lock-canals around falls and rapids in otherwise navigable rivers. Settlers' migratory trails such as the Great Wagon Road from Pennsylvania to the Carolinas provided the only major overland routes (V. Clark 1949:335).

Beginning at the turn of the century, turnpike construction was inaugurated. These and other roads promoted intraregional development (Ehrlich 1976:80). Canals constructed in the 1810s and 1820s further stimulated growth and initiated a transformation of inland transport. Canals reduced cost, shortened the time of carrying bulky freight, connected formerly isolated transportation systems, and opened areas previously inaccessible to settlement

(V. Clark 1949:335).

The turnpike and canal transportation revolution of the early nineteenth century concentrated the merchant milling industry in specific regions and cities. One of the cities favored by transportation improvements was Baltimore. By 1805, it surpassed Philadelphia to become the foremost milling center in the country (Steen 1963:32).

Baltimore's pre-eminence was due to several factors. First, improvements in transportation provided larger wheat supplies to its mills than to rural milling centers. Baltimore's wheat came from Maryland, Pennsylvania, the Virginia Piedmont and Valley, and from the Eastern Shore of Maryland. Wheat had expanded as a staple crop to the former area during the last quarter of the eighteenth century and at the same time had replaced tobacco in the latter. The spread of wheat production to these regions encouraged the construction of a network of merchant mills ringing Baltimore that furnished much of the flour marketed by this city (Kuhlmann 1973:39).

Second, Baltimore mills had adopted Oliver Evans' automatic milling improvements in advance of other milling districts, thus providing the city with a decided advantage in production capabilities for the remainder of the eighteenth century. Third, Baltimore's merchant millers had developed a considerable export trade to Brazil, the West Indies, and Great Britain. Added to this was an extensive domestic market centered in the South Atlantic and Gulf States (Steen 1963:33; Kuhlmann 1973:41-42). As a result of these factors, Baltimore's position as the foremost milling center in the country was not supplanted until the development of extensive railway networks in the mid-1800s.

The railroad influenced the course of the flour milling industry in the nineteenth century more than any other transportation advancement:

> Perhaps of most importance in increasing millsize was the dramatic growth of the railroads . . . In the case of milling, a concern that had been limited to its own community suddenly found itself able to reach markets that had previously been as unavailable as if they had been in the middle of Asia (Steen 1963:38).

Railroad transportation promoted increasingly larger economies of scale in milling and thus contributed to the further growth of merchant milling. The railroads also brought isolated communites--strongholds of custom milling--within reach of larger markets, aiding in the eventual demise of the custom mill.

The flour and grain trade influenced the placement of the early railway routes. The first line, completed in 1828, extended from Baltimore to Ellicott Mills--a large merchant milling center located a short distance outside the city. The second railroad built in America (1831) paralleled the Erie Canal and subsequently expanded to tap the grain and flour markets of Buffalo and New York. As a result of the railroad, New York City by the 1850s again had become the leading flour market in the United States, if not in the world (Storck and Teague 1952:184).

Midway through the nineteenth century the typical flour mill continued to be the community-oriented custom mill or combined custom/merchant mill. The accelerating advance of industrialization from the 1840s and the progressive, though gradual, penetration of rural life by the market economy had caused the small community-oriented mills to steadily decline, however, in usefulness and importance (Hunter 1979:47; Steen 1963:58). Despite this decline, the following observation is high-flown nonsense:

> As the midpoint of the century passed, time seemed to be whizzing by with uncomfortable velocity . . . The world of wood and water

> power was vanishing . . . The moss-covered wheel of the old gristmill was silent, its millpond filled with silt, the limestone banks of the millrace crumbling . . . (Gutheim 1949:235-236)

Country-based mills did decline in relative importance, but their absolute numbers decreased slowly. According to Hunter (1979:47), the number of gristmills and sawmills diminished by about ten percent (from approximately 55,000 to 50,000) between 1840 and 1880. Thousands of community mills continued to function, though hardly to flourish, well into the first decades of the twentieth century (Hunter 1979:1).

Technological Developments in Milling

The shift from subsistence-based custom milling to commercial milling in a market economy placed increasing demands on the power supply of water wheels and supporting facilities (Hunter 1979:293). Growing power requirements necessitated more effective use of available water supply and the development of greater wheel efficiency. The turbine wheel provided the solution to this difficulty. Superficially, the turbine resembled the tub wheel in design, as it too was a horizontal wheel:

> The [Fourneyron] turbine was a relatively simple mechanism with three principal components: a central fixed disk on which were mounted a number of iron guides that curved downward and outward, forming spiral passages by which the water passed from the penstock to the wheel proper; a horizontal wheel, or runner, mounted on a vertical shaft and having two outer rims, separated by vertical metal strips dividing the space between them into a number of curved passages, or buckets, through which the water received from the fixed guides moved outward; and a gate mechanism by which the admission of water from the penstock to the wheel was regulated. In sharp contrast with the buckets of the overshot and breast wheel, which held and carried the falling water, the turbine's buckets simply presented curved surfaces against which the water exerted force by pressure and reaction in

passing through the wheel (Hunter 1979:82).

Turbines were introduced into this country during the 1840s and quickly became a feature of most large milling establishments. In small merchant mills, and in some custom mills, the turbine gradually replaced water wheels as the older equipment became in need of repair (Reynolds 1970:66).

Following the Civil War, the traditional millstone proved less and less satisfactory. Stone grinding resulted in the loss of a proportion of the flour through inadequate milling and left discoloring particles of bran in the product. The antiquated stone-grinding process also left oily wheat germ in the flour. Wheat germ, although nutritious, precipitated flour spoilage during transport and storage—a major consideration in the age of the railroad and before the development of refrigeration. The millstone also failed to grind adequately the hard winter wheat that became increasingly popular from the 1850s onward (Reynolds 1970:54-55).

The solution to these problems was found in the roller process. Smooth rolls of chilled iron rubbing against each other crushed grain more efficiently than millstones and quickly rendered grinding with stones obsolete. The roller method arrived in the United States in the 1870s, initially in Minneapolis (the principal milling center of the era), and quickly spread across the country. According to Steen (1963:46), "no all-millstone mill of any importance was built after 1880, and rolls were substituted for buhrs . . . in practically all of the milling plants of more than grist classification throughout the nation."

The development of roller milling proved comparable to Oliver Evans' far-reaching innovations almost a century earlier. The rollers manufactured more flour from a given amount of wheat and furnished a uniform product (something not done previously) (Steen 1963:47). As with Evans' inventions, the roller process increased the scale of commercial milling. A mill building that formerly housed millstones now could accomodate enough rolls to produce more flour in the same amount of space (Steen 1963:54). Flour mills of tremendous size became practical. Raw material needs increased and markets became immense. Milling centers became even more firmly linked to transportation networks and the grain producing Midwest (Steen 1963:42; Storck and Teague 1952:239).

Roller milling accelerated the demise of the community-oriented mill. Few small-time millers could afford to install the new, complex machinery and therefore could not meet the overwhelming public demand for white flour produced by the new method (Reynolds 1970:55). Stringent sanitary regulations supported by the larger milling concerns in the 1930s also proved too expensive for the smaller mills (Browning 1983:86-87). Consequently, the number of small mills decreased rapidly from approximately 50,000 in 1880 to 8,000 in 1900 and to 3,000 in 1930 (Steen 1963:71). Those custom-oriented mills that did survive into the new century were of negligible importance and many ended their days producing corn meal and animal feeds for local needs (Hunter 1979:498).

Milling industries within the United States, including flour milling, depended almost totally upon water for all power requirements prior to the Civil War. By 1870, in American industry as a whole, steam engines just surpassed water wheels of all types in total horsepower produced. In flour and grist mills of this period, however, steam furnished only two-fifths as much power as water. Because it already was well established at waterpower sites, flourmilling converted to steam more slowly than other, newer industries.

Adaptation to steam power occured in the flour milling industry when increased economies of scale and shifts in wheat production centers removed mills from waterpower sites and forced them to use more power than water alone could provide. By 1890, steam power had drawn alongside waterpower in flour milling; by 1900, it was one and two-thirds times as great (Storck and Teague 1952:194). At the turn of the century, steam was recognized as the power source upon which all but the most limited of traditional local industries depended. Power supply thus gave way to transportation facilities as the most critical factor in mill location. The absence of waterpower in most commercial centers, long regarded as a major deterrent to manufacturing operations in most urban communities, ceased to be relevant (Hunter 1979:484).

As the twentieth century has advanced, the number of merchant mills, as well as custom mills, has steadily decreased. Storck and Teague (1952:281) have stated that "over the entire period from 1909 to 1933, when the drop was especially severe, the rate of decline averaged about one mill in nine for every year"; however, "although we had less than one-eighth as many merchant mills in 1947 as in 1914, the total production of all merchant mills in service remained essentially unchanged." By 1960, sixty mills, each with more than 5,000 cwt. daily capacity, produced approximately half of the nation's flour. One-hundred seventy mills supplied the remainder (Steen 1963:13).

CHAPTER 3
FLOUR MILLING IN WASHINGTON COUNTY TO 1820

Early Settlement in the Antietam Valley

A century passed between the construction of the first gristmill in Maryland at St. Mary's City in 1634 and the erection of a mill in present-day Washington County (Kuhlmann 1973:27). Settlement into the western reaches of Maryland proceeded slowly. The Maryland frontier at the beginning of the eighteenth century roughly extended along the edge of the coastal plain through the locations of Baltimore and Washington, D.C. (Gray 1933:116). English settlers moved along the Potomac into present-day Montgomery County in the first quarter of the eighteenth century. Here they confronted the eastern edge of a southward moving stream of German Palatinates from Pennsylvania.

German settlers entered the remote western portions of Maryland about 1729, first occupying territory along the eastern edge of the Blue Ridge and then crossing into the fertile limestone lands of the Antietam Valley. The Lords Proprietory of Maryland began granting lands on the west side of South Mountain as early as 1732; a number of families were probably established there by 1735 (Gray 1933:120; Scharf 1882:981).

The Antietam Valley formed a part of Prince George's County when the first settlers entered. Not until 1748 was a separate county created in western Maryland. This sparsely settled county of Frederick embraced the territory now included in Montgomery, Washington, Allegheny, Garrett, Frederick, and part of Carroll Counties, all total encompassing about three-fourths of the land area of Maryland (Scharf 1882:58). Washington County was created in 1776.

Within a short period after initial settlement, a network of primitive roads spread through the Antietam Valley. According to Herbert Bell (1898:15), an early Washington County historian, the first road was laid out in 1735-36 from Harris's Ferry [Harrisburg] on the Susquehanna to the Potomac at the mouth of the Conococheague, essentially corresponding to the present course of the Williamsport-Greencastle Road. In addition, Bell listed four other major roads as existing in 1749. These roads also appeared to run mainly in a north-south direction towards the Potomac and Susquehanna Rivers, suggesting a reliance on water transport as the primary link with the coast (Mullenix 1976:22). Even with the construction of these roads, which may have been little more than paths, settlements in the Antietam Valley were isolated and relatively inaccessible prior to the French and Indian Wars.[1]

Little information on the earliest mills of Washington County has survived. Documentation does remain, however, on three mills constructed in the Antietam drainage before the French and Indian Wars. Undoubtedly more existed.

The earliest known record of a mill in the study area was found in a 1739 patent outlining land along Beaver Creek, upon which sat a log dwelling house and a mill house. Forerunner of Witmer's Mill, this mill house undoubtedly was constructed of log as well. Stull's Mill, situated on Antietam Creek, was built circa 1739 and quickly became a local landmark as many roads were constructed by it. The Stull family also owned the mill on Beaver Creek during this period (FCWB A:23). The third mill—Trovinger's—was erected sometime before 1761 and also was located along the Antietam (Dickey WCHSS: WA I-071).

Bell (1898:90) believed that few mills existed in the Antietam Valley during the opening years of settlement. Writing of the Lietersburg District (located northeast of Hagerstown) previous to 1760, he claimed:

> Before the erection of a mill upon the territory of the District its inhabitants resorted to Stull's, on the Antietam near Hagerstown, which was built prior to 1748; Stoner's, which was in operation as early as 1749 on the Antietam east of Waynesboro [in Pennsylvania] at the present site of B. F. Welty's; or possibly to Wolgamot's on the Conococheague.

That so few mills existed in the Antietam Valley as late as the 1750s, however, is improbable. For example, Bell did not mention Witmer's Mill, nor Trovinger's, and probably left out other small and crudely built mills that may have served localized communities.

In addition, a contemporary account of travels through the near-by Shenandoah Valley revealed a relatively large number of mills operating in that region during this period:

> On October 18, we rose early at 3 o'clock . . . We had but one mile to Robert Konniken's mill and eleven further to Frederickstown [Winchester], but no water for seven miles. . . At noon we passed Frederickstown . . . A mile beyond Frederickstown we stopped at a mill and bought some bread and corn . . . We continued and again soon came to water. We still had four miles to Jost Haid'd [Hite's] mill . . . We traveled five miles farther and came to Baumann's [Bowman's] mill. We bought several bushels of oats, but had to wait several hours till it had been threshed . . . We still had five miles to Justice Funk's mill, but we had to drive for some time during the night and arrived there pretty late (Hensley 1969:3-4).

The path traveled in this account was probably part of the Great Wagon Road, which also passed through Washington County. It seems likely that an equivalent number of gristmills would have been found on the Maryland section of this trail as on the portion passing through the Shenandoah Valley.

The mills operating in the Antietam Valley during the initial decades of settlement were probably rather primitive. The most common type, in fact, may have been the hand mill. Samuel Kercheval (1902:274-275), writing of eighteenth century Shenandoah Valley settlements, asserted:

> The hominy blocks and hand mills were used in most of our houses. The hand mill . . . was made of two circular stones, the lowest of which was called the bed stone, the upper one the runner. These were placed in a hoop, with a spout for discharging the meal. A staff was let into a hole in the upper surface of the runner, near the outer edge, and its upper end through a hole in a board fastened to a joist above, so that two persons could be employed in turning the mill at the same time. The grain was put into the opening in the runner by hand.

Kercheval also affirmed that the earliest waterpowered mills in the Valley were tub mills, which agrees with evidence presented in Chapter Two that the first mills built in any frontier community tended to be the simple, inexpensive tub mill. From these sources it is postulated that the first waterpowered mills of Washington County were also tub mills, although documentary evidence does not exist to confirm or disprove this supposition.

The advent of the French and Indian Wars in 1754 had serious consequences for settlers in the Antietam Valley. Braddock's defeat in 1755 exposed the settlers' homes to Indian attack and led to the virtual abandonment of all settlement west of South Mountain. George Washington noted in 1756 that "the whole settlement of Conococheague [at that time the name given to all of present-day Washington County] in Maryland is fled, and there remains but only two families from thence to Fredericktown [Frederick]" (Hays 1910:12). This war largely negated the effect of the first wave of pioneers in the Antietam Valley. With the return of peace in 1763, resettlement progressed quickly.

Development of the Flour Milling Industry 1783-1820

Many flour mills were established during the period of resettlement, in part because the limestone lands of the region were well suited to grain cultivation. In fact, from 1763 to the end of the eighteenth century, the most important wheat producing regions of the South were centered around Frederick and Hagerstown in Maryland and the lower Shenandoah Valley and northern Piedmont of Virginia (Gray 1933:608). A traveler of the period noted that around Frederick and Hagerstown, although not upon navigable rivers, mills, forges, and furnaces were common (V. Clark 1949:107).

Early mills in the Antietam Valley apparently located at fords, especially fords along the Antietam Creek. Helen Ashe Hays (1910:109-110) pointedly emphasized that the "sequence . . . which is repeated again and again along the Antietam would be, the ford, the mill, the bridge." Hays reasoned that fording spots attracted roads and that these roads facilitiated access to the creek, creating opportunities for millers to establish a local market. Increasing trade at the mill eventually occasioned bridge construction. Although major public-financed bridge building was not inaugurated until after 1820, instances of millowners building private bridges at their mill sites prior to this date are documented.[2]

A 1783 tax assessment that recorded mills by owner and listed the value of each mill revealed the extent of the milling industry in the Antietam drainage. Mill types generally were not differentiated in this document, making it difficult to separate flour mills from fulling, saw and other types of mills. Through the use of other historical documentation in conjunction with the tax assessment, however, the problem of identification of mill types within the study area was overcome. Approximately twenty flour mills were listed within the Antietam drainage in 1783.

An examination of mill values relative to mill placement provided insights into the development of milling in the Antietam drainage. Thirteen of the twenty mills were located on Antietam Creek, which suggests that it provided the major waterpower for the area. The average value of the Antietam mills was £325, with a mean of £600. In great contrast, the seven mills on tributaries of Antietam Creek averaged £125 per mill. Clearly the mills on the Antietam were more substantial, not only in terms of capital investment, but most likely in production capability and size as well.[3]

The fact that over half the mills listed in the tax assessment were situated on Antietam Creek contrasts with the statement in Chapter Two that mills generally located on the smaller tributary streams of an area during initial settlement. It is doubtful that a revenue producing document such as a tax enumeration would have missed capital improvements like mills; therefore it is unlikely that the assessment is incomplete. Two possible answers exist, however, for the discrepency between the data discussed here and the broad statement of the previous chapter. The French and Indian Wars may have disrupted the usual evolution of mill placement from branch to trunk streams. As a result, when resettlement occured, Antietam Valley mills may have skipped developmental steps. On the other hand, the idea of mills spreading from smaller to larger streams essentially arose from studies of milling development in the northeastern United States, particularly New England. Mills in the Mid-Atlantic and South may very well have not followed this pattern. Continued studies involving these areas must be conducted, however, before such a conclusion can be verified.

Within the Antietam drainage an arbitrary division—the average value of all mills in the study area (£274)—was used to separate mills into two groups, those above the average and those below. This procedure revealed a marked difference between mills on the Antietam Creek and those on its tributaries. Of the ten mills valued above the average, nine were located along the Antietam. The remaining flour mill, Doub's, sat on a major road between Hagerstown and Frederick.

A contrast emerged not only between the two spatially differentiated groups of mills within the Antietam drainage, but also between mills in the study area and mills lying in the western reaches of the county (which then included present-day Allegheny and Garrett Counties). As the milling industries of the latter region have not been investigated, differentiation of mill types was not possible. For broad comparative purposes, however, this did not present a hindrance.

The 1783 tax assessment listed forty-two mills in Washington County operating outside the Antietam basin. Average value of these mills was £90, an amount inflated by roughly a half dozen large mills along Marsh Run and Conococheague Creek in central Washington County. Even so, this average is considerably less than the £274 for the mills operating within the study area.

When figures for the six western-most districts of the County only were tallied, an even more striking picture emerged. Nineteen mills were recorded in the western precincts with a total value of £593—equivalent to one large mill on Antietam Creek—with a meager average value of £31. Many of these mills were probably associated with saw milling, the major industry of the western region at this period, and sawmills were generally less valuable than gristmills. None of the mills enumerated for this region, however, had much worth attached to them individually.

Several factors accounted for the extreme difference in average mill values between the Antietam drainage and the western-most districts. Characterized by steep mountains and narrow valleys, the western reaches of Washington County were not suited to large-scale wheat production. Nor was this region easily accessible. In addition, the small size and dispersed nature of the mills from the western districts may have represented an initial stage of milling in a frontier community; in other words, small, custom-oriented mills serving a small number of individuals.

It follows that mills located in the central portions of the County may have represented an intermediary stage toward market integration, with a few large mills operating on Marsh Run and Conococheague Creek, but the majority of medium size and ranging in value from £100-200. Eastern Washington County, with its large mills along Antietam Creek, probably represented the most advanced stage of market integration in the County.

The number of flour mills within the Antietam Valley greatly increased during the early years of the Republic. Approximately eighteen mills were constructed between 1783 and 1820, almost doubling the number previously established within the study area. Contrary to previous trends, only three of these mills were built along Antietam Creek. By 1820, the Antietam, foremost waterpower in the area, probably contained the maximum number of mills that could operate along its banks without one mill privilege infringing upon another.

Growth of the flour milling industry was not restricted to the Antietam Valley alone. A considerable expansion of wheat production occured from 1783 to 1795 in the western regions of Virginia and the Carolinas (Gray 1933:608-609). In 1793 a Shenandoah Valley merchant boasted "In 4 years the 3 little counties of Augusta, Rockbridge, and Rockingham . . . from having but one manufacturing mill only has upwards of 100 merchant mills in great perfection . . ." (Hensley 1969:57) By 1810 Maryland had become the third largest flour-producing state in the nation behind Pennsylvania and Virginia. Washington County was the state's foremost County in terms of the value of its flour mills and the number of barrels of flour produced by these mills (Mullenix 1976:62).

Marketing and Transportation

Without question the mills along the Antietam Creek were substantial for their time period and produced more than enough flour for the local populace. Where did the surplus go? Contemporary accounts pointed to the coastal cities. Christian Boerstler (Journal), a local manufacturer, wrote in 1785 that "almost all farmers have the wheat ground into flour, that is packed into barrels weighing 175 pounds and taken to port-cities, 80 to 130 miles away." Joseph Scott, writing circa 1807, maintained:

> Large quantities of flour are manufactured, particularly on the Anti-Etam, and transported to Baltimore. In some seasons quantities are sent down the Potomac to Georgetown and Alexandria . . . There are about fifty grist-mills in the county, several saw-mills, fulling, hemp, and oil-mills. The water of the Anti-Etam turns fourteen mills. It is the largest and most constant stream in the county, and where the largest quantities of flour are manufactured (Scharf 1882:980).

As discussed in the preceding chapter, Baltimore became the leading flour market in the United States during the latter part of the eighteenth century and retained that position into the third decade of the nineteenth (Sharrer 1976:322; Steen 1963:247). Flour from Washington County traveled to the port city by expensive overland routes. In 1798 it cost approximately $3.30 to haul a barrel of flour from Hagerstown to Baltimore, where it sold for $7.40 (Sharrer 1976:328). By the 1790s, as many as five major roads crossed through gaps in the South Mountain. These roads ran primarily from Hagerstown to Frederick, and from thence to Baltimore. How much Washington County flour passed to market along these routes has not been investigated, but certainly the Baltimore market during the late eighteenth century spurred the growth of the flour milling industry along the Antietam Creek and its tributaries.

Organization of the Patowmack Canal Company in 1785 threatened Baltimore's control of markets in western Virginia and Maryland, including Washington County's flour milling industry. Up to this time the Potomac River had been impassible above Georgetown to all but the lightest traffic. Through the construction of skirting canals and locks around obstructing falls and rapids, the Patowmack Company planned to open the Potomac to continuous navigation for approximately 220 miles (Barnes 1978:21). The Company encountered opposition, however, to its project:

> Regional intrastate economic rivalry, pitting the merchantile interests of Baltimore against those of Georgetown, initially prevented passage of the necessary legislation [for incorporation]. The merchants in Baltimore feared the loss of a substantial portion of their lucrative and expanding commerce with the interior. Bulk good were then being brought to Baltimore by relatively expensive overland transport. The merchants believed that, with the construction of the Patomack Company's cheaper water route, much of this trade would be diverted to Georgetown (Barnes

1978:16-17).

Only the personal intervention of George Washington, a leader of the Patowmack Company, overcame the resistence of the Baltimore merchants (Barnes 1978:17).

Completion of locks around Great Falls by 1802 removed the last major obstacle to navigation on the Potomac (Barnes 1978:21). Because water volume fluctuated widely with the seasons, the river was navigable primarily from September to June (V. Clark 1949:338-339). Thomas Harbaugh's Journal, which recorded traffic on the Shenandoah Canal at Harpers Ferry, part of the Patowmack Company system, revealed water transport on the canal throughout the year, but with sharp decreases in volume over the winter months and equally sharp increases during the summer. Traffic appeared to be heavy, however, whenever the river was open.

Flour was the major commodity transported along the canal system. Mullenix (1976:66) cited figures of 30,000 barrels of flour shipped annually between 1800-1804, 40,000 between 1805-1809, 62,000 between 1810-1814, and 53,000 in the post-War of 1812 recession. Certainly a portion of this shippage comprised flour from Washington County mills.

Financial troubles pursued the Patomack Canal Company almost from its inception. In 1828 it formally dissolved and relinquished its charter privileges to the nascent Chesapeake and Ohio Canal Company (Barnes 1978:21).

Barnes (1978:47-48) believed that the Patowmack Company had negligible impact on development within the Potomac River basin. This simply was not true for Washington County, where the Company's navigation improvements certainly provided further impetus to the development of the flour milling industry in the Antietam Valley. According to Thomas Williams (1906:131):

> The trade of [Washington] County at this time [c. 1800] was in a flourishing condition, and the shipments in boats down the Potomac were very large. A few years previously the flour market of Georgetown was of so little account that it was with difficulty that two or three wagon loads could be sold for cash in a single day. In the first twelve days of April, 1803, no less than fourteen thousand barrels of flour passed through the locks at Great Falls, and other produce which altogether would have required a thousand wagons, a thousand men, and four or five thousand horse to move.

Warehouses were built in Williamsport, and most likely at other points as well, to receive the flour prior to shipment down the Potomac (Hays 1910:111-112).

As part of its original plans, the Patowmack Company intended to open several major tributaries of the Potomac River to navigation. Included in these proposals was Antietam Creek. Thomas Harbaugh (Journal), engineer for the Antietam project, explained:

> Of the Antietam Locks, the Potomac Company had in contemplation to render this creek navigable for Boats of 120 Barrels [of flour] Burden from its mouth to the head of said creek which would have required about 20 Locks . . .

Harbaugh completed part of this navigation system during 1813-1814:

> Locks I commenced at sundry places and shall speak of But one, at Funks Town I completed one intirely—above and below that, I had others on hand but did not finish, at or near the Mouth of the Creek I had commenced and in great forwardness 2 Locks as at this place we had the greatest fall of water on the Creek.

Work was discontinued, however, due to lack of funding. Harbaugh had figured that the project required $100,000 for completion, partly because of work needed to bypass the many mill dams on the creek. The Patowmack Company, already financially strapped, never could have completed such an expensive project. As a result, Antietam Creek was not used for navigation to any extent.

Use of Evans' Inventions in Washington County

The large quantities of flour produced by Washington County millers in the first decades of the nineteenth century points to adoption of Oliver Evans' automatic milling techniques. As considerable amounts of Antietam Valley flour were marketed in Baltimore, it is likely that millers in Washington County knew about the innovations at a relatively early date. The first advertisement for Evans' method did not appear in a Washington County newspaper, however, until 1813 (Hagers-town Gazette, March 23, 1813). At present, the period when millers in the Antietam Valley began using Evans' automatic milling innovations is unknown.

By 1820 almost all mills in the study area had incorporated at least some of Oliver Evans' ideas into their milling operations. Of twenty-three mills enumerated in the 1820 Census of Manufactures, twelve were listed as containing both hopperboys and elevators--considered here a "complete" Evans' mill. With one exception (Barkman's Mill), these "complete" mills tended to be the large producers in the study area, with an average input of 18,867 bushels of grain per year per mill as compared to 13,665 bushels per mill for the twenty-three mills taken together.[4] Nine of the twelve mills were located on Antietam Creek, pointing to the continuing dominance of this stream within the Antietam drainage.

Eight mills were inventoried as possessing hopperboys alone. These mills averaged 7,750 bushels of grain per year per mill—substantially below the average for all mills and especially the average of the "complete" mills. Perhaps hopperboys required less capital to install than did Evans' other inventions and were more suited to smaller milling operations than elevators. It must be kept in mind, however, that some of these mills may have contained elevators, for in most cases one cannot ascertain from the schedules if mills do not possess specific machinery, but only if they do possess it.

It appears that the great majority, if not all, of the mills in the Antietam Valley installed at least some of Evans' inventions. The small "one-run gristmill," depicted by Hunter as unable to incorporate the automatic mill and by Storck and Teague as whole-heartedly embracing it, did neither in the Antietam Valley. Rather, it used what it needed or could afford from Evans' stock of ideas.

In summary, the Antietam drainage mills that fully incorporated Oliver Evans' inventions were its substantial, merchant-oriented mills. These mills tended to be the largest mills in the study area before they added Evans' machinery; evidently at least some capital was necessary to convert to an automatic mill along Evans' design. The mills that adopted his automatic milling methods in part were smaller in scale and probably more community-oriented.

1820 Census of Manufactures

The 1820 census schedules for Washington County provided an extensive amount of information on flour mills within the Antietam drainage (for instance, the adoption of Evans' inventions as discussed above).[5] This period was not a prosperous one for Washington County millers: "The wheat crop was badly damaged by a hail storm in 1818. In 1819, demand collapsed as a result of the national depression . . ." (Mullenix 1976:65). The schedules reported most of the mills as "occassionally in operation." The price of a barrel of flour ranged from $4.50 to $3.25 at the immense Claggett Mill.

Census data furnished a base from which to compare mill production relative to mill placement. Not surprisingly, eight of the ten foremost flour manufactures were located along Antietam Creek.[6] The two other mills—Newcomer and Newcomer/Graff—sat near main roads leading from Hagerstown to Frederick. In contrast, the nine mills utilizing 9,000 or less bushels of grain per year were, with the exception of the Fowler & Zeigler Mill, located on branches of the Antietam away from main roads and close to small communities.

Associated with flour mills in the Antietam drainage were a variety of other waterpowered industries. More than half the flour mills in operation prior to 1820 had at least one other industry operating alongside them. The most common were plaster mills and saw mills. Less commonly associated were carding mills, hemp mills, fulling mills, and powder mills. Exact information on the numbers of these different types of mills has not been found. Information gleaned from land records and newspapers, however, revealed a tendency for associated industries to locate at the large, merchant-oriented flouring mills.

CHAPTER 4
MILLING IN WASHINGTON COUNTY AFTER 1820

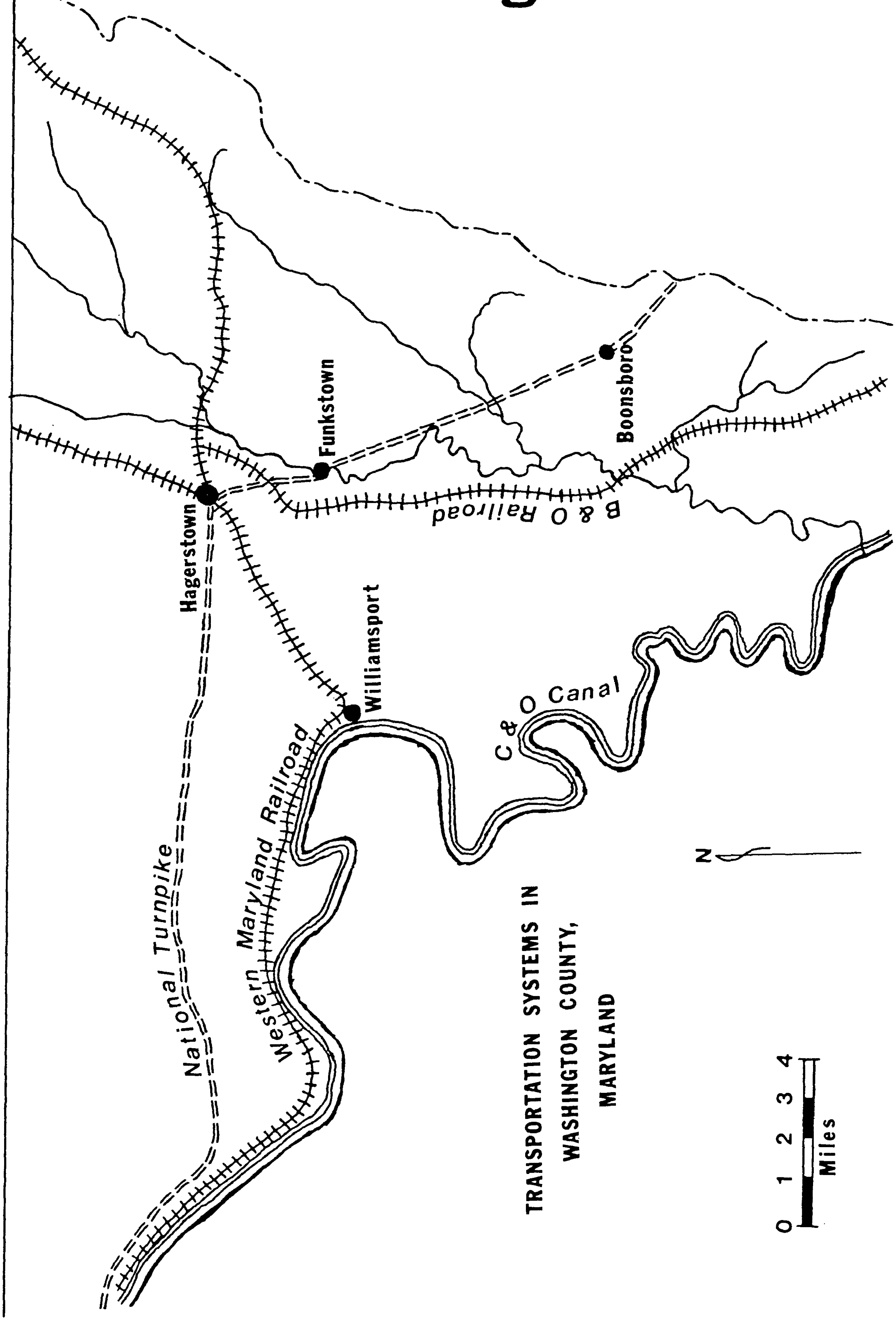
Markets and Transportation 1820-1850

The 1820 manufacturing census revealed a flour milling industry firmly established within the Antietam basin. Although much of the flour produced by these Washington County mills was transported by overland routes to market, road conditions remained poor into the second decade of the nineteenth century. Williams (1906:151) maintained that "the peculiar character of the soil of the country between Hagerstown and Baltimore made good roads of any other kind than those of stone almost impossible." Before the turnpikes were constructed, the County frequently was cut off from communication with the outside world.

The National Road was constructed from Cumberland, Maryland, to the Ohio Valley in the first decades of the nineteenth century. A good road from Baltimore to Cumberland became a necessity if the port city wished to attract trade from this region (Hays 1910:21-22). A portion of this connecting turnpike passed through Washington County. By 1821 the road from Hagerstown to Boonsboro was the only section of the turnpike from Baltimore to Wheeling, Ohio, not yet completed (Scharf 1882:997). This portion was finished by 1825.

Construction of the National Turnpike spurred the formation of smaller turnpike companies in Washington County. The roads these companies built radiated from Hagerstown, drawing trade to the city and encouraging

Figure 3


TRANSPORTATION SYSTEMS IN WASHINGTON COUNTY, MARYLAND
Hagerstown
Funkstown
Boonsboro
Williamsport
B & O Railroad
C & O Canal
Western Maryland Railroad
National Turnpike
N
0 1 2 3 4
Miles

development within previously remote corners of the County.

The National Road had a tremendous impact on Washington County, for it provided the first relatively cheap and efficient land route to the seaboard (Mullenix 1976:52). A barrel of flour that cost $3.30 in 1798 to haul from Hagerstown to Baltimore cost only $ .50 in 1825 (Williams 1906:156).

> On the pike, it took a wagon about seven days to make the round trip from Hagerstown to Baltimore and return. A team consisted of four, five or six horses, and a load for a good team was twenty-four barrels of flour (Sharrer 1976:328).

Although the amount of freight carried on the road was not researched, doubtlessly the turnpike stimulated flour production within the Antietam Creek drainage area.

Baltimore's bid for the western markets did not go unchallenged by its rival, the port of Georgetown. Although the Patowmack Canal Company had failed in its attempt to open the Potomac River to navigation, the dream of using the river as a gateway to the West had not died. On July 4, 1828, president of the United States John Quincy Adams turned a shovel full of dirt and symbolically began construction of the Chesapeake and Ohio Canal (Williams 1906:206). The Chesapeake and Ohio (C&O) was envisioned as a slack-water canal extending from Georgetown into the Ohio Valley along the Maryland side of the Potomac River.

Baltimore quickly responded to this new threat:

> On the same day, the fourth of July 1828, when President John Quincy Adams removed the first spade full of earth in the construction of the Chesapeake and Ohio Canal, the venerable Charles Carroll of Carrollton, the last survivor of the brave men who more than fifty years before had signed the Declaration of Independence, placed in position the first stone in the construction of the Baltimore and Ohio Railroad (Williams 1906:227).

The reason for building this railroad?

> The citizens of Baltimore had soon become jealous of the canal as being a feeder to the rival city of Washington . . . It is likely that if the Eastern terminus of the canal had been assured to Baltimore, it would have been many years before a railroad would have been considered necessary (Williams 1906:227).

Continued rivalry between the two market centers had a profound influence on the economic development of Washington County. At Point of Rocks, Maryland, the canal and railroad clashed over the right of way through the County. The railroad regarded a course along the Potomac River as essential because its locomotives were not powerful enough to cross the mountains bordering the river. The C & O Canal Company countered this move in court, claiming that this right of way had been granted to them as the successor of the old Patowmack Company (Willliams 1906:228). The Canal won its legal battle and forced the railroad into Virginia at Harpers Ferry, where it effectively by-passed Washington County. By 1834 the Canal had been completed almost to Williamsport; by 1839 it had reached Hancock (Mullenix 1976:98).

The National Road steadily declined in importance after the construction of the canal and railroad (Mullenix 1976:97). The transportation system which had won the right to pass through Washington County--the C & O Canal--was obsolete even before it terminated in Cumberland, Maryland (it never reached the Ohio Valley). The detour of the Baltimore and Ohio (B&O) Railroad around Washington County deprived the County of the strategic crossroads position it had enjoyed when the National Road was in its primacy. These three factors together precipitated the slow decline of Washington County into a backwater of economic development following the Civil War (Mullenix 1976:102).

Lower freight costs on the C & O Canal brought some measure of prosperity, however, to the County's agricultural producers. The canal may actually have promoted flour production in mills located where they could take advantage of the canal's low cost.[1] According to Williams (1906:156), "when the Canal was opened to Williamsport, a great deal of flour was sent to Georgetown by boat. Warehouses were built and flour was hauled and stored during the winter awaiting the opening of navigation in the spring." Williamsport, which lies outside the present study area, was the major canal port for the eastern half of the county.

A substantial quantity of the grain supplied to mills in the Antietam Valley evidently came from outside the County limits.

> The whole crop of Washington County was manufactured into flour at home, besides a large quantitiy which was brought from Franklin County [Pennsylvania]. Hagerstown was always a good wheat market, and the large mills of Jonanthan Hager, George Shafer, Samuel, David and Hezekiah Clagett [all located on Antietam Creek], and others drew wheat from places as far as Chambersburg (Williams 1906:156).

The decades of the 1830s and 1840s appeared to be prosperous ones for the merchant millers of the Antietam Creek and its tributaries.

1850 Census of Manufactures

The 1850 census schedules for manufactures reflected the continued prosperity of the flour milling industry in Washington County. Although only a slight increase had occured in the number of flour mills in the Antietam drainage—from roughly 36 in 1820 to about 41 in 1850--the average number of bushels of grain consumed annually by these mills had risen from 13,665 bushels per mill (in 1820) to 17,274 bushels per mill (hereafter cited as bu/mill).[2]

The increase in grain consumption (and thus flour production) was not evenly distributed among all the mills in the study area. Relative differences in grain consumption increased between mills located on Antietam Creek and those situated on its tributaries. Whereas the mills on the Antietam consumed an average 23,300 bu/mill annually, mills on its tributaries utilized 10,891 bu/mill.[3] This contrasts with the 1820 ratio of 19,390 bu/mill for Antietam Creek to 11,222 bu/mill for its tributaries.

The mills enumerated in the 1850 census clustered into two groups. The first set generally consumed between 10-15,000 bushels of grain anually. The mills in this group perhaps represented small merchant mills or combination custom/merchant mills. The second group consumed from 30-35,000 bu/mill. One mill, Claggett's, towered above the others at 75,000 bu/year--almost double the grain utilized by the second largest mill in the study area. Of the seven mills in the second group, six were located on Antietam Creek, primarily around and south of Hagerstown.

Bowman's Mill, located in the northeastern corner of the county, was the one mill from the second group not situated on the Antietam Creek. In 1850 it was the third largest mill in the study area. No other mill in the immediate vicinity became half as large. The question remains as to why this particular mill expanded to such a large size and others in the same area did not.

Other waterpowered industries continued to associate with flour mills prior to the Civil War. Although information remains sketchy, at least one-third of the flour mills in the Antietam drainage had sawmills attached to them. More than half of the flour mills probably had associated industries of some type connected with them. In addition to sawmills, these industries included plaster, woolen, hemp, and carding mills. A trend away from combining more than three waterpowered industries at a single location was apparent the second quarter of the nineteenth century. As information on associated industries was gleaned from land records and newspapers, any conclusions are tentative.

Civil War Era

The decade prior to the Civil War witnessed a decline in Washington County's flour production relative to other areas of Maryland and of the United States. Railroad transportation tapped the rich grain resources of the midwest, displacing the eastern mid-Atlantic as the granary of the nation (Mullenix 1976:114). Ironically, the same B & O Railroad that had by-passed Washington County transported a sizeable amount of this midwestern grain to Baltimore. As a result of these shipments, by 1860 Baltimore mills considerably out-produced those in western Maryland (Kuhlmann 1973:44; Storck and Teague 1952:153). Despite its great output, however, Baltimore already had been surpassed by milling centers in the midwest located closer to the new grain fields.

According to the 1860 Census of Manufactures, Washington County flour mills ranked sixth out of the twenty counties in Maryland in the value of their annual product. Twenty-one flour mills were listed in the census from the County. This relatively small number of mills represented a tremendous decrease from the forty-seven mills listed for Washington County in the 1850 census.

Suspiciously, not one mill was enumerated for the three southern-most districts of the study area. In addition, many mills located in the northeast corner of the county were not listed in the census schedules. This leads one to believe that the striking decline of flour mills in Washington County chronicled by the 1860 Census was due at least in part to poor canvassing by the enumerators, especially as the mills reappear on the 1880 census. Many of the mills that escaped recording were the smaller mills of the Antietam drainage; some of these mills indeed may not have been operating during this period. Nevertheless, serious questions are raised about the validity of the 1860 survey. Because of these doubts, the 1860 census schedules have not been used as comparative data in this study.

Although both Northern and Southern armies marched through and occupied Washington County during the Civil War, no serious damage was sustained by flour mills within the Antietam Valley.[4] Many mills were probably forced to shut down at times during the course of the War, and others may have been out of repair. Almost all the mills in the Antietam drainage, however, reopened after the Civil War.

Railroads in Washington County

A belated railroad building spree occured in Washington County the second half of the nineteenth century. The Cumberland Valley Railroad had been constructed to Hagerstown from Pennsylvania in 1841, but financial trouble quickly forced the line to close. In 1860 it reopened as the Franklin Railroad:

> Great quantities of flour awaited the [reopening], and in a few days five thousand barrels, which would naturally have gone to Georgetown or Baltimore, were carried off from Hagerstown to Philadelphia (Williams 1906:300).

Characteristically, Baltimore quickly countered the threat to its market in Washington County by initiating construction of a branch line of the Baltimore and Ohio Railroad from Weverton to Hagerstown. Delayed several years by the war, it was completed in 1867. By accident or by design, this line passed near many of the flour mills located in the southern half of the county (Scharf 1882:1009).

The Western Maryland, another rail line originating in Baltimore, entered the northeast corner of Washington County in 1866, extended to Hagerstown in 1872, and was completed to Williamsport in 1873. The final railroad constructed in the County, the Norfolk and Western, opened in 1880 and ran from Hagerstown into the Valley of Virginia (Bell 1898:16; Scharf 1882:1004). This line did not pass through any part of the study area.

As the depiction of the opening of the Franklin Railroad demonstrated, millers were quick to take advanatage of the marketing opportunities presented by the railroads. Bills of sale for mills in the latter decades of the nineteenth century frequently included lines detailing proximity to the nearest rail station. One, Claggett's Mill, even had its own small station (WCCR 24:601).[5] Without doubt, rail transport rapidly became the pre-eminent mode of shipping flour and provided expanding markets to Washington County millers. An advertisement for Claggett's Mill boasted that "the brands of flour manufactured there are well known and have a ready sale in the New York markets."

1880 Census of Manufactures

The 1880 manufacturing census depicted a prosperous flour industry.[6] In contrast to the small numbers given in the 1860 census, fifty-two flour mills were enumerated for Washington County; thirty of these were located on the Antietam Creek and its tributaries. The County jumped to fourth place out of twenty-one Maryland counties in number of mills and to third in the value of its annual milling product.

Mills in the study area averaged 13,504 bushels of grain annually per mill--a decline from the 17,274 bu/mill of the 1850 census. The average for mills located on Antietam Creek was 19,996 bushels, a drop from the 23,300 bu/mill recorded in 1850. In contrast, the 10,258 bu/mill average for the mills on other streams indicated only a slight drop from the 1850 figure of 10,891 bu/mill. Thus, the overall decline in grain consumption by 1880 was due to decreasing production at the larger mills on the Antietam Creek. Of the flour mills on the Antietam, half (five) were recorded as market-oriented, half as custom-oriented. Significantly, four of the larger flour mills along the stream had converted to other lines of manufactures by this period, indicating a deeper change in Washington County's economic structure.

The 1880 census was the first to list flour mills as custom, market, or combination custom/market. For simplification, mills enumerated as producing one-half or more of their flour for market were labeled "merchant", those manufacturing under one-half of their product for market "custom." A tremendous disparity in annual grain consumption existed between these two groups. The fourteen market-oriented mills averaged 22,058 bushels of grain annually per mill, whereas custom-oriented mills consumed an average of just 5,910 bu/mill.[7] Such a tremendous difference in grain consumption probably existed between merchant and custom mills throughout nineteenth century

Washington County. As information on marketing orientation had not been gathered in previous manufacturing censuses, however, comparisons could not be made with the earlier data.

When grain consumption data for the merchant and custom mills was broken down into two categories--wheat and other grains--another striking difference between merchant and custom mills became apparent. The ratio between merchant and custom mills of average bushels of wheat utilized per mill compared to the ratio for the average of all grains did not differ significantly. For grains other than wheat, however, a marked change occured in the ratio of consumption between merchant and custom mills. The latter averaged 1,614 bu/mill, larger than the 1,116 bu/mill for merchant mills. This reversal can be expected as a primary function of the custom mill was to grind cereal crops of neighborhood farmers and to produce feed meals. Corn by far was the most common of these other grains.

In summary, the 1880 census revealed a healthy flour industry in Washington County. Its days as an important flour producer were past, however, as the drop in overall grain consumption from the 1850 level and the decline of the large mills on the Antietam demonstrated. Although the large, merchant-oriented mills of the Antietam continued to out-produce others in the study area, it was not to the extent that it had been during the antebellum period. By 1880 the smaller merchant/custom mill consuming 10-15,000 bushels of grain a year predominated. An apparent shift towards increased local marketing had occured.

By 1880 few waterpowered industries paired with flour mills with the exception of sawmills. At least two-thirds of all flour mills operating during this period had sawmills on the premises. Other types of waterpowered milling industries, such as fulling and carding mills, rarely operated in small rural settings by this date.

Technological Developments

Eighteen of the thirty mills in the Antietam drainage used overshot wheels as their motive power in 1880. Seven others employed turbines; two additional mills used a combination of turbines with another motive power. Of the nine turbine-driven mills, eight were located on Antietam Creek. Several reasons may account for their predominance on this particular stream. First, the fall on the Antietam was relatively low—usually about four feet where turbines were installed. The submerged wheel of the turbine proved ideal in this situation (those mills on the Antietam that did not employ turbines used undershot wheels). Second, turbines powered the larger mills in the study area, which tended to be located on the Antietam. The turbines may have been necessary to keep these mills competitive. Third, turbines may have required capital that many small-time millers could not raise. Smaller mills that depended primarily on local markets may not have required the expanded capabilities that turbines provided. Finally, in most instances, the fall on tributaries of Antietam Creek was great enough that efficient overshot wheels could be installed.

Only one steam-powered mill, Lehman's, was recorded in the 1880 census. As steam was listed in conjunction with two turbines, the engine probably operated during periods of low water. In the early 1870s newspapers advertised a steam powered mill for sale in Hagerstown. It housed seven run of burrs (Booth's Mill, largest in the 1880 census, had five) and could produce 800 barrels of flour in 24 hours. Most likely this mill had gone out of business by 1880. Another steam-powered mill was constructed in Hagerstown in 1896, but little information about it was uncovered.

CHAPTER 5
MILL SETTLEMENT PATTERNS IN THE ANTIETAM DRAINAGE

Preceding chapters have considered various aspects of flour milling in the Antietam Valley. To begin with, a general discussion of milling technology was culled from secondary sources. This brief outline provided a framework with which to compare flour milling in the Antietam drainage. A history of milling in the study area furnished the data base for analyzing patterns in mill settlement relative to external markets and changing transportation networks.

Statistical analysis, consisting of coefficients of correlation and linear nearest neighbor analysis, use the data provided in preceding chapters to discern patterns in mill settlement. Although the methods employed in this chapter are relatively unsophisticated, they should point towards apparent patterning:

> A quantitative approach would seem to provide a clarity in the demonstration of spatial trends, patterns and relationships. It also provides a certain objectivity in the analysis of these patterns. The techniques also often lead to the discovery of patterns not revealed by usual archaeological analysis, and thus provide something for the archaeologist to explain (Hodder and Orton 1976:241).

In this chapter, the statistical methods employed are explained initially. Possible connections between mill placement, production, and transportation networks are examined second. Third, the relationship of natural factors-- such as stream size--to mill placement are discussed to provide additional insights into mill settlement patterns. Finally, custom mills and merchant mills are compared to determine whether the two represent different economic and settlement systems.

Discussion of Statistical Methods

The correlation coefficient is used to obtain an indication of the linear relationship between two independent variables x and y (Mendenhall 1979:350). Without discussing its derivation, the formula is given as follows:

$$r = \frac{n\sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{\sqrt{\left[n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2\right]\left[n\sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right]}}$$

The correlation coefficient r always equals a number between 1 and -1. If the coefficient equals 0, no relationship exists between the two variables. The closer r is to 1, the stronger the positive relationship between the two variables. Conversely, the closer the coefficient is to -1, the stronger the inverse relationship.

According to David Hurst Thomas (1976:392): "Whenever r assumes an intermediate value between zero and unity, the correlation coefficient should be assessed for statistically significant deviations by chance." In this paper, a table provided by Hurst (1976:Table A:11) is used to check significance probabilities for figures revealed by the coefficient of correlation.

The primary function of the correlation coefficient in this study is to determine whether a relationship exists between mill size and proximity to various transportation systems. It must be kept in mind, however, that distance from a transportation network certainly is not the only variable related to mill production, but the one that is of interest here for viewing economic and natural aspects of mill settlement patterns. In addition, this test does not determine causation, but only confirms a relationship between two variables.

Linear near neighbor analysis reveals whether points are clustered, random, or dispersed in their placement on a line. In using this method, Barbara L. Stark and Dennis L. Young (1981:290) stress:

> To analyze site spacing it may be desirable first to separate different functional categories of sites, because distinct factors may structure placement of different kinds of sites. Second, one should use as complete a sample of sites as possible because otherwise elements of patterning may be obscured or falsified. Third, the sites should be contemporaneous, and, fourth, accurate mapping must be available at an appropriate to scale. Fifth, relatively large samples are desirable for statistical evaluation.

The mills of the Antietam drainage meet the criteria outlined above in most respects. Waterpowered industries in addition to flour mills are used to determine the linear nearest neighbor statistic because these industries shared streams with the flour mills. These industries belong to the same functional category as flouring mills--waterpowered mills within the study area.

Sample size presented a problem as the linear nearest neighbor statistic was computed for each stream within the Antietam drainage. In some instances, there were as few as five mills on an individual stream. For obvious reasons, the test was not conducted for streams that contained only one or two mills.

As the stream lengths and the end points, or furthest mills, of these streams are known, the statistic

$$\frac{1}{L}\left(M_1 + M_2 + \ldots + M_n\right)$$

is utilized, where M represents the distance of each mill to its linear nearest neighbor, and L represents the length of the stream (Stark and Young 1981:287). Stark and Young (1981:288) provide a table of critical values that are used here to determine significance.

Mill Settlement Patterns and Transportation Systems

A stated goal in Chapter One is the investigation of aspects of culture change through the study of transformations in mill location and production over time. In this section, changes in mill placement and production relative to developments in transportation—one small aspect of culture change—are examined.

Kuhlmann (1973:31) contended that shipment by water from merchant mills to market was essential in the eighteenth and early nineteenth centuries due to the existence of few good roads. In this appraisal Kuhlmann apparently was regarding mills in tidewater, where rivers are navigable. Prior to navigation improvements on the Potomac, overland transport was the only means that merchant millers in Washington County had to convey their flour to the coastal cities.

Of the 19 flour mills in the Antietam drainage and marked on the 1794 map of Washington County, eight were located alongside the major roads illustrated by the map. The other eleven mills sat off of, but relatively close to, a roadway. These eleven mills all were established on the Antietam Creek—the largest stream in the study area—and represent the most valuable mills of that era.

About a dozen mills in operation before 1794 were not shown on the map.

These mills clustered in the northeast corner of the County along Forbush's Run and represented some of the smaller establishments in the study area during this era. Neither the stream nor any roads were pictured in this area. As with many maps surveyed during this period, an individual paid to have his house or industry placed on the map.

The impact of the Patowmack Canal Company upon the flour mills of the Antietam drainage is not clear as records of flour shipments by the Company have not been consulted. Observations by contemporaries and local historians, however, suggest that large amounts of flour were transported to Georgetown and Alexandria when weather permitted.

It is apparent that overland transport of flour remained important throughout the first decades of the nineteenth century. Analysis of a correlation coefficient employing as variables grain consumption data from the 1820 manufacturing census and distance to the nearest major road (primarily those shown on the early maps) reveals an inverse correspondence ($r=-.5190$, $df=21$, $p<.02$). Not surprisingly, the larger flour producers tended to be located closer to these roads than the smaller producers.

The correlation between mill size and proximity to major roads decreased by 1850. Comparison of the 1850 census data on grain consumption relative to distance from thoroughfares revealed less of an association ($r=-.3131$, $df=27$) than was apparent in 1820. In fact, this correlation was not significant statistically.

Although statistical analysis failed to reveal an overwhelming one-on-one relationship between mill production and proximity to primary roads, the location of the seven flour mills constructed after 1820 apparently was influenced by the newly constructed National Road. Two mills—Benevola and Boerstler—were situated directly beside the Pike. Four others lay within three miles of the turnpike.

The 1820 census data on grain consumption per individual mill compared with distance from Hagerstown showed a surprising correspondence. Those flour mills situated closer to the town tended to be the larger producers in the study area ($r=-.6341$, df=21, $p<.01$). This association suggests that Hagerstown dominated the local flour milling industry and, as all roads radiated from this town, provided a base for overland trade with the coast.

The correspondence of grain consumption with proximity to Hagerstown dropped somewhat by the 1850 census ($r=-.5423$, df=27, $p<.01$). This decline may indicate that trade was not centered quite so heavily on Hagerstown or that flour production was increasing in areas away from the county seat.

A strong correlation was revealed between grain consumption by flour mills in 1820 relative to grain utilization in 1850 ($r=.7704$, df=19, $p<.01$). This positive associated suggested that grain consumption (and thus flour production) increased at the majority of mills, primarily the larger establishments. The smaller flour mills tended to rise only slightly or to drop in production.

The by-passing of Washington County by the railroad precipitated a gradual decline in mill productivity within the study area. Apparently no flour mills were constructed between 1850 and 1880. Although the number of mills decreased only slightly, the overall average of grain consumption declined in the Antietam drainage by 1880. As discussed in Chapter Four, this decline occured primarily at the large flour mills established on the Antietam Creek. The smaller mills situated on the secondary streams, on the other hand, maintained basically the same output between 1850 and 1880.

A relationship existed between the amount of grain consumed per mill in 1850 and the quantity utilized by each mill in 1880 ($\underline{r}$=.5267, df=27, $\underline{p}$<.01). Unlike the association between grain consumption in 1820 and 1850, the data from the 1850 and 1880 censuses revealed a decrease in overall grain consumption/flour production. The positive correlation noted here resulted from the tendency of the flour mills to decline in production relative to each other. In fact, of the 29 mills enumerated in the 1880 manufacturing census, only seven had increased their output from 1850. Of these, five were mills located in the south half of the County that apparently had benefited from the construction of the spur line of the B & O Railroad in the 1860's.

After the Civil War, several railroads were constructed in the eastern half of Washington County. Overall, there was little correlation between grain consumption in 1880 and proximity to the nearest railroad ($\underline{r}$=-.3253, df=28, $\underline{p}$<.1). As mentioned previously, there was an association, however, between one of the railways—the B & O spur—and grain utilization by those mills located closest to it ($\underline{r}$=-.5149, df=13, $\underline{p}$<.05).

The degree of association between production by individual mills and distance from Hagerstown continued to decline the second half of the nineteenth century. Correlation between 1880 census figures and proximity to the town were low ($\underline{r}$=-.3518, df=28, $\underline{p}$<.05).

No association was evident between the quantity of grain utilized by mills in 1820 and the amount consumed in 1880 ($\underline{r}$=.0790, df=25). Overall the nineteenth century was revealed as a period of transformation within the flour milling industry of the Antietam Valley. Although there had been short term continuity in grain consumption ratios between 1820 and 1850 and again between 1850 and 1880, these did not reveal the long term trend of decline in the merchant mills and stability in the custom mills.

Several trends became apparent in the flour milling industry during the nineteenth century. First, large milling establishments had reached their pinnacle about mid-century. By 1880 several of these large mills had converted to other lines of manufacture. Those merchant mills that continued producing flour decreased their output. This decline may have been initiated by the detour of the railroad around Washington County before the Civil War and by the development of the Midwestern flour industry in the latter half of the century.

Second, the middle-sized merchant mills of 1850 generally were recorded as custom mills in 1880. The emphasis had shifted away from producing flour for the market towards manufacturing for the local community. Third, several small mills in the southern half of the County became medium-sized merchant mills the second half of the nineteenth century, probably as a direct result of the construction of the B & O Railroad spur. Unanswered are questions as to why the other railroads passing through the County generated no growth in flour production.

It is obvious that proximity to roads, canals, or railways, was not the only factor affecting mill location. By definition, a mill in the period under consideration had to be placed on a stream. In addition, the amount of flour an individual mill could produce was restricted by the stream it was located on and by the technology available to that mill.

Natural Factors in Mill Settlement Patterns

The assumption was made in Chapters One and Two that the first mills constructed in an area most likely were established on small branch streams due to technological and capital restraints, and subsequently expanded to larger streams. This succession may not have occured in the Antietam drainage, at least during the resettlement following the French and Indian Wars. Over half the flour mills listed in the 1783 tax assessment were constructed along the Antietam Creek—the largest stream in the study area. It is conceivable, however, that the tax assessors did not count very small mills operated by individual families—the first mills that would have been constructed in a newly settled area and established on small streams.

The mills operating along the Antietam Creek dominated the flour milling industry of the study area throughout most of its history. These mills generally were the most valuable and the largest producers of flour. The prime mill seats on the creek were occupied well before 1783, and it is likely that the Antietam was saturated with the maximum number of mills it could hold by 1820.

Why was the Antietam Creek focused upon at such an early date? Judging from the high values accorded to the mills on this stream by the 1783 tax assessment, it is highly doubtful that these mills were constructed to provide flour for the local populace only. The Antietam mills most likely were conceived as merchant mills from the first. Although not a particularly large stream, the Antietam still provided the most power potential for such enterprises in the study area. It also required capital improvements beyond the reach of many small-time millers.

The advantage of greater waterpower potential on the Antietam Creek may have offset the benefit of sitting on the primary thoroughfares of eighteenth, and even nineteenth century Washington County. This advantage may have been the reason why so many of the mills located on the Antietam in the 1794 map of the County were not beside major roads.

The mills located within the Antietam drainage exhibited patterning in their spacing along the streams. On the Antietam Creek, a total of eighteen mills with known locations were constructed along its course over the history of the County. These mills, which included those other than flour mills, revealed significant regularity of spacing ($p<.1$). Flour mills considered by themselves were not quite regular in their spacing; however, the flour mills on the Antietam recorded in the 1783 tax assessment were highly regular in their distribution along the stream ($p<.025$).

Waterpowered industries of all types on Little Beaver and Little Antietam Creeks were also regularly spaced ($p<.1$), although flour mills were not. It must be kept in mind, however, that the sample sizes for these two streams--three and six flour mills respectively—were very small.

In contrast, the flour mills on Beaver Creek were tightly clustered ($p<.025$). Both clusters lay near major roads extending from Hagerstown towards the east. Those mills on Forbush's Run (seven) exhibited randomness in their spacing along this stream.

It is possible that the regularity of mill spacing on several of the creeks represented the saturation point for mills on these streams. This certainly could have been true for the Antietam Creek, which had a low head or fall, and could support relatively few mills without the dam of one backing water onto the wheel of the mill immediately upstream. Several court suits detailing the disruption of mill operations on the Antietam by backwater are recorded in Washington County. Few suits were recorded for the other streams as the fall of water was higher and thus less inclined to back up onto upstream mills.

The amount and fall of water determined the power available to a mill. In 1820 a negative correlation existed between the fall of water and the quantity of grain utilized at a given mill in the Antietam drainage (r=-.5476, df=21, $p<.01$). As discussed previously, those mills that produced the most flour were constructed primarily along the Antietam, which—although it had a relatively low fall—carried a greater force of water relative to other streams in the study area.

At mid-century, the correlation of fall and flour production essentially remained unchanged (r=-.5064, df=26, $p<.01$). By 1880, however, less of an association existed between the two (r=-.3452, df=27, $p<.01$). The mills on the Antietam had decreased in productivity, whereas several mills with falls ranging from 18 to 22 feet in the south half of the study area had increased their output. The drop in association may not mean that the fall of water was any less important, but rather it may have signalled the decline in the large mills on the Antietam.

Merchant Mills vs. Custom Mills

Merchant mills and custom mills, although they utlized the same machinery throughout most of their history, belonged to different economic systems. Custom milling remained tied to the community, serving people within a limited range. Merchant mills, on the other hand, produced flour for markets and customers outside the local community.

A fundamental problem with Langhorne's assertion discussed in Chapter One--that gristmills as a market-oriented industry will be located near their markets and sawmills (a material-oriented industry) will be dispersed across frontier areas—originates from the fact that Langhorne did not differentiate between the two systems of custom and merchant milling. It can be argued that merchant mills also were material-oriented as they too were near the grain fields necessary for flour production and thus away from their markets.

The question arises as to whether individual mills in the study area shifted from one system—custom or market—to the other during the course of their history. As discussed in the previous section, the large mills on the Antietam most likely were perceived as market-oriented flour mills from the beginning. These same mills continued in their market orientation throughout their history, even in their decline during the latter half of the nineteenth century.

Reviewing tax assessment values and grain consumption figures, it appears that the majority of the small mills that probably began as community-oriented custom mills continued in that capacity until their demise. An exception was the flour mills along the B & O Railroad spur which experienced a florescence in the latter decades of the nineteenth century.

Although the primary concern of custom mills was to grind the wheat and corn of the local populace for their own use, it was not uncommon for these small mills to produce a modest amount of flour for the market. This somewhat blurred the distinction between custom and merchant milling, but nonetheless it is postulated that merchant and custom mills represented separate economic systems of flour manufacturing. There did not appear to be much switching from one system to the other by flour mills within the study area.

It was presumed initially that when flour milling declined in Washington County during the latter half of the nineteenth century, the first flour mills to close would have been the small, marginal producers. Instead, the large merchant mills declined in production or converted to other lines of manufacturing. The small custom mills in the study area, on the other hand, remained in production and declined but little.

The market-orientation of the merchant mills made them more suseptible to outside decision-making than did the community-orientation of the custom mills. Custom mills, which produced corn meal and animal feed in addition to flour, served local needs that were only slightly affected by larger marketing forces. The decline in flour production apparently was initiated by shifts in external markets since it was the merchant mills that first suffered a downturn and not the community-oriented mills. The decline of the custom mill followed the increasing penetration of national markets into rural areas and the stringent sanitary laws enacted in the 1930's.

Many waterpowered industries associated with flour mills during the eighteenth and nineteenth centuries. As discussed in Chapter Two, several of these—saw, fulling, and carding mills—generally operated on a custom basis. Although information is incomplete, most known sawmills from the first half of the nineteenth century operated alongside the large mills of the Antietam Creek. Carding mills were found at both large and small flour mills in the study area.

Additional industries—paper, powder, plaster, and small textile mills--also paired with flour mills in the Antietam drainage. The majority of the known plaster mills were associated with the larger flour mills. A paper mill operated at Martin's Mill and a powder mill at Booth's Mill. Both of these sat on the Antietam and were medium-sized flour producers in the early decades of the nineteenth century.

It appears that most ancillary waterpowered industries were established at the larger flour mills in the study area. This apparent tendency provides additional evidence of the commercial character of the larger flour mills, especially those along the Antietam.

CHAPTER SIX
CONCLUSION

One of the more interesting aspects of mill settlement in the Antietam drainage was the division of flour mills into two apparent systems—custom mills and merchant mills. Although separated into two distinct groups in the literature on the history of milling, differences in settlement patterns had not been previously investigated. In the Antietam Valley distinct patterns emerged between custom and merchant mills in size, location, and influence of external marketing forces. It is probable that the two types of flour mills represented different aspects of eighteenth and nineteenth century culture—custom mills tied to the local community and merchant mills to the larger region or nation.

Discussions in preceding chapters revealed that flour production in Washington County was linked to large marketing centers on the coast. In turn, competition between these cities for trade in Washington County and in other areas produced rival transportation networks constructed by each city to draw business to itself. It was determined that these external markets and their transportation systems primarily affected the merchant mills of the Antietam drainage.

The construction of apparent market-oriented mills on the Antietam Creek prior to 1783 points towards an early tie to regional marketing centers, in particular Baltimore. Accounts written in the early 1800's describe overland shipment of flour to Baltimore and water-borne transport to the port cities of Georgetown and Alexandria. Without these cities, or others like them, there would have been no merchant milling industry in Washington County.

The merchant mills of the Antietam drainage clearly were part of a large-scale economic system. The development of various transportation networks from the coastal cities into Washington County reflect the core/periphery or city/hinterland relationships that tied the merchant milling industry to these cities. Correlation of mill production with distance from Hagerstown probably indicates the intermediary role Hagerstown played as an entrepot (Paynter 1982:116-117).

Shifts in transportation networks, with the probable exception of the B & O Railroad spur, did not heavily influence flour production at individual mills already in operation. Instead, the predominant transportation mode of an era affected the location of newly constructed flour mills. Early mills sat near or alongside the first roads through the County. Larger mills were established close to Hagerstown, the center of trade. The flour mills constructed during the second quarter of the nineteenth century were built alongside or near the National Road.

As most of the mills in the Antietam drainage were constructed by 1820, difficulties were encountered with studying changes in mill placement through time. Obviously, flour mills were fixed assets on the landscape--once constructed they did not move. To circumvent this problem, relationships between grain consumption/flour production by individual mills and changes in transportation networks were investigated to determine whether a mill's output was influenced by shifts in transportation modes. Statistical tests of these two variables were not very successful and on the whole revealed slight connection between the two variables.

A problem with the statistical methods used in this study is their simplistic nature. To arrive at a more sophisticated understanding of mill settlement patterns, statistical tests that examine the interrelationships of several factors at one time are required. Grain consumption, distance from transportation networks, distance from Hagerstown, and stream location (head of water) are all factors that, taken together, formed the patterns for mill placement in the study area. These components of mill settlement can be understood only when viewed in relation to each other. This study represents only a tentative step towards pattern recognition.

Relative to the milling industry of the United States in general, flour milling in the Antietam drainage passed through several phases. As in any newly settled area, mills initially were small and served a limited number of people. The rise of merchant milling in Washington County was tied to the development of Baltimore as a major flour exporter during the second half of the eighteenth century. Although shipment to market involved laborious transport over poor roads, the flour milling industry in the Antietam Valley apparently was highly developed by the first decades of the nineteenth century.

With the improvements of the Patowmack Company followed by the C & O Canal, much of the flour produced by the mills of Washington County was shipped to the growing cities of Georgetown and Alexandria. The National Turnpike, however, also conveyed large amounts of flour from the study area to Baltimore. Indeed, the first half of the nineteenth century was a prosperous time for the millers of the Antietam drainage.

The railroad transformed the complexion of the flour milling industry within the United States. The center of flour production shifted to the Midwest, closer to new and larger wheat fields. In the long term, this caused a decline in flour milling on the East Coast. In the short term, the railroad hurt mills in the Antietam drainage because it by-passed them in favor of other areas in the East.

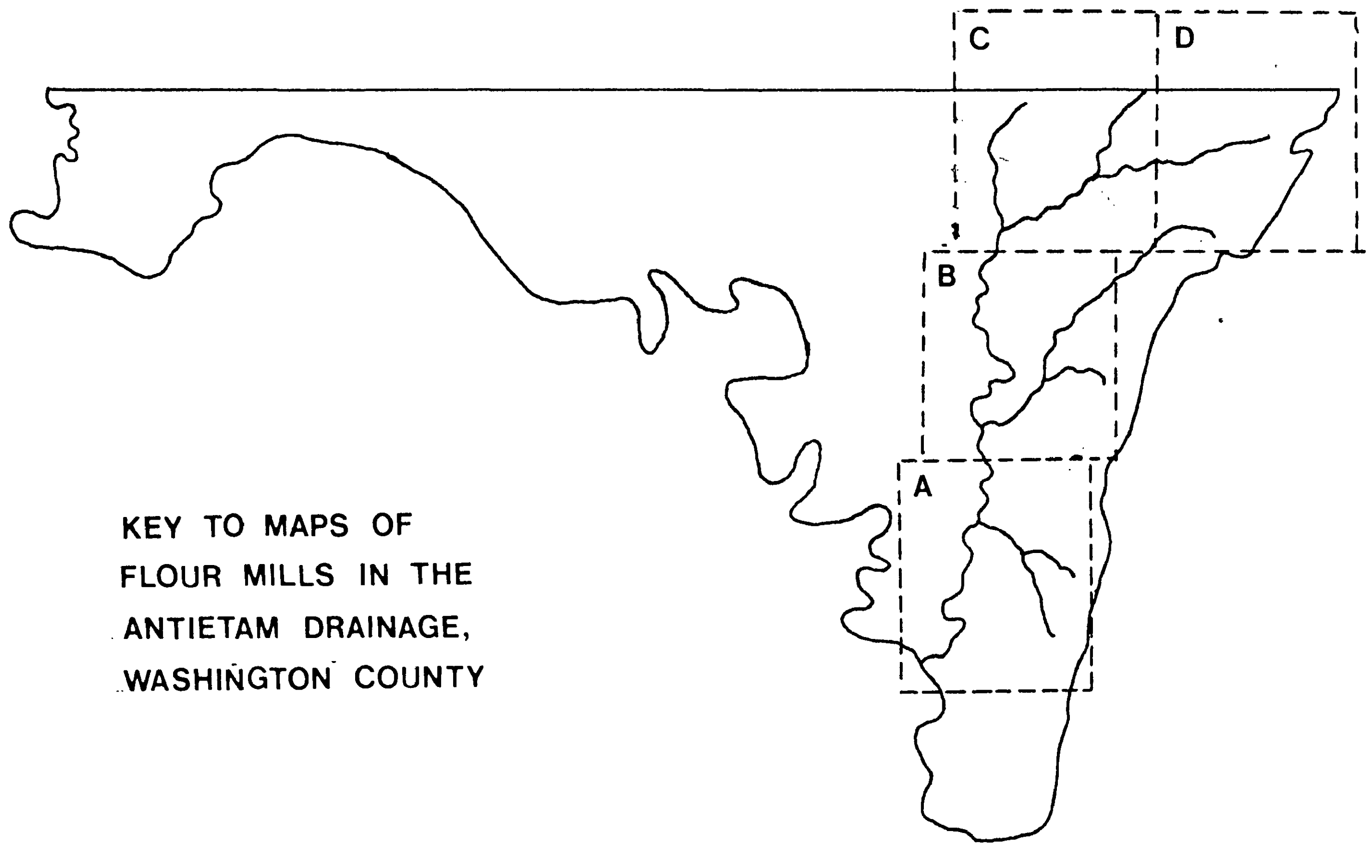
The association of the merchant mills in the Antietam Valley to external marketing centers, especially Baltimore, is eloquently testified by the decline of these mills with the decline of the eastern ports as flour producers and exporters. The gradual demise of merchant milling within the Antietam drainage represented one small part of the large-scale shift of flour milling to the Midwest and the city of Minneapolis. The history and settlement patterns of the market-oriented flour mills in the Antietam Valley can be understood only in the context of the larger marketing, or core/periphery, system.

Custom mills, on the other hand, were patterned within the context of the local cultural system. The spatial relationship between the community and custom mills, however, remains poorly understood.

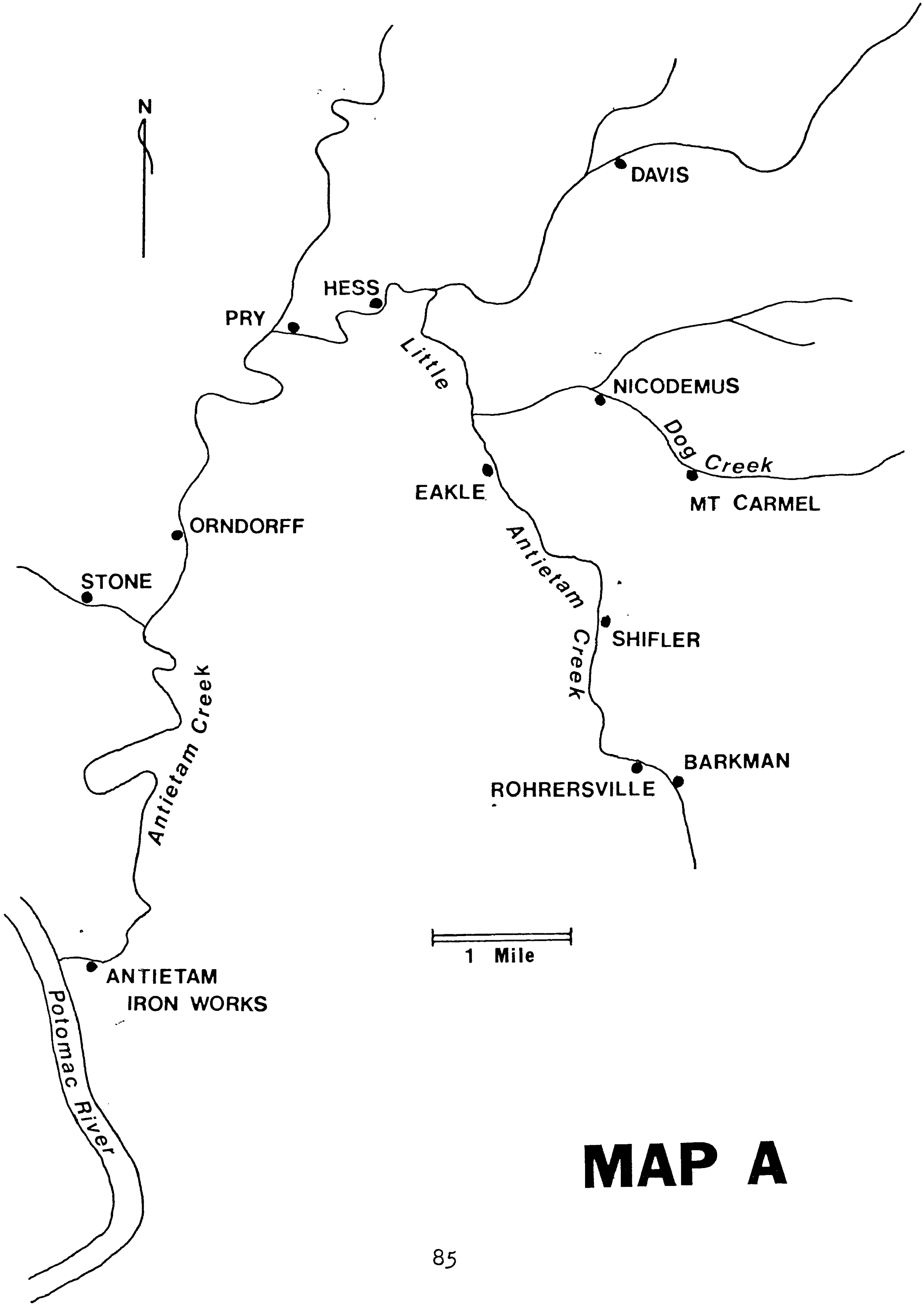
The Antietam drainage may represent too small an area to study effectively the progression of mills from smaller to larger streams, especially as the Potomac River is not included in this survey. From a regional perspective, a gradual mastering of larger and larger streams, up to the development of the large mill town, is probably an accurate representation.

In conclusion, the settlement patterns of flour mills do represent cultural patterning. Merchant mills reflect the presence of large-scale interregional marketing processes. Custom mills are part of a local, small-scale economic system. Shifts in the large-scale system are revealed through changes in settlement patterns of merchant mills within the Antietam Valley. The apparent stability of the custom mills within the study area may represent the durability of small-scale cultural systems within the larger region or nation. A more refined understanding of the patterning behind the flour mill industry in the Antietam drainage may be gained through a multivariate approach to statistical analysis that considers the many factors involved in mill settlement patterns.

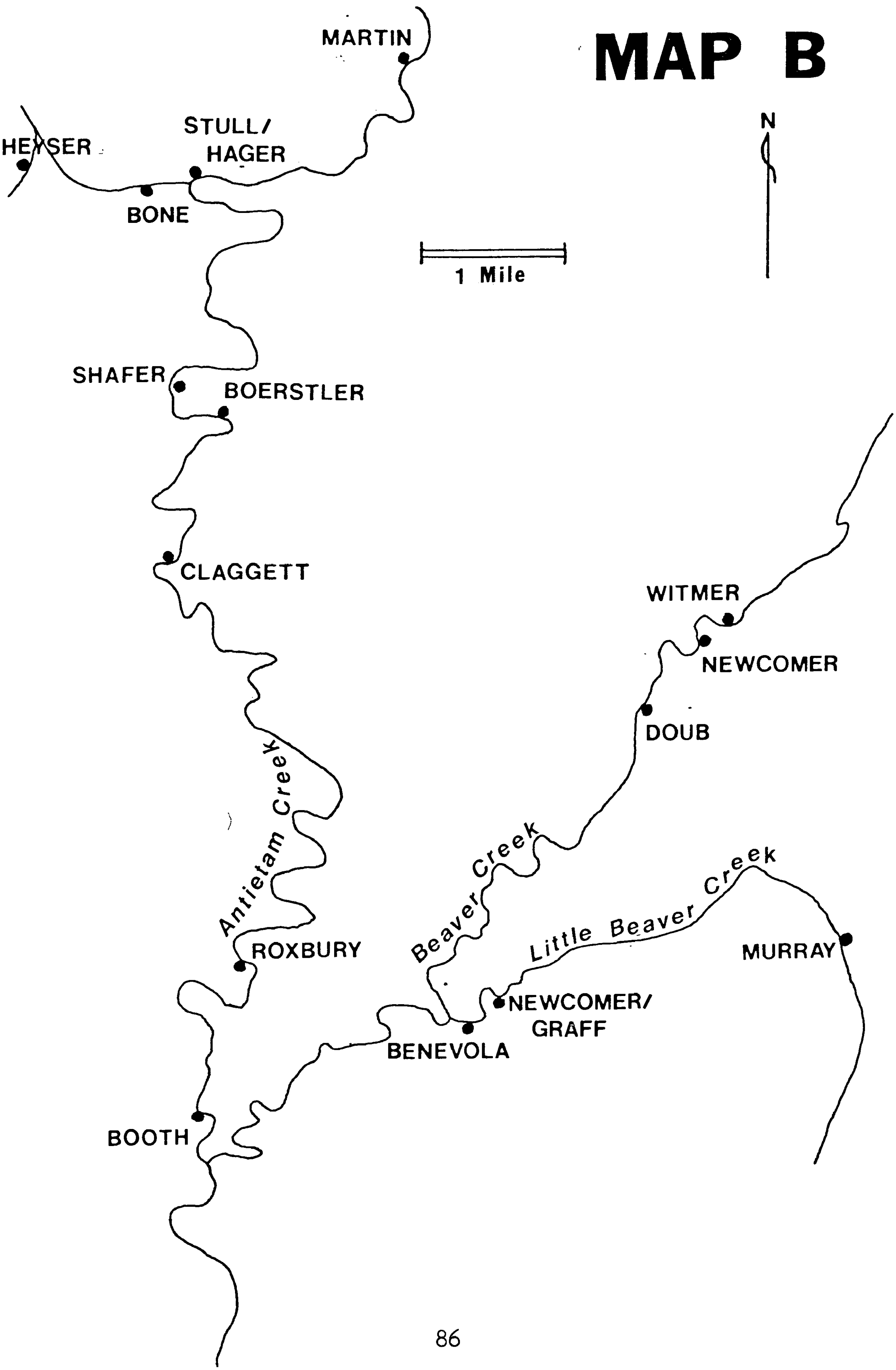
APPENDIX 1
LOCATION OF FLOUR MILLS IN THE ANTIETAM DRAINAGE



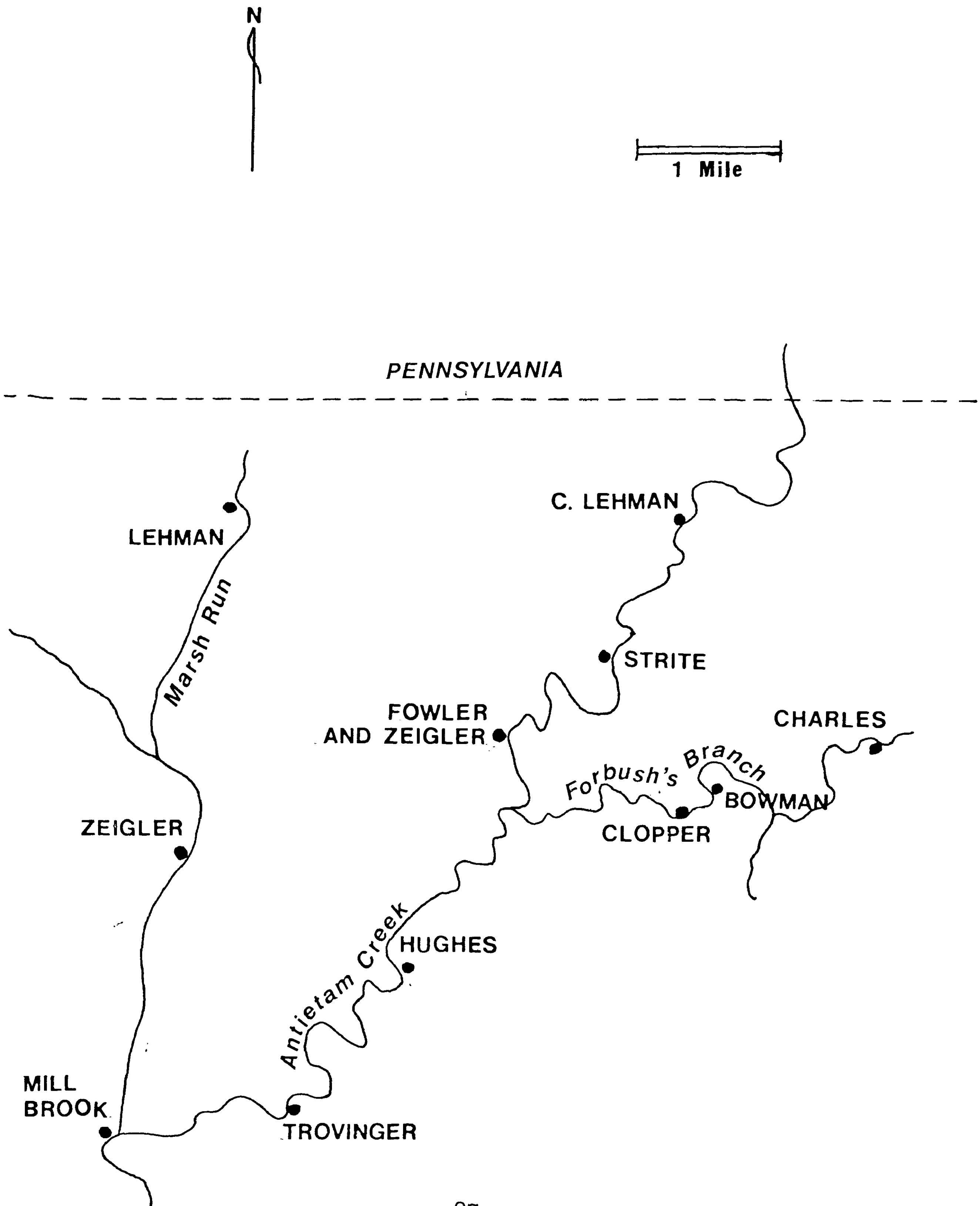
KEY TO MAPS OF
FLOUR MILLS IN THE
ANTIETAM DRAINAGE,
WASHINGTON COUNTY


N
DAVIS
HESS
PRY
Little
NICODEMUS
Dog Creek
EAKLE
MT CARMEL
ORNDORFF
STONE
Antietam Creek
SHIFLER
Antietam Creek
BARKMAN
ROHRERSVILLE
1 Mile
ANTIETAM
IRON WORKS
Potomac River

MAP A

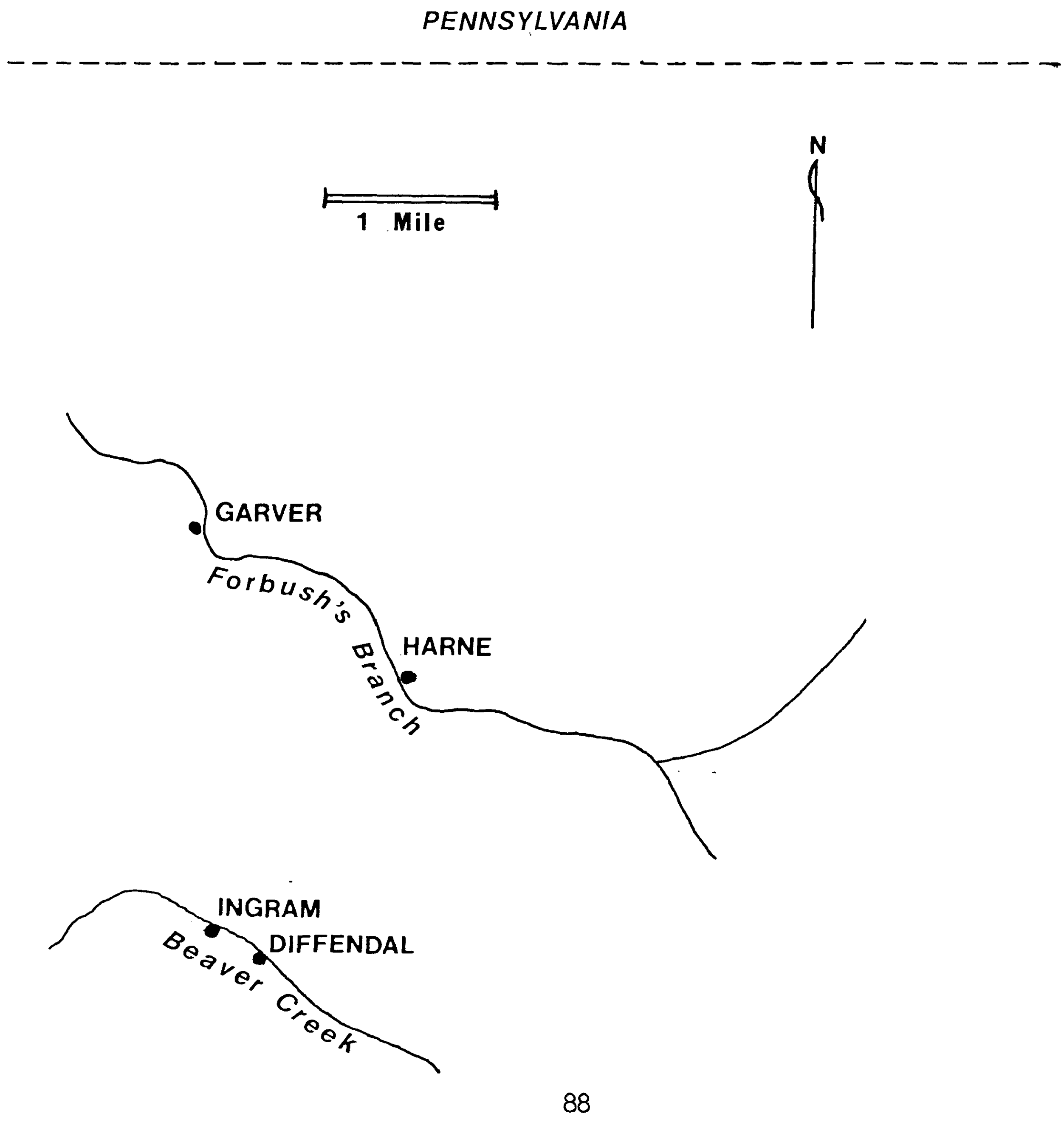

MAP B
N
1 Mile
MARTIN
HEYSER
STULL/
HAGER
BONE
SHAFER
BOERSTLER
CLAGGETT
Antietam Creek
ROXBURY
BOOTH
WITMER
NEWCOMER
DOUB
Beaver Creek
Little Beaver Creek
MURRAY
NEWCOMER/
GRAFF
BENEVOLA

MAP C



N
1 Mile
PENNSYLVANIA
LEHMAN
Marsh Run
ZEIGLER
MILL
BROOK
C. LEHMAN
STRITE
FOWLER
AND ZEIGLER
CHARLES
Forbush's Branch
BOWMAN
CLOPPER
Antietam Creek
HUGHES
TROVINGER

MAP D


PENNSYLVANIA
1 Mile
N
GARVER
Forbush's Branch
HARNE
INGRAM
DIFFENDAL
Beaver Creek

APPENDIX 2
GRAIN CONSUMPTION DATA FROM MANUFACTURING CENSUSES

GRAIN CONSUMPTION DATA FROM MANUFACTURING CENSUSES (IN BUSHELS)

Name of Mill	1820	1850	1880
Antietam Forge	listed	13,500	
Antietam Iron Works	listed	-----	3,910
Barkman	4,000	1,000	6,250
Benevola		11,600	11,375
Boerstler		-----	
Bone	-----	-----	
Booth	10,000	-----	62,000
Bowman	12,000	36,500	6,000
Charles	9,000	-----	-----
Claggett	30,000	75,000	50,000
Clopper	-----	-----	-----
Davis	10,000	15,000	2,727
Diffendal	6,000	2,600	8,000
Doub	-----	13,700	13,400
Eakle	2,000	2,000	15,350
Fowler & Zeigler	8,000	9,000	distillery
Garver	-----	13,200	6,000
Harne	8,000	6,000	2,933
Hess	-----	6,450	16,500
Ingram	-----	10,500	1,500
C. Lehman	21,000	10,000	3,500
Lehman	-----	22,000	12,000
Martin	12,000	-----	22,500
Mill Brook	25,000	42,000	paper
Mt. Carmel	-----		
Murray		2,700	3,700
Newcomer	20,000	14,375	10,700
Newcomer/Graff	15,000	16,000	9,600
Nicodemus		8,800	12,900
Orndorff	20,000	31,000	12,500
Pry		13,000	30,000
Rock Forge	listed	-----	implements
Rohrersville	4,000	6,000	
Rose	26,035	-----	-----
Roxbury	18,250	31,000	14,203
Shafer	25,000	35,300	fertilizer

Name of Mill	1820	1850	1880
Shifler		———	
Strite	———	24,000	14,000
Stone Mill	8,000	———	1,600
Stull/Hager	———	30,000	16,000
Trovinger	18,000	10,500	1,350
Virginia Ave.	———	implements	
Wealty		5,500	
Witmer	3,000	———	7,000
Zeigler	———	———	27,632

APPENDIX 3
FLOUR MILL DATES OF OPERATION

DATES OF OPERATION FOR MILLS IN THE ANTIETAM DRAINAGE

Name of Mill	Construction	Demise
Antietam Forge	c 1770	1854-1880
Antietam Iron Works	before 1783	after 1880
Barkman	1802-1808	after 1920
Benevola	1820-1824	after 1880
Boerstler	1820-1832	1856-1877
Bone	1794-1808	c 1880
Booth	before 1783	1898
Bowman	1773-1783	after 1930
Charles	before 1783	after 1885
Claggett	1783-1794	1883-1901
Clopper	1808-1818	c 1900
Davis	1808-1820	after 1882
Diffendal	just before 1820	c 1930
Doub	1783-1794	c 1900
Eakle	1783-1794	c 1900
Fowler & Zeigler	before 1783	1860-1880
Garver	1783-1794	c 1900
Harne	just before 1820	after 1880
Hess	1762-1770	after 1910
Ingram	c 1798	c 1920
C. Lehman	c 1770	1886
Lehman	1783-1808	present
Martin	before 1800	c 1900
Mill Brook	before 1783	c 1864
Mt. Carmel	1794-1808	1824-1859
Murray	c 1826	1880-1904
Newcomer	before 1783	1920's
Newcomer/Graff	1783-1794	after 1880
Nicodemus	1829	c 1900
Orndorff	c 1762	c 1900
Pry	c 1830	1926
Rock Forge	c 1783	c 1907
Rohrersville	before 1783	c 1880
Rose	before 1783	c 1900
Roxbury	before 1783	1887-1904
Shafer	before 1783	1850-1860
Shifler	c 1850?	c 1880?

Name of Mill	Construction	Demise
Strite	1798	after 1898
Stone Mill	1801-1808	c 1920
Stull/Hager	c 1739	c 1900
Trovinger	before 1761	c 1900
Virginia Ave.	?	?
Wealty	c 1844	1850-1880
Witmer	c 1739	after 1880
Zeigler	1780-1783	after 1905

APPENDIX 4
1880 CENSUS DATA

1880 CENSUS DATA

Mill Name	Trade	Stones	Fall	Wheels	Capacity (bu/day)
Antietam Iron Works	custom	3 run	20 ft	1 20-in Leffel turbine	200
Barkman	custom	2 run	18 ft	1 3-ft overshot	50
Benevola	1/3 custom	2 run	13 ft	1 12-ft overshot	200
Booth	market	5 run	8 1/2 ft	2 4-ft turbines	400
Bowman	custom	2 run	6 ft	2 5-ft overshot	75
Claggett	market	4 run	7 ft	2 4-ft turbines	600
Davis	custom	2 run	22 ft	1 20-ft overshot	200
Diffendal	custom	2 run	28 ft	1 3-ft overshot	150
Doub	1/8 custom	3 run	9 ft	2 16-ft overshot	100
Eakle	3/4 custom	2 run	16 ft	2 5-ft overshot	100
Garver	custom	2 run	18 ft	1 4-ft overshot	50
Harne	custom	2 run	14 ft	1 3-1/2-ft overshot	60
Hess	1/4 custom	3 run	12 ft	1 9-ft overshot	150
Ingram	custom	2 run	——	1 2-1/2-ft overshot	25
C. Lehman	custom	4 run	7 ft	2 5-ft turbines	75
Lehman	1/3 custom	4 run	14 ft	2 2-1/2-ft turbines 1 boiler engine	140
Martin	1500 bu custom	3 run	4 ft	2 4-ft reaction turbines	100
Murray	custom	2 run	24 ft	1 2-ft pitchback	60
Newcomer	market	3 run	9 ft	2 20-ft overshot	160

Mill Name	Trade	Stones	Fall	Wheels	Capacity (bu/day)
Newcomer/Graff	2/5 custom	2 run	13 ft	1 12-ft overshot	210
Nicodemus	1/3 custom	2 run	20 ft	1 18-ft overshot	200
Orndorff	custom	1 run	8 ft	2 6-ft undershot	60
Pry	1/2 custom	5 run	22 ft	2 5-ft overshot	300
Roxbury	custom & market	3 run	9 ft	1 4-ft turbine	225
Strite	custom	3 run	4 1/2 ft	2 4-ft turbines	100
Stone Mill	custom	2 run	24 ft	1 4-ft overshot	25
Stull/Hager	1000 bu custom	3 run	6 ft	3 overshot, 1 turbine	100
Trovinger	custom	2 run	8 ft	2 7-ft undershot	50
Witmer	9/10 custom	2 run	9 ft	1 15-ft overshot	150
Zeigler	1000 bu custom	3 run	18 ft	2 5-ft overshot	75

NOTES

Chapter One

[1] Langhorne bases his ideas of material vs. market orientation on Alfred Weber's Theory of the Location of Industries. In the words of Langhorne (1976:77): "An industry will be material oriented (i.e. located at the source of its chief raw materials with gross materials) if there is a large weight loss during manufacture and if the raw material makes up a relatively large portion of the cost of the finished product. Market orientation (location at the market/customer area with pure materials) will occur if there is little or no weight loss between raw material and finished product, if transportation costs are higher on the product than on the material and if the material has a high value relative to its weight."

[2] As far as I have been able to determine, industrial archeologists rarely "do" archeology in the traditional sense of the word. Reviewing newsletters of the Society for Industrial Archeology, it is apparent that most enthusiasts are engineers, architects, and historians. The emphasis has been on recording and studying standing structures, particularly bridges and large-scale nineteenth century milling complexes. Relatively little attention has been given to small, rural-based industries.

[3] Of course there is another component to mill settlement patterns not discussed in this paper— the institutional. This includes laws that define miller's rights, litigation over waterpower between millers, and legislative acts promoting and defining the construction of gristmills in newly settled areas. Such traditions and legislative acts influenced mill placement, but they will not be examined here. For a good account of institutional aspects of mill settlement see Hunter (1979).

[4] Census schedules furnish the raw data from which tabulated and published census results are drawn. The schedules record information on individual establishments, providing invaluable data on each mill. For an excellent review of nineteenth century manufacturing censuses and their accuracy (or inaccuracy) consult Fishbein (1973).

Chapter Two

[1] A head of water is the difference in level between water entering the water wheel and that leaving the wheel. It is also known as the fall of water.

[2] A rynd, or rind, is the crossbar containing the bearing on which the upper stone of a pair of millstones rests.

[3] The elevator was a revolving band of leather upon which were attached wooden or sheet metal buckets spaced about twelve inches apart. The conveyer, as desribed by Bathe and Bathe (1972:14) originially was "a succession of wooden plows staggered along a revolving wooden core." Subsequently, it "was improved into an endless screw of two spires made of sheet iron and wound around a wooden shaft from five to twenty feet long; this revolved in a close fitting trough of boards and by this means the grain could be moved anywhere in the mill in a horizontal plane." The drill was used for purposes similar to the conveyer. It was a revolving leather band with wooden rakes attached to it which was operated by pulley action (as was the elevator). The drill was used on a horizontal plane or for slight ascents—it pushed the grain along a trough until it reached the necessary chute.

[4] Hundredweight.

Chapter Three

[1] According to Bridenbaugh (1980:147), this isolation would have been relative indeed: "Although these crude thoroughfares were not all that one would have desired, abundant evidence demonstrates that a network of highways spread over the Back Country within a relatively short time after settlement. The popular cry was for more and better communication, not a wail over no roads at all, as we have often been led to think. The authorities, moreover, seem to have responded promptly and, on the whole, generously to demands for bridges and ferries."

[2] One such instance of millowners privately constructing bridges occured at Rose Mill. On January 13, 1795, owner David Rowland advertised in the Washington Spy: "Whereas I gave notice . . . that as the bridge over Antietam, at my mill, was built at my private expense, I would hereafter charge persons making use of said bridge certain Tolls, mentioned in said advertisement, to reimburse me for building the same— And whereas I did not intend by said advertisement, to include persons who should make use of the bridge by reason of having work done for them either at the Grist, Saw or Hemp Mills, or at the Blacksmith's Shop at said place.— Now I hereby give public notice that all such persons may pass and repass the said bridge, for said purposes, without paying any toll . . ." Rowland also exempted those traveling to and from church on Sundays.

[3] A Student's *t*-test comparing average values for mills on Antietam Creek and those on other streams provides significant figures: $t=2.58$, $df=19$, $p<.01$. The Student's *t* statistic for comparing two means is

$$t = \frac{(\bar{y}_1 - \bar{y}_2) - D_0}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

In this instance, y_1 represents the mean value of the flouring mills on the Antietam and y_1 the average value for mills on other streams. The standard deviation is expressed by s; n_1 indicates the number of mills on the Antietam and n_2 the number of mills on the other streams.

The Student's *t* statistic allows one to make inferences about the comparison between two means. Using a table provided by Mendenhall (1979:535), the significance level of the critical value, *t*, is disclosed. In this example, the differences in the mean values between mills on the Antietam and mills on other streams is shown to be significant because t=2.58 does not fall within the rejection region of the chart for df=19.

4 A Student's t statistical test comparing "complete" Evans' mills against those mills that may not have had the full complement of machinery gives t=4.10, df=21, p<.01.

5 Problems exist, however, with the data for the 1820 manufacturing census. In many instances it is difficult to match the census data with its particular mill, for the person who provided the information for the census and was listed as the proprietor of the mill was not necessarily the owner. Leases were rarely recorded in land records and could not be traced in most cases. As a result, 26 mills were matched with census schedule data out of approximately 36 flouring mills believed operating at that period (i.e. maps or deeds provide evidence of a mills operating before 1820). This leaves about 10 mills unaccounted for in this study.

Not surprisingly, approximately 10 sets of mill data from the 1820 census have not been identified as belonging to a particular mill. The data on these schedules reflects mills with below average outputs, which means that the average production figures cited in the text for the 1820 census are somewhat high. Perhaps this points to a higher percentage of the smaller mills being leased or run by wage-earning mills than with the larger mills.

Three mills out of the 26 matched with census schedules are not used here because they primarily document iron-making complexes and do not detail operations at the flouring mills on the properties.

6 A Student's t-test comparing average grain consumption figures in 1820 for mills on Antietam Creek and those on other streams provides significant figures: t=3.86, df=23, p<.01. The average bushels of grain consumed by Antietam Creek mills was 19,390/mill; for streams on it tributaries 11,222/mill.

Chapter Four

1 A November 27, 1835 bill of sale in The Mail for Shafer's Mill in Funkstown listed proximity to the canal as an asset and, in fact, heavily stressed transportation features overall: " . . . Being distant only six miles from Williamsport on the Chesapeake and Ohio Canal, and near Hagerstown, (with a Turnpike leading to both places) one of the best wheat markets in the state, where large quantities of grain find its market from Pennsylvania, etc. The proposed railroad contemplated from Chambersburg and passing through Hagerstown, to intersect the Baltimore and Ohio Rail Road at Weverton on the Potomac, will pass very near this place."

2 The 1850 manufacturing census schedules had many of the same problems as those from 1820. In this case, 30 mills were paired with census data out of about 41 mills known to have operated around this period.

3 A Student's t-test comparing wheat consumption of mills located on Antietam Creek with mills located on other streams reveals a significant

statistic of t=3.45, df=28, p<.01.

[4] Minor injuries to the mill properties did occur, however, as revealed in an 1863 Chancery Court suit (CR 8:210) concerning the Newcomer/Graff Mill on Little Beaver Creek: "/The/ property is greatly out of repair and is decaying daily. The mill now requires new floors, new works, and constantly needs repairing, all the fencing on the land has been destroyed by the armies."

[5] An advertisement recorded in the chancery suit states: "There is a private switch upon the Washington County branch of the B. & O. R.R., 1/2 mile from the Mill, from which shipments of flour are usually made. This switch and the rights connected therewith will be sold with the mill property."

[6] Unlike the previous two industrial censuses, all data on the 1880 census schedules were matched with their individual mills. Although men other than the owners were still listed as proprietors, additional information—such as the streams on which individual mills sat—allowed identification of the mills.

[7] Student's t comparing consumption averages of merchant and custom mills gives a significant result in this case: t=2,921, df=28, p<.01.

BIBLIOGRAPHY

Abbreviations

FCWB—Frederick County Will Books
WCCR—Washington County Chancery Records
WCHSS—Washington County Historic Structures Survey

Primary Sources

Frederick County Land Records
Frederick County Will Books
Washington County Chancery Court Records
Washington County Land Records
Washington County Patent Books
Washington County Road and Land Records
Washington County Tax Assessment, 1783
Washington County Will Books

1794 Map of Maryland, by Dennis Griffith. 2nd Edition (1813)
1808 Map of Frederick and Washington Counties, surveyed by Charles Varle
1859 Map of Washington County, surveyed by Thomas Taggart. Published by L. McKee and C.G. Robertson
An Illustrated Atlas of Washington County, Maryland. Surveyed by Lake, Griffing and Stevenson. Philadelphia, 1877.

The Boonsboro' Odd Fellow
Hagers-Town Gazette

The Hagers-town Torch Light and Public Advertiser
Hagerstown Weekly Mail
The Herald and Torch Light

The Maryland Herald and Elizabeth-Town Advertiser
The Maryland Herald and Elizabeth-Town Weekly Advertiser
The Maryland Herald and Hagerstown Times
The Maryland Herald and Hagers-town Weekly Advertiser

1820 Census of Manufactures schedules, Washington County, Maryland
1850 Census of Manufactures schedules, Washington County, Maryland
1860 Census of Manufactures schedules, Washington County, Maryland
1880 Census of Manufactures schedules, Washington County, Maryland

Secondary Sources

Adams, William Y.
1965 "Settlement Pattern in Microcosm: The Changing Aspect of a Nubian Village during Twelve Centuries." In Settlement Archaeology, edited by K.C. Chang. Palo Alto, California: National Press Books.

Barnes, Arthur G.
1978 History of Patowmack Canal: Matildaville. Williamsburg: Southside Historical Sites, Inc.

Bathe, Grenville and Dorothy Bathe
1972 Oliver Evans, A Chronicle of Early American Engineering. New York: Arno Press.

Bell, Herbert C.
1898 History of Leitersburg District, Washington County, Maryland. Leitersburg: By the author.

Binford, Lewis R.
1972 An Archaeological Perspective. New York: Seminar Press.

Boerstler, Christian
n.d. "The Autobiography of Doctor Christian Boerstler." Edited by Jeffrey A. Wyand. Typescript on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

n.d. "The Journal of Doctor Christian Boerstler, Prominent Funkstown Resident." Translated by Jeffrey A. Wyand. Typescript on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

Bridenbaugh, Carl
1980 Myths and Realities: Societies of the Colonial South. New York: Atheneum Press.

Browning, Lyle E.
1983 "Woods and Trees in the Desert." In Piedmont Archaeology: Recent Research and Results, edited by J. Mark Wittkofski and Lyle E. Browning. Archeological Society of Virginia, Special Publication No. 10.

Buchanan, R.A.
1972 Industrial Archaeology in Britain. New York: Penguin Books.

Chinitz, Benjamin
1969 "The Effect of Transportation Forms on Regional Economic Growth." In Locational Analysis for Manufacturing, edited by Gerald J. Karaska and David F. Bramhill. Cambridge, Massachusetts: The M.I.T. Press.

Clark, Linda B., editor
1982 An Index to Hagerstown Newspapers, The Washington Spy, August 26,

1790-February 1, 1797. Hagerstown: Washington County Free Library.

Clark, Victor S.
1949 History of Manufactures in the United States, 1607-1860. New York: Peter Smith.

Dickey, Paula Stoner
n.d. "Washington County Historic Structures Study." Materials on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

Drake, Julia Angeline and James Ridgely Orndorff
1938 From Mill Wheel to Plowshare. Cedar Rapids, Iowa: The Torch Press.

Earle, Timothy K.
1976 "A Nearest-Neighbor Analysis of Two Formative Settlement Systems." In The Early Mesoamerican Village, edited by Kent V. Flannery. New York: Academic Press.

Ehrlich, Richard L.
1976 "Report of the Transportation Subcommittee." In Regional Economic History: The Mid-Atlantic Area since 1700. Worchester, Massachusetts: The Hefferman Press.

Fishbein, Meyer H.
1973 The Census of Manufactures, 1810-1890. Reference Information Paper Number 50. Washington D.C.: National Archives and Records Service.

Flannery, Kent V.
1976a "Research Strategy and Formative Mesoamerica." In The Early Mesoamerican Village, edited by Kent V. Flannery. New York: Academic Press.

1976b "Evolution of Complex Settlement Systems." In The Early Mesoamerican Village, edited by Kent V. Flannery. New York: Academic Press.

1976c "Linear Stream Patterns and Riverside Settlement Rules." In The Early Mesoamerican Village, edited by Kent V. Flannery. New York: Academic Press.

Gray, Lewis Cecil
1933 History of Agriculture in the Southern United States to 1860. Washington D.C.: Carnegie Institution of Washington.

Gutheim, Frederick
1949 The Potomac. New York: Holt, Rinehart and Winston.

Harbaugh, Thomas
n.d. "The Journal of Thomas Harbaugh." Photocopy on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

Hays, Helen Ashe
1910 The Antietam and Its Bridges: The Annals of an Historic Stream. New York: G.P. Putnam's Sons..

Hensley, Paul Brent
1969 "Grist Milling in Eighteenth-Century Virginia Society: Legal, Social, and Economic Aspects." Masters Thesis, College of William and Mary.

Hodder, Ian and Clive Orton
1976 Spatial Analysis in Archaeology. Cambridge: Cambridge University Press.

House, John H.
1977 "Survey Data and Regional Models in Historical Archeology." In Research Strategies in Historical Archeology, edited by Stanley South. New York: Academic Press.

Howell, Charles and Allen Keller
1977 The Mill at Philipsburg Manor Upper Mills and a Brief History of Milling. Tarrytown: Sleepy Hollow Restorations.

Hunter, Louis C.
1979 A History of Industrial Power in the United States, 1780-1930. Volume 1: Waterpower in the Century of the Steam Engine. Charlottesville: University Press of Virginia.

Kasson, John F.
1976 Civilizing the Machine: Technology and Republican Values in America, 1776-1900. New York: Penguin Books Limited.

Kephart, Horace
1976 Our Southern Highlands. Knoxville: The University of Tennessee Press.

Kercheval, Samuel
1902 A History of the Valley of Virginia. Woodstock, Virginia: W.N. Grahill.

Kuhlmann, Charles B.
1973 The Development of the Flour-Milling Industry in the United States. Clifton: Augustus M. Kelley.

Langhorne, William T.
1976 "Mill Based Settlement Patterns in Schoharie County, New York: A Regional Study." Historical Archaeology 10:73-92.

Leone, Mark
1977 "Foreward." In Research Strategies in Historical Archeology, edited by Stanley South. New York: Academic Press.

Lewis, Kenneth E.
1977 "Sampling the Archeological Frontier: Regional Models and Component

Analysis." In Research Strategies in Historical Archeology, edited by Stanley South. New York: Academic Press.

Lloyd, Peter E. and Peter Dicken
1972 Location in Space: A Theoretical Approach to Economic Geography. New York: Harper and Row.

McGrain, John W.
n.d. "Introduction to the Mills of Washington County." Typescript on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

Mendenhall, William
1979 Introduction to Probability and Statistics. North Scituate, Massachusetts: Duxbury Press.

Morrill, Richard L.
1970 The Spatial Organization of Society. Belmont, California: Duxbury Press.

Mullenix, James W.
1976 "The Economic Development of Washington County, Maryland to 1860." Paper in requirement of A.B. degree, Princeton University. Manuscript on file at the Western Maryland Room, Washington County Free Library, Hagerstown.

Paynter, Robert
1982 Models of Spatial Inequality: Settlement Patterns in Historical Archeology. New York: Academic Press.

Pratt, Joseph A.
1976 "Regional Development in the Context of National Economic Growth." In Regional Economic History: The Mid-Atlantic Area since 1700. Worchester, Massachusetts: The Hefferman Press.

Reynolds, John
1970 Windmills and Watermills. New York: Praeger Publishers.

Rubin, Julius
1967 "Urban Growth and Regional Development." In The Growth of the Seaport Cities, 1790-1825. Charlottesville: The University Press of Virginia.

Scharf, J. Thomas
1882 History of Western Maryland. Philadelphia: Louis H. Everts.

Sharrer, G. Terry
1976 "Flour Milling in the Growth of Baltimore, 1750-1830." Maryland Historical Magazine, 71(3):322-333.

Soltow, James H.

1976 "Foundations of Regional Industrialization." In Regional Economic History: The Mid-Atlantic Area since 1700. Worchester, Massachusetts: The Hefferman Press.

South, Stanley
1977 "Research Strategies in Historical Archeology: The Scientific Paradigm." In Research Strategies in Historical Archeology, edited by Stanley South. New York: Academic Press.

Stark, Barbara L. and Dennis L. Young
1981 "Linear Nearest Neighbor Analysis." American Antiquity 46(2):284-300.

Steen, Herman
1963 Flour Milling in America. Minneapolis: T.S. Denison and Company, Inc.

Storck, John and Walter Dorwin Teague
1952 Flour for Man's Bread. Minneapolis: University of Minnesota Press.

Tenth Census, Volume 16
1885 Reports on the Water-Power of the United States, Part 1. Washington D.C.: Government Printing Office, 1885.

Thomas, David Hurst
1976 Figuring Anthropology. New York: Holt, Rinehart and Winston.

Trigger, Bruce
1970 "Settlement Patterns in Archaeology." In Introductory Readings in Archaeology, edited by Brian M. Fagan. Boston: Little, Brown, and Company.

Weiss, Harry B. and Robert J. Sim
1956 The Early Grist and Flouring Mills of New Jersey. Trenton, New Jersey: New Jersey Agricultural Society.

Willey, Gordon R.
1968 "Settlement Archaeology: An Appraisal." In Settlement Archaeology, edited by K.C. Chang. Palo Alto, California: National Press Books.

Williams, Thomas J. C.
1906 A History of Washington County, Maryland. Hagerstown: John M. Runk and L.R. Titsworth.

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