Mills in the Upcountry: a Historic Context, and a Summary of a Mill Site on the Peters Creek Heritage Preserve, Spartanburg County, South Carolina

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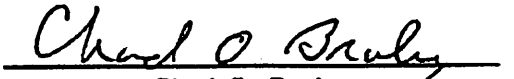

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Introduction

This report is part of the mitigation required for a permit from the U.S. Army Corps of Engineers and the South Carolina Department of Health and Environmental Control for a project to increase the size of the Lake Blalock Reservoir for the Spartanburg Water System to provide additional water resources to the residents of Spartanburg County. At the site of an old mill on Peters Creek near Spartanburg, a new stream channel will be dug around the dam, draining the mill pond and allowing the stream to return to a normal flow. The mill ruins have been recorded as an archeological site (38SP304), which is considered eligible for listing in the National Register of Historic Places (Ledbetter and Gainey 1998). Consequently, additional archival and other documentary work were undertaken to meet the mitigation requirements of the United States Army Corps of Engineers and the South Carolina Department of Health and Environmental Control for the project. This report contributes to the recently established Peters Creek Heritage Preserve by outlining the history of the mill and its associated features. In addition, this document contains rudimentary information on several hundred mills in the Upcountry of South Carolina in order to place the Peters Creek mill within a regional historic context of the development of small water powered industries such as grist mills, saw mills and cotton gins. The Upcountry is the South Carolina Piedmont encompassing Abbeville, Anderson, Chester, Cherokee, Edgefield, Fairfield, Greenville, Lancaster, Laurens, Lexington, McCormick, Oconee, Pickens, Richland, Saluda, Spartanburg, Union and York Counties.

Historic Overview

South Carolina was established in 1670 with the settlement of Charles Town, and an agricultural economy based on slave labor developed very early along the coast. In response to the colony's vulnerability to attack from Indians or slave revolts, in 1731 Governor Robert Johnson proposed that a series of townships should be established in the frontier, to be settled by European immigrants. Eight townships were originally proposed (Figure 1). They were to be located on major rivers and contain at least 20,000 acres each. The two earliest townships established in the Upcountry were New Windsor (1734), located at the fall line of the Savannah River near the site of Fort Moore, and Saxe-Gotha (1733), situated on the Congaree River in present day Lexington County (Kovacik and Winberry 1987:78-79). Both of these were also located on major trading paths leading to the Cherokee settlements in the extreme western portion of the state. By 1735, six of the townships had been partially settled.

In contrast to the original concept, little settlement took place within the township boundaries but instead spread up and down stream valleys so that the settlers could take advantage of the best agricultural lands. In New Windsor Township, settlers avoided the main portion of the Savannah River valley in favor of its smaller tributaries whose valley walls were less steep and whose floodplains were ideally suited for agriculture. The smaller valleys also were less susceptible to devastating floods. Repeating this preference for the smaller river valleys, early settlements were established along Stevens Creek south of Ninety-Six and along Long Cane Creek and its tributaries.

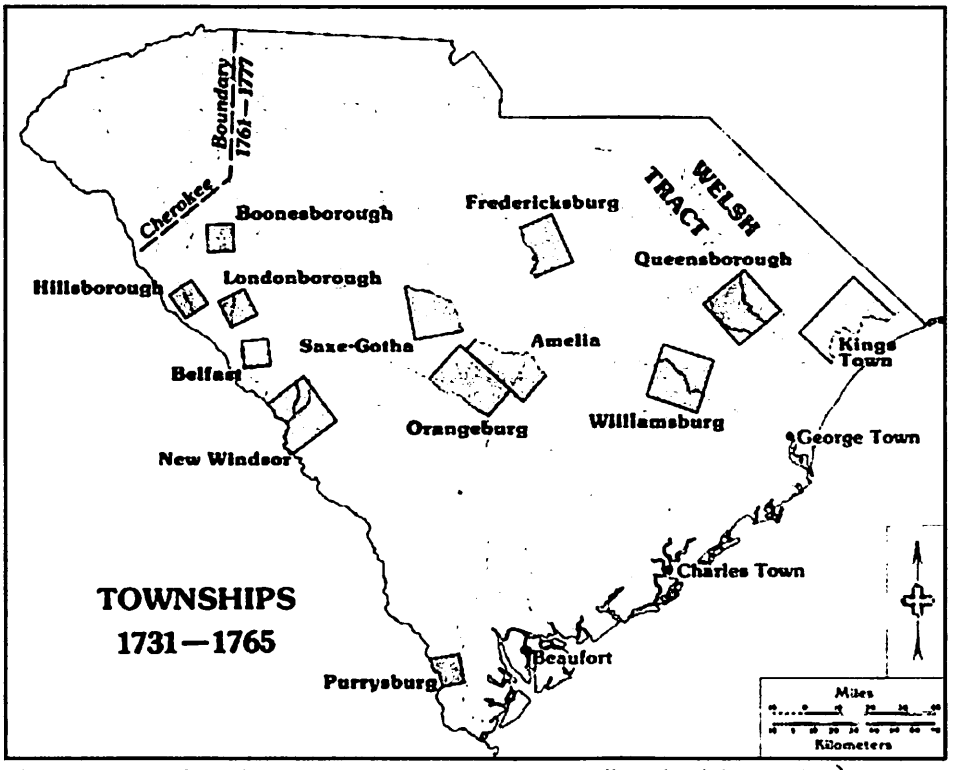

Figure 1. Map Showing Townships 1731-1765 (Kovacik and Winberry 1987).

Construction of grist mills lagged behind the initial settlement of the Upcountry, but only for the time it took to produce enough grain to warrant a mill. Clearing the land was an arduous task. Usually, the trees were killed by girdling, then they were felled. The first crops were planted among the stumps and fallen trunks. Cultivation was easier after the stumps and roots had decayed, at which point plows replaced hoes as the main implements of cultivation. Corn was the first crop planted on the newly cleared land, and farmers could expect to harvest from 20 - 30 bushels per acres (Meriwether 1940:165-166). Wheat became an important Upcountry crop during the mid-eighteenth century.

Before the first grist and flour mills were constructed, the frontier people ground their grain by hand, using a wooden mortar and pestle, small hand-turned mill stones (querns), or with a hand-cranked iron mill which had an appearance much like a large coffee grinder. In 1765, newly arriving Huguenot settlers at New Bordeaux (Hillsborough District) ground their corn with an iron mill (Meriwether 1940:253).

Several water powered mills were in existence in the 1730s and 1740s in Saxe Gotha Township, making these some of the earliest in the Upcountry. According to Meriwether (1940), in 1739 Joseph Crell wrote that he had been at great expense "in Erecting a Water Mill." Probably this mill was on Thoms Creek in Lexington County. About 1749, William Hay built a "Griss Mill" in the southern portion of Richland County, probably near the site of the dam on the present Adams Pond on Mill Creek. Back in Lexington County, a grist mill, wind mill(!) and a broken saw mill were on Herman Geiger's property around 1750 (Meriwether (1940). Perhaps these correspond to the Geigger's Mills depicted in *Mill's Atlas;* one on Thoms Creek and the other on a tributary of Congaree Creek.

Elsewhere in the Piedmont, again citing Meriwether (1940), around 1747 a mill was in existence at the headwaters of Stevens/Cuffytown Creek, not too distant from Ninety-Six. In the Broad River drainage, the first mill mentioned was on Wilkinsons Creek in 1752. In 1753 Peter Crim

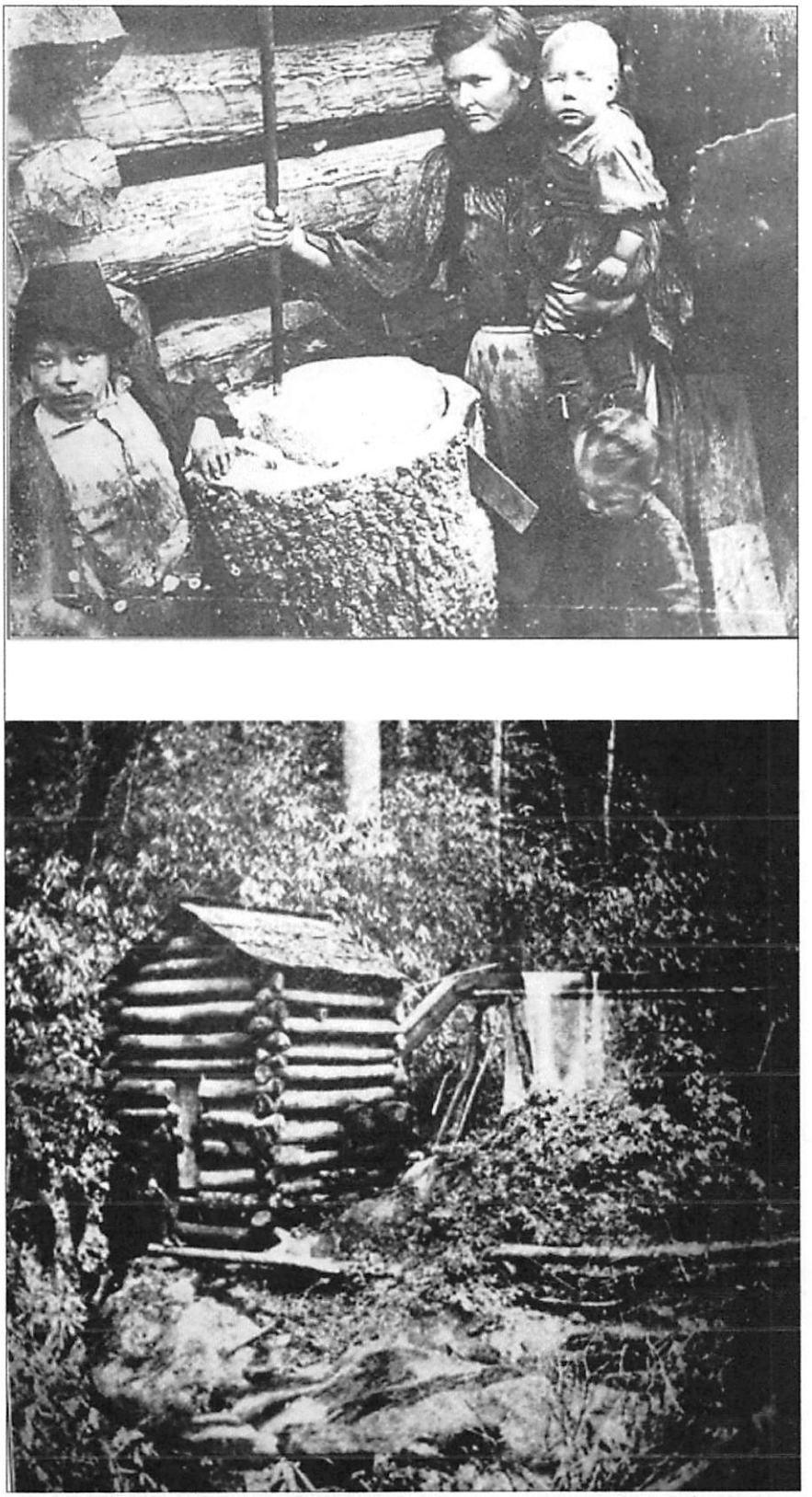

Figure 2. Grist Mills at their Simplest. Top: woman using a hand mill (quern). Bottom: a tub mill in the Appalachians (Hunter 1979).

operated a mill on Crims Creek (northwest Lexington County) and Isaac Pennington had two mills on the Enoree River.

Settlement began during the 1750s on the upper portion of the Catawba River, an area known as the Waxhaws. By 1756, Parson's Mill stood on Rocky Creek. Further to the east, Lynah's gristmill had been built on Singleton's Creek (Meriwether 1940). Sawmills were rare in the Upcountry before the Cherokee war (1759 - 1760). Most of the houses were of log construction, so there was little immediate need for sawed lumber.

In 1759 the Upcountry population consisted of about 7000 whites and 300 African-American slaves. The Broad River valley had 1800 Germans and 1000 Britons, or about twice the population in the Wateree-Catawba or Saluda valleys. Settlement exploded after the Cherokee war of 1759 - 1760. In 1762, following additional land cessions from the Cherokees, four new townships, Boonesborough, Belfast, Londonborough and Hillsborough were established in the fertile valleys of Long Cane Creek, Little River, Hard Labor Creek and Stevens Creek. Most of the settlers were Scots-Irish, although some 475 French Huguenots settled at New Bordeaux near the confluence of Little River and the Savannah. Fort Charlotte was built in 1765 to protect the western settlements from Indian attacks. By 1765 the Upcountry was home to nearly 10,600 people, with many of the newcomers emigrating from Pennsylvania and Virginia (Kovacik and Winberry 1987). In what is now Spartanburg County, Scots-Irish settlers occupied the various branches of Tyger River by 1761, but the first permanent settlement was at Lawson's Fork (Glendale) in 1775 (SUWP 1940:11, 205).

On the eve of the American Revolution, South Carolina's population stood at 180,000. Wheat and tobacco were the most important crops in the Upcountry, and several interior trading centers such as Camden, Ninety-Six and Congaree were well established.

Table 1. Population of the Upcountry, 1860.
(Source South Carolina Population Census).

District	White	Black	Total
Abbeville	11,516	20,502	32,018
Anderson	14,286	8,425	22,711
Chester	7,096	10,868	17,964
Edgefield	15,653	24,060	39,713
Fairfield	6,373	5,650	12,023
Greenville	14,631	7,049	21,680
Lancaster	6,054	5,650	11,704
Laurens	10,529	13,200	23,729
Lexington	9,333	6,202	15,535
Newberry	7,000	13,695	20,695
Pickens	15,335	4,195	19,530
Richland	6,863	11,005	17,868
Spartanburg	18,537	8,240	26,777
Union	15,874	8,670	24,544
York	11,329	9,984	21,313
Totals	**170,409**	**157,395**	**327,804**

During the Revolution the Upcountry was the scene of bloodshed, beginning with a second Cherokee war (1776 - 1777), followed by guerilla warfare between Loyalists and Patriots and battles at Cedar Springs, Wofford's Iron Works, Camden, Musgrove's Mill, Kings Mountain, Cowpens, and Ninety-Six. Although regular British troops were sometimes involved in the Upcountry clashes, most of the blood spilled was from Americans fighting Americans.

Following the war many properties belonging to Loyalists were confiscated and redistributed to supporters of the revolution. For a time, agricultural production lagged because Britain was no longer a trading partner.

Table 2. Bushels of Wheat and Corn Grown in 1860 and 1880 (Source: South Carolina Agricultural Censuses).

County	1860	1880	1860	1880	Totals
	Wheat		Corn		
Abbeville	103,300	107,608	665,698	471,955	1,348,561
Anderson	95,065	101,950	579,082	492,646	1,368,743
Chester	51,895	35,768	424,814	357,308	869,785
Edgefield	77,499	67,841	949,117	559,086	1,653,543
Fairfield	47,523	24,511	522,200	367,930	962,164
Greenville	82,015	62,132	623,288	582,156	1,349,591
Lancaster	30,781	16,852	361,421	294,939	703,993
Laurens	111,400	62,243	613,486	381,933	1,169,062
Lexington	68,812	48,107	406,269	304,509	827,697
Newberry	87,716	64,136	452,191	315,863	919,906
Oconee	—	26,107	—	268,899	295,006
Pickens	57,450	31,663	675,407	314,064	1,078,584
Richland	7,235	3,916	223,401	171,040	405,592
Spartanburg	114,648	79,991	800,960	593,454	1,589,053
Union	73,586	33,951	496,713	379,330	983,580
York	101,793	75,173	616,735	626,505	1,420,206
Totals	1,110,718	841,949	8,410,782	6381,617	16,845,066

However, by 1795 cotton became the dominant cash crop of South Carolina's plantations. The invention of the cotton gin enabled planters to plant more short-staple or upland cotton, which did not need as long of a growing season as Sea Island cotton. Soon, large portions of the Piedmont landscape were transformed. Reflecting the rise of cotton as the dominant crop, between 1830 and 1850 whites were outnumbered by slaves in much of the Upcountry. However, unlike coastal plantations, few Upcountry plantations had more than 20 slaves, and small farms continued to dominate the landscape in much of the region (Kovacik and Winberry 1987:101).

The expansion of the cotton crop into the interior also had a predictable outcome: depletion of soil fertility and massive amounts of erosion. As a consequence, there was a significant outmigration of both blacks and whites during the mid-nineteenth century. Many moved west to Georgia, Alabama, and Mississippi as planters opened new land.

The Civil War devastated South Carolina's economy, but by 1880 cotton production exceeded the pre-war levels (Kovcik and Winberry 1987:109). With the greater emphasis on cotton, corn and wheat harvests were substantially lower compared to pre-war levels. Little cash could be secured from the corn crop and it was relegated to poorer land, worked in spare time, fertilized insufficiently, and the leaves were stripped for fodder before the ears had fully matured. By 1900 cotton production exceeded one million bales, over three times the best antebellum rate. Although erosion continued to deplete what was left of the topsoil in the Piedmont, the application of phosphate fertilizers allowed planters to profit from growing cotton.

Most of the large textile factories in the area were built after the Civil War. However, three small textile factories were in existence by 1790 in Williamsburg, Sumter and Chester Districts, located in the upper Coastal Plain. Small creeks were preferred because the large rivers

were too powerful for the local builders to manage. In Spartanburg County, two textile mills had been built on the Tyger River by 1816. Large textile mills were built on the Pacolet River, east of Peters Creek, during the late 1800s.

The textile industry expanded rapidly in the late 1800s and early 1900s as can be seen in the following data: in 1850 there were 18 cotton mills in South Carolina; by 1892 there were 51; in 1900 there were 115; and, by 1925 there were 220. The vast majority of textile mill operatives were rural whites: "into the mills came the Up Country farmer who was barely making a living, and out of the mountains came the barefoot man and sunbonneted woman, to take charge of spindles and looms" (SUWP 1940).

The cotton market collapsed after World War I, partially due to the invasion of the cotton boll weevil in 1919. However, other problems, including erosion and declining soil fertility, were more important factors (Kovacik and Winberry 1987:110). As a result of negligent land management practices and the overdependence on cotton cultivation, much of the Piedmont had lost up to 10 inches of topsoil, but more than a foot was removed in some places. Stanley Trimble (1974) estimates that the Southern Piedmont lost about six cubic miles of topsoil during the agricultural era. By the early part of the twentieth century, much Piedmont land was useless for agriculture. Additionally, the erosion led to significant accumulations of sediments in stream bottoms, affecting the operation of mills. To counteract this, some millers would drain the mill ponds on a weekly basis to wash out the silt. Left unchecked, the buildup of silt would clog ponds, raceways, and machinery. Additionally, the lack of upland vegetation exacerbated the severity of floods or "freshets," which could destroy mills altogether. Finally, the development of steam power, hydroelectric power, and improvements in transportation networks made small water-powered industries obsolete by the mid twentieth century.

Methods

A wide variety of sources were researched during this project. Concerning the broader historic context of mill development in the Upcountry, the background and literature review began with an inspection of *Mill's Atlas* (1825). In addition to maps of each district, the reprinted version of the atlas contains an index of place names. Thus, a list of all of the mapped grist mills and saw mills was compiled for each of the districts within the study area: Abbeville, Chester, Edgefield, Fairfield, Greenville, Lancaster, Laurens, Lexington, Pendleton, Richland, Spartanburg, and York (Appendix A). Researchers should note that the maps were prepared by a number of different cartographers; some were more thorough than others in showing the location of mills and other cultural features.

Although a number of mills have been recorded as archeological sites, and site forms are on file at the Institute of Archaeology and Anthropology, the only way to identify them is by studying every topographic map and reviewing individual forms, tasks that were too time consuming for this project.

Through the internet we gathered a listing of the nine standing Upcountry mills or mill sites that are listed in the National Register of Historic Places (Appendix B). The most productive on-line search located *Carolina Arts*, a newsletter published by Shoestring Publishing Company. The August, 2002 issue announced an exhibit in the Pickens County Museum entitled *The Mills of Pickens County*. The exhibit documented 65 mill sites in the county through photography and oral history. Today, only three of the mills are still standing. Much of the documentation was prepared by Mr. Alan Warner, who serves as the miller at Hagood Mill which is maintained by the Pickens County Museum. See Appendix C for a location map and brief descriptions of each mill.

Correspondence with the Society for the Protection of Old Mills (SPOOM) established that approximately 95 South Carolina mill sites are listed in their records, but, to date, we have not received this list.

Next, the Manufacturing and Industrial censuses were examined for the years 1810, 1860 and 1880. Coverage was spotty at best in 1810 and 1860, and much better in 1880. Even though the 1880 census is more accurate, it appears that the numbers of mills are under-reported for some counties. Most likely, this is because the census only listed establishments that grossed over $500.00 per annum. Thus, small private mills and plantation mills would not be enumerated.

The Agricultural censuses of 1860 and 1880 provided data on the corn and wheat harvest. Because both cereals were ground into meal or flour, the numbers of bushels provide a rough index of the importance and necessity of having local mills.

In Columbia, we examined the 1880 Manufacturing schedule for data concerning the mills in the Upcountry. This microfilmed census provided data on over 300 mill sites (Appendix D). Specifically, we recorded the surname of the mill owner, the mill's function (grist and flouring mill, saw mill, cotton gin, public cotton gin), the stream name, the type of wheel, the breadth or diameter

of the wheel and the horsepower. Some of the entries were totally illegible and poor penmanship made some of the names nearly illegible. We make no apologies for errors in transcribing surnames and creek names.

In early September of 2004, letters of inquiry were sent to 26 historical societies and museums in the study area. The questionnaires asked the recipients if any mill sites were still standing in their counties and if any historic photographs of the mills were available. Enclosed with the questionnaire was a county map and a stamped, self-addressed envelope so that the recipient could mark the approximate location of mill sites and return the information to the author. Eight of the societies responded. Appendix E contains summaries of their responses. Copies of photographs, newspaper articles and County maps showing mill locations that were sent by the respondents will be curated at the South Carolina Department of Archives and History.

Secondary sources such as Meriwether's (1940) *The Expansion of South Carolina 1729-1765* yielded good information about early settlements and mills. The earliest mills in the Upcountry date to the 1740s and were located in Saxe-Gotha Township on the Congaree River (in present-day Lexington and Richland Counties). Louis Hunter's (1979) treatise on the history of water powered industry provided a great amount of information about the evolution of milling and mill technology in the United States. An especially valuable resource is *Knight's 1880 Mechanical Dictionary* which describes in detail 28 types of water wheels

In Spartanburg, Joseph Gainey conducted an extensive review of deeds for the Peters Creek mill tract and surrounding lots. His full report has been submitted separately, but salient items are presented here. Mr. Gainey also researched genealogical and historical sources at the Spartanburg County courthouse and library. Old maps of Spartanburg County were also researched at the SCDAH. At the South Caroliniana Library in Columbia, we conducted an unsuccessful search for photographs of the mill on Peters Creek and other mills in Spartanburg County. Information about the 1903 Pacolet Flood, and other floods, was located on the internet. A special thanks goes to Dr. Terry Ferguson of Wofford College for making that information available.

Archeological and historical studies also yielded comparative information about the development of mills in the region. Among these are *Archaeological Investigations at Seven Mill Sites* (Newman 1984), *Catawba River Valley Grist Mill Survey* (Joy et al. 2000), and *The Archeological and Architectural Investigations at the Boardman Dam and Pond Site, Fort Gordon, Georgia* (Braley and Froeschauer 1991). All of these sources built on the previous investigations at the site (Ledbetter and Gainey 1998; Braley 2002).

Results

Historical Context for Mills in the Upcountry

In keeping with the theme of this project we have concentrated on flour and grist mills, saw mills, and, to a lesser extent, cotton gins. These were relatively small enterprises that could be built and operated without tremendous outlays of capital. Therefore, we have omitted larger water powered enterprises such as textile factories, iron furnaces, stamp mills, and other industrial sites.

The development of water powered mills in the Carolina Piedmont was influenced by a number of factors, among them the local geology, changing technology, and population increases through time. To a large extent the region's geological setting influenced the size and configuration of mills. In the Piedmont, water power could be easily tapped, particularly in narrow stream valleys such as Peters Creek. The mill stream had to have a fairly dependable flow of water, and with a sufficient amount of fall to eliminate the necessity of constructing huge dams. An area above a natural constriction would be ideal to create a mill pond (Figure 3).

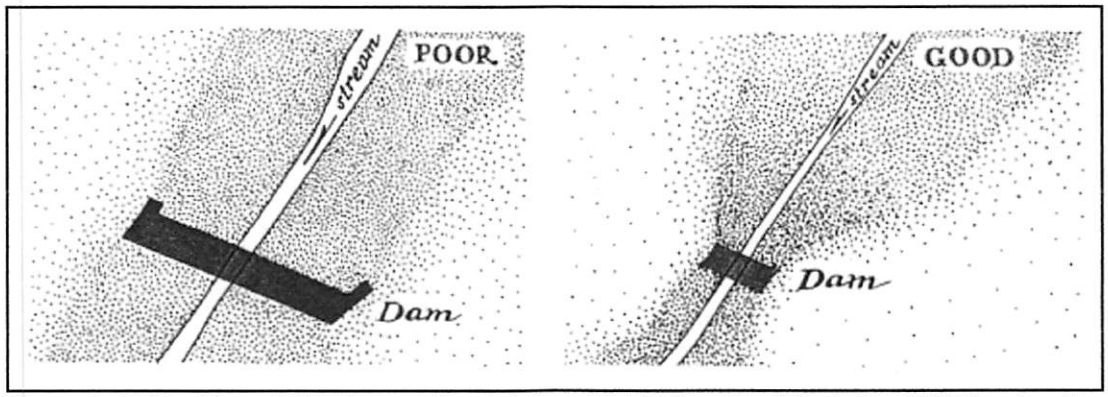

Figure 3. Valley Floors With Natural Constrictions (right) **Were Ideal Spots For Mill Construction** (Lord and Costello 1983).

Mill Types

The largest grain mills were merchant mills, whose product, wheat flour, was intended for regional markets or export. The mill owner supplied the capital for its construction and hired a miller to operate it. These mills would buy grain from dealers and make a profit or loss on the sale of flour. Custom mills were locally owned and operated at a smaller scale. Generally, these were grist mills that ground corn and wheat for the surrounding population. Often, these served several functions by incorporating a cotton gin and a saw mill. The miller was paid for his services by

collecting a toll, which was a portion of the grain, cotton or lumber brought to the mill for processing. Because custom mills became a focal point for the local farmers, small communities sometimes grew around them, particularly if the mills were located close to a good road that crossed the stream. A third category of mill was the plantation mill which served large farms and plantations, not the surrounding community. These were relatively small operations that processed grain and cotton that was grown on the plantation (Worthy 1983; Joy et al. 2000). Smaller yet were private mills, whose owners ground corn or wheat for their neighbors on a seasonal basis.

Grain milling technology was revolutionized at the turn of the nineteenth century by a millwright named Oliver Evans, who invented mechanized equipment such as the elevator, conveyor, drill, descender and hopper boy (Joy et al. 2000). Consequently, mill architecture was modified to accommodate production, and three-story buildings were typical for mechanized grain mills. The gearing was on the first floor or basement and the grinding stones and hoppers were on the main floor above. From the main floor an elevator would carry grain to the floor above for cleaning before it was transported into the hoppers for grinding (Wood 1992:128). Often, corn meal was not sifted, but in order to produce fine grades of wheat flour it was "bolted," or sifted through cloth.

Mill Buildings

Grist and flour mills typically were housed in heavily framed buildings that were supported on well constructed foundations of stone or wooden pilings.

According to Joy et al. (2000):

> *One face of the building usually had a series of doors that opened on each floor to allow equipment and/or tools to be hoisted. The other facades had double hung windows for light and ventilation. Often the facade facing the wheel had no windows. Exteriors were usually covered with clapboards or shingles; the walls were constructed of braced frames characterized by heavy timber posts at the corners often with intermediate posts between them. The whole structure was built on a heavy foundation. Enormous timber girths ran from post to post. Mortised joints joined all parts. Most of the beams were hand hewn oak. Often they were massive, spanning eighteen feet. The strong construction was meant to withstand the elements and the constant vibration of the wheel and stones. To further strengthen the building flood abutments were place upstream or against the mill.*
>
> *The interiors were arranged for functional tasks. Some mills had a series of trap doors for hoisting sacks and materials through the floor. The top floor was for storage of sacks of unprocessed grains, which were hoisted directly from the delivery wagon. From the top floor, grain could be poured into the hopper and stones on the floor below. At the very bottom were gears and shafts; the wheel was usually out of doors, but sometimes the mill was built directly over the sluice with the wheel inside.*

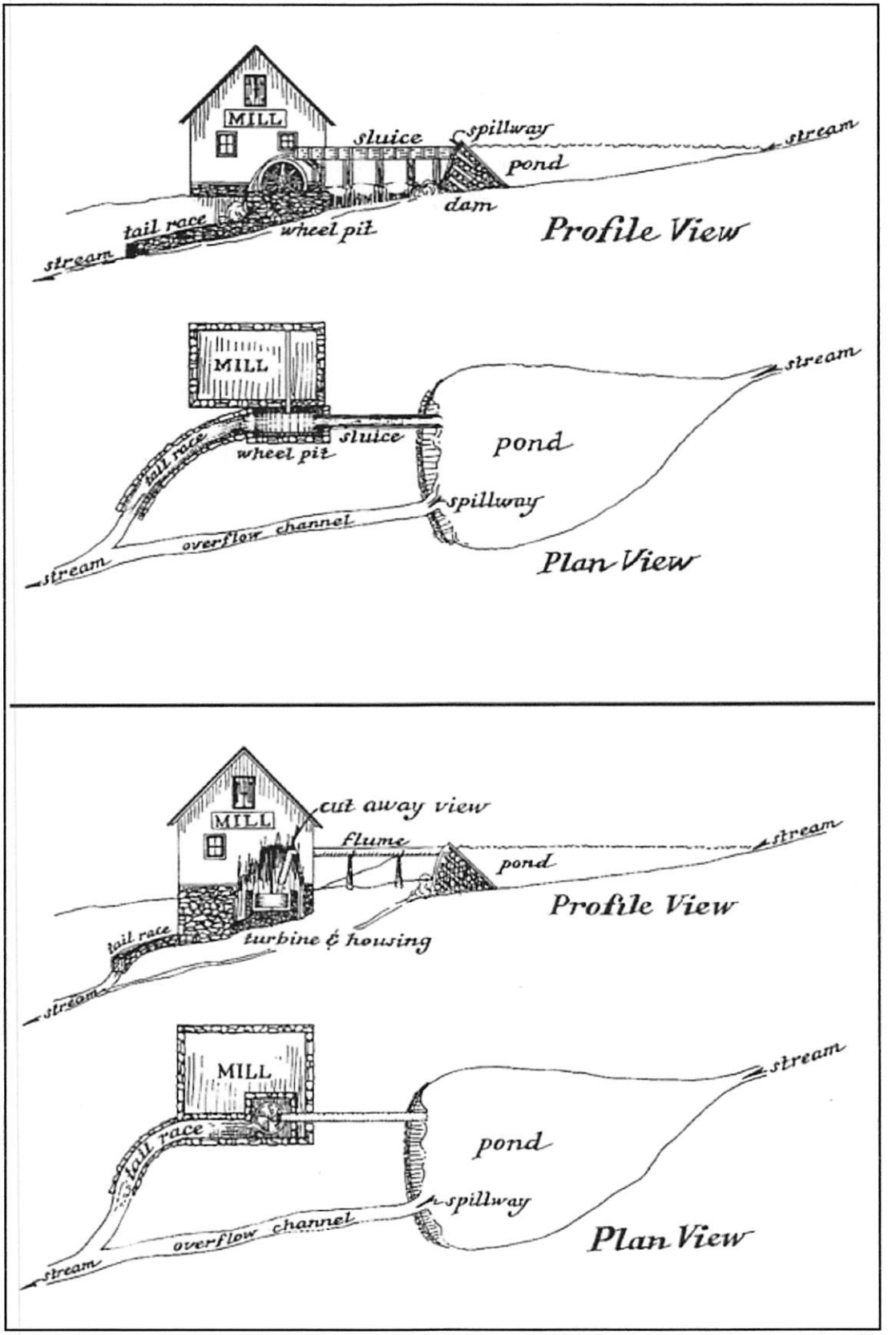

Figure 4. Plan and Profiles of Mills Using Vertical Wheels and Horizontal Wheels (Lord and Costello 1983).

As shown in historic photographs, some grist mills were of simpler construction, such as Pope's Mill in Saluda County (Figure 5). This was a one-story mill that was supported above flood waters on large wooden pilings. Shinburg's Mill in McCormick County was of similar appearance, and Hinkle's Mill in Pickens County measured about 16 x 20 ft. At the other extreme were multistoried grist mills constructed of masonry, such as Calhoun's Mill in McCormick County (Figure 6).

A saw mill could often be found at the site of a grist mill. The two could be powered by the same wheel or turbine by using different gearing, but some operations had more than one water powered motor. If the saw mill was directly attached to the mill dam, logs could be floated in the pond until ready for use, and then hoisted up a ramp into the mill (Figure 7). Boards were produced by placing a log on a carriage that was slowly advanced into the saw blade. Early saw mills used vertically mounted gang saws that were held in a wooden sash and driven by a crank and connecting rod. Later mills used the more efficient circular saw to produce lumber.

It appears that many plantation cotton gins were mule powered, but sometimes gins were associated with water powered grist mills and saw mills. Typically these were two stories high with the gearing on the ground floor and the gin itself on the second floor.

Other structures that could be associated with mill sites include blacksmith shops, store houses, tool sheds, a mill office if the operation was large enough, employees (slave or free) houses, and the miller's residence.

Dams

Although the Piedmont abounds in naturally occurring stone, the core of many mill dams consisted of a framework of large timbers anchored into the stream bed and abutments at the stream banks. Wood was abundant and almost free for the taking, making it an ideal medium for small dams. The timber framework was often faced with boards to make the dam watertight. At rocky shoals the framework could be anchored to the stream bottom with large iron pins. Rock could then be piled within the framework to further anchor the dam to the stream bottom and counteract the lateral pressure of the impounded water. Prior to the widespread availability of Portland cement (late nineteenth to early twentieth century), timber frame dams were a must in areas that lacked stone, such as the Sandhills and Coastal Plain. The wood dams were extremely strong and relatively easy to repair if damaged by floods. Researchers should refer to Leffel (1881) for descriptions of the various types of dams that were suited to small milling operations.

On larger streams and rivers it was not necessary to construct a dam across their entire width. Instead, short wing dams were sufficient to divert enough water into a head race to operate the machinery. This also had the benefit of permitting shad and other anadromous fish to migrate upstream during the spring. The mass procurement of shad at fish trap dams was an important aspect of rural subsistence during the eighteenth and nineteenth centuries (Frazier 2004).

Figure 5. Small Upcountry Mills. Left: Pope's/Rudolph's/Ethridge's Mill on Little Saluda River in Saluda County. This probably was powered with a tub wheel; note timber frame dam (photo courtesy of Dr. Bela Herlong, Saluda County Historical Society). **Right: Shinburg Mill on Cuffy Town Creek, McCormick County** (photo courtesy of Bob Edmonds).

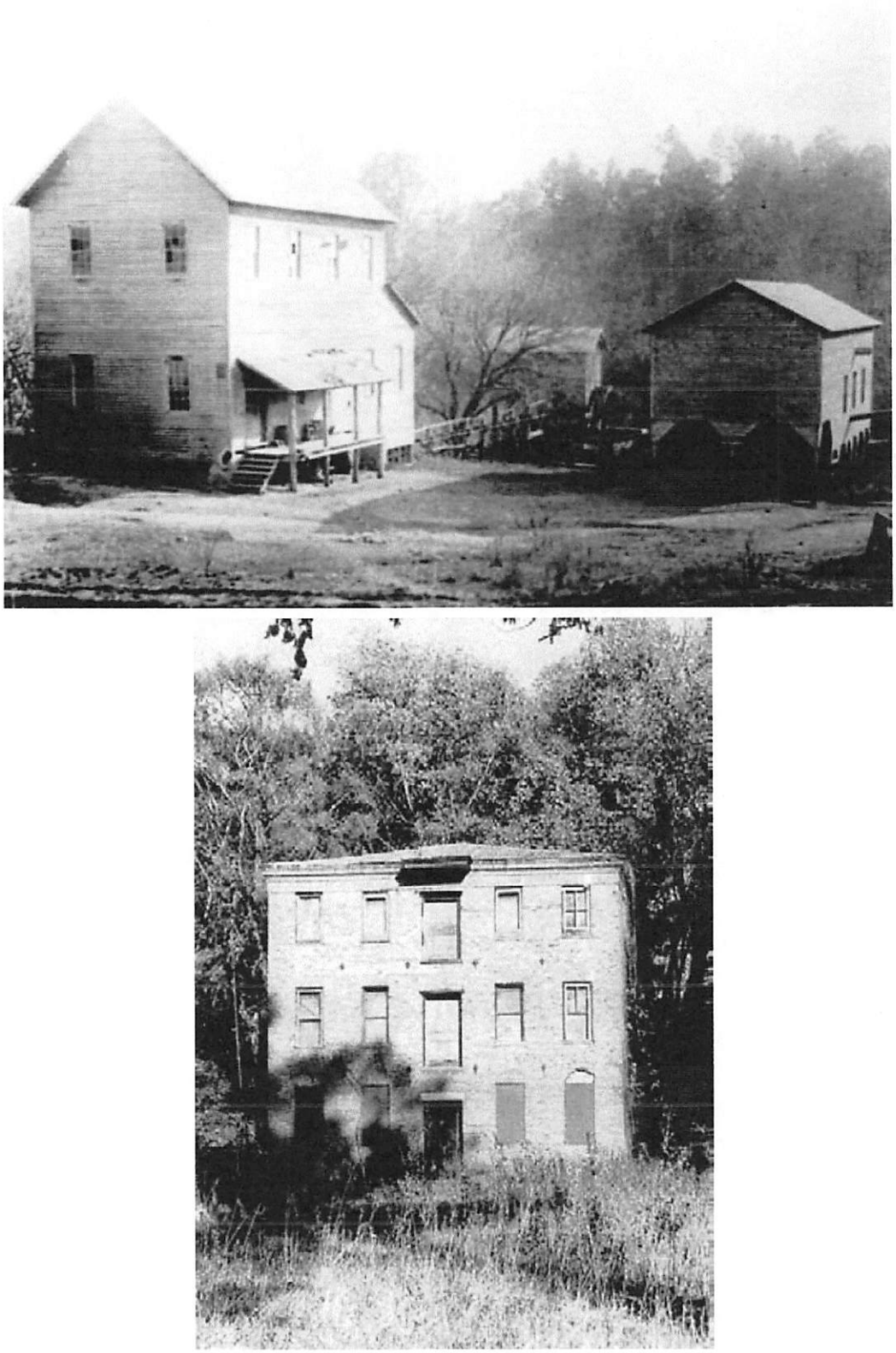

Figure 6. Larger Mills. Top: Price's Mill on Stevens Creek McCormick County, early twentieth century; note separate structures for the turbine house (center) **and cotton gin** (right)**. Bottom: Calhoun's Mill, McCormick County. Both mills are National Register properties** (photos courtesy of Bob Edmonds).

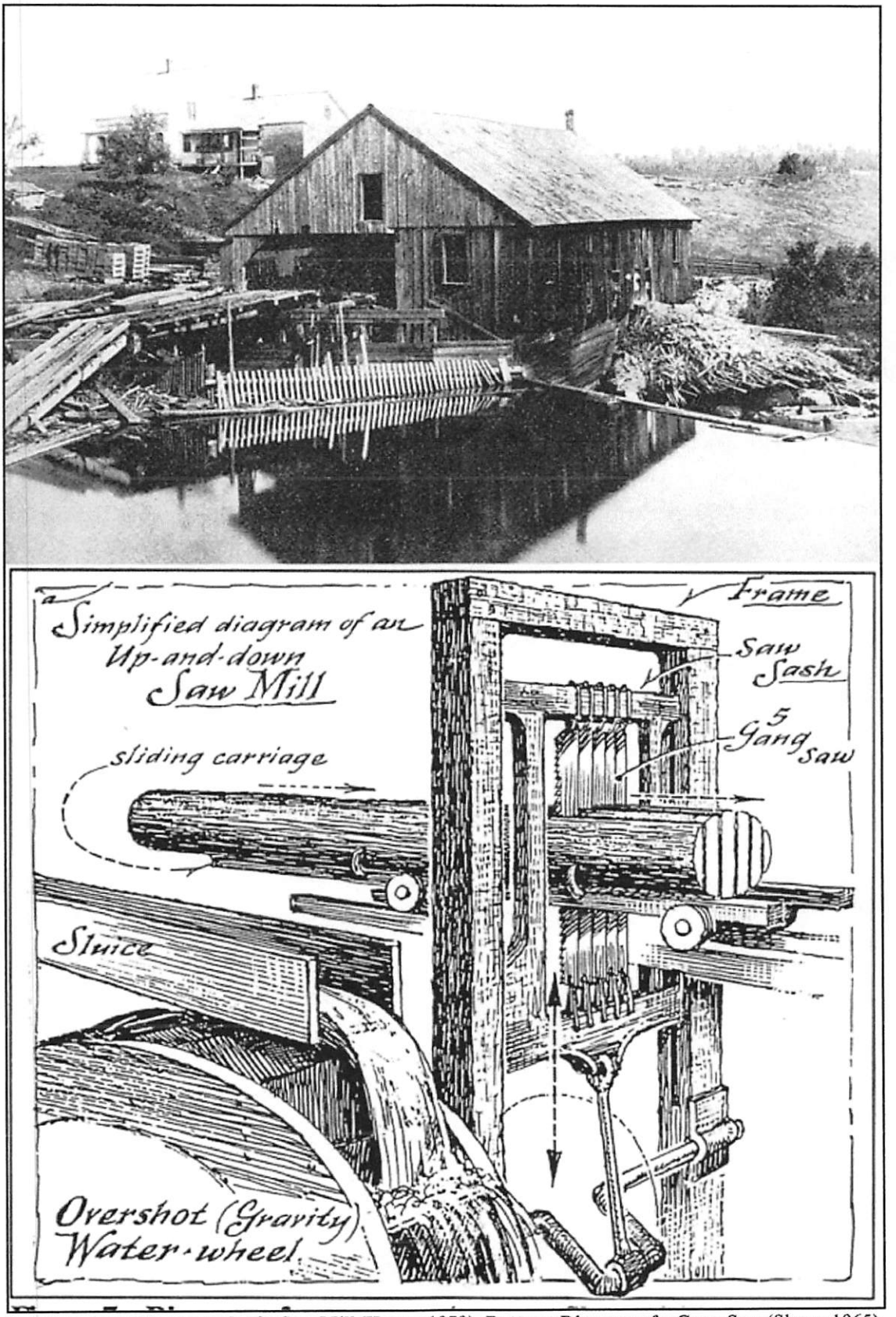

Figure 7. Top: Photograph of a Saw Mill (Hunter 1979). **Bottom: Diagram of a Gang Saw** (Sloane 1965).

Raceways

If a dam was high enough to develop sufficient head, the mill house could be directly attached. However, many Piedmont mills relied on a headrace, a small canal cut into a hillside, to deliver water to the wheel or turbine. Sometimes headraces could be over 2000 ft long. Headraces allowed the mill to be built above the level of most floods, and take advantage of the topography to facilitate transportation of goods to and from the site. Also, a well engineered headrace meant that dams did not have to be too massive. To prevent erosion and the accumulation of sediment, headraces often were lined with cut stone. At the downstream end of the headrace the water was delivered to the mill by a wooden flume supported on wooden trestles or rock piers. After energy was exhausted by the wheel, the water was channeled away from the mill foundations and back into the stream through a tailrace.

Waterwheel Types

There are two basic types of water motors, vertical water wheels and horizontal water wheels (Figures 8-10). Two main varieties of vertical wheels, undershot and overshot, were in widespread use until the mid-nineteenth century. These were modified according to specific locational and manufacturing situations. The undershot wheel was the most basic: the stream simply flowed underneath the bottom of the wheel and the current turned the paddles. Gravity was not a factor because the undershot wheel did not use buckets to contain the water. They were very inefficient motors and were primarily used in areas where the fall was less than six feet, such as in tidal mills and elsewhere in the Coastal Plain.

Flutter wheels, a type of vertical wheel, were so-named because of the fluttering sound that they made while in operation. These were of moderate diameter and placed at the bottom of a chute so as to receive the impact of the head of water in the chute and penstock (Knight 1880:894). Flutter wheels turned at high rpms and were used primarily in saw mills where rapid motion was necessary. Only five flutter wheels are listed for the study area in the 1880 manufacturing census.

The overshot wheel was much more efficient, powered by water delivered by a flume to the top of the circumference of the wheel (Newman 1984:7). The diameter of overshot wheels was determined by the height of fall. Generally, overshot wheels were used when the fall was greater than 10 feet.

The breast wheel combined aspects of both the undershot and overshot types. Like the overshot it used a sluice, but the water entered the buckets about midway up on the wheel's circumference. The "breast" or "breasting" was a wooden or metal casing that enclosed 60 - 90 percent of the periphery of the wheel, keeping water in the buckets for a maximum amount of time. Breast wheels should not be confused with center discharge wheels (e.g. Joy et .2000:8).

The breast wheel outperformed the overshot in at least four areas: it allowed use of wheel diameters much greater than the height of fall, for water did not need to be carried over the top of the wheel; it could be adapted to variations in the level of the water supply resulting from

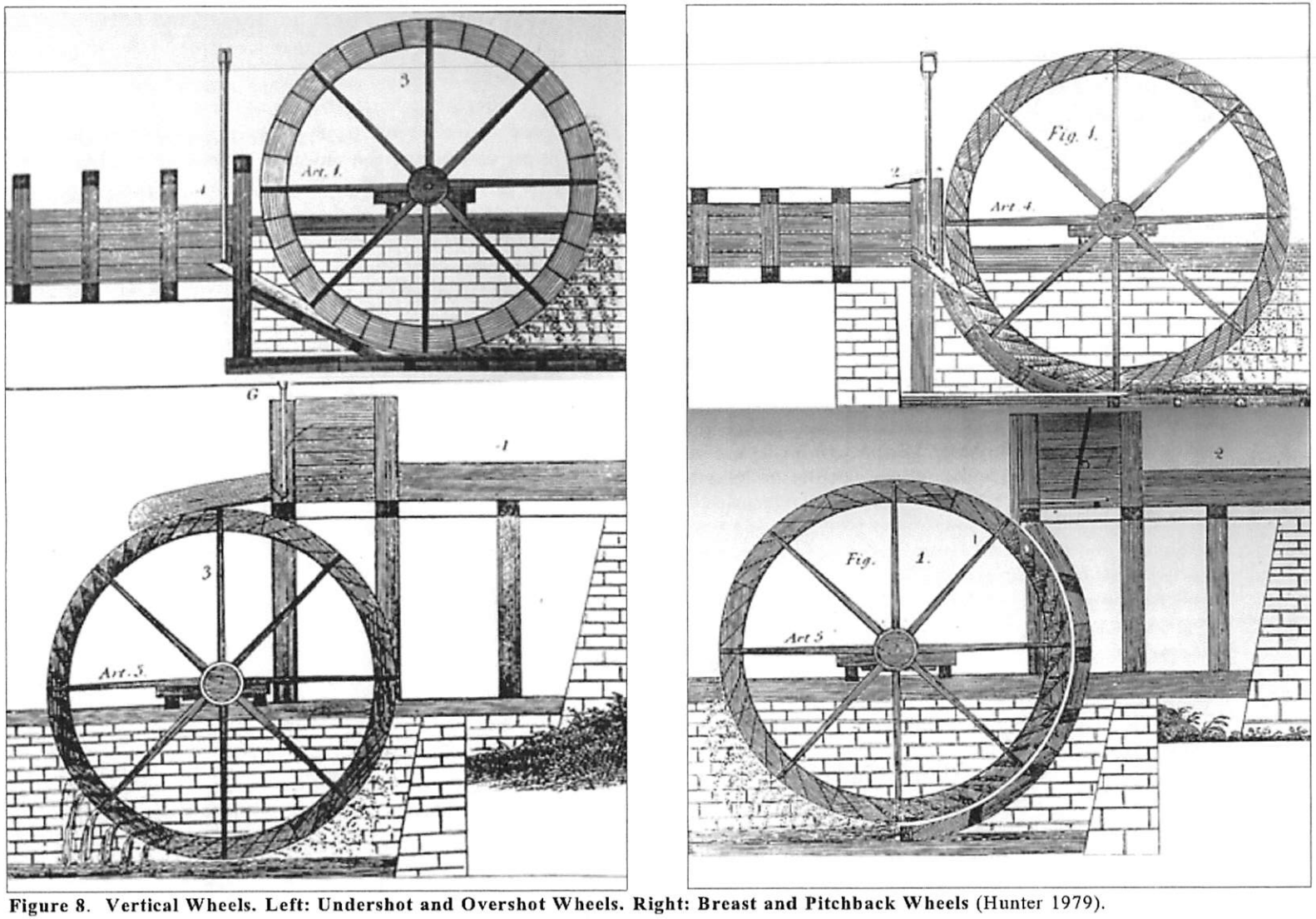

Figure 8. Vertical Wheels. Left: Undershot and Overshot Wheels. Right: Breast and Pitchback Wheels (Hunter 1979).

seasonal variations in streamflow; the rotation of the lower part of the wheel with instead of against the current in the tailrace enabled the wheel to run more efficiently, and; it could be adjusted for optimal operation of the machinery. The breast wheel was developed during the latter part of the eighteenth century, but it did not play an important role in industry until after 1800 (Hunter 1979:71).

A variant form of gravity wheel was the "pitchback" wheel. Like the breast wheel, the pitchback rotated with the direction of the stream, with water entering the buckets near the top of the wheel. Overshot, breast and pitchback wheels usually operated at low rpms but generated considerable torque and horsepower. Most Upcountry vertical wheels where 3 to 4 feet in breadth (the distance between the rims of the wheel, not diameter) and generated between 4 and 20 horsepower.

The 1880 Manufacturing census also records that at least 14 "Willis" wheels supplied the power to mills. Based on the available evidence, Willis wheels were a type of overshot wheel, possibly commercially produced: they were 3 to 5 feet in breadth, generated 6 to 28 horsepower, and turned at low rpms (one in York County turned at 8 rpm).

Horizontal wheels include tub wheels and turbines of various types (see Figures 9 and 10). The tub wheel was well suited to low head situations. It was first developed in Scandinavian countries and was inexpensive to construct and simple to operate. Tub wheels became popular in the mid-nineteenth century. Often, the vertical shaft was directly coupled to the mill stone, eliminating the need for complex gearing or drive shafts. The wheel was comparatively small (4 - 6 ft diameter was standard) with the wooden paddles mortised into a hub that turned on a central bearing. This mechanism was enclosed by a wooden tub. Water was directed through a flume and spout against the paddles, then exited the tub through a hole at the bottom. Tub wheels were not very efficient, but they were easy to maintain.

Hunter (1979:105-106)) hypothesized that "beyond much doubt the vast majority of water mills in colonial America were driven by the simpler, more readily made impact wheels of the undershot and tub-wheel types in preference to gravity (overshot and breast) wheels. The latter's more efficient performance must have been offset by the greater care and cost in construction and limited range of usefulness. Mill seats with the minimal fall required for the advantageous use of bucket wheels were far less numerous than the lesser falls to which the simpler impact wheels were suited."

Closely related to tub wheels were center discharge wheels. Like tub wheels these early horizontal turbines had simple flat wooden or iron paddles that were mortised or bolted into a central hub. In later examples the paddles were replaced with curved runners, allowing the motors to run at higher rpms. What separated them from tub wheels was being encased in a close-fitting wooden or metal jacket, and powered by a jet of water that spiraled into the case along the side of the turbine and then exited through a hole in the bottom. These are also referred to as "scroll case" turbines from the spiral shape of the jacket. They were widely adopted during the first half of the nineteenth century (Safford and Hamilton 1922). Archeological examples have been excavated at Millwood Plantation (38AB9) in Abbeville County and other mill sites in the Savannah River drainage

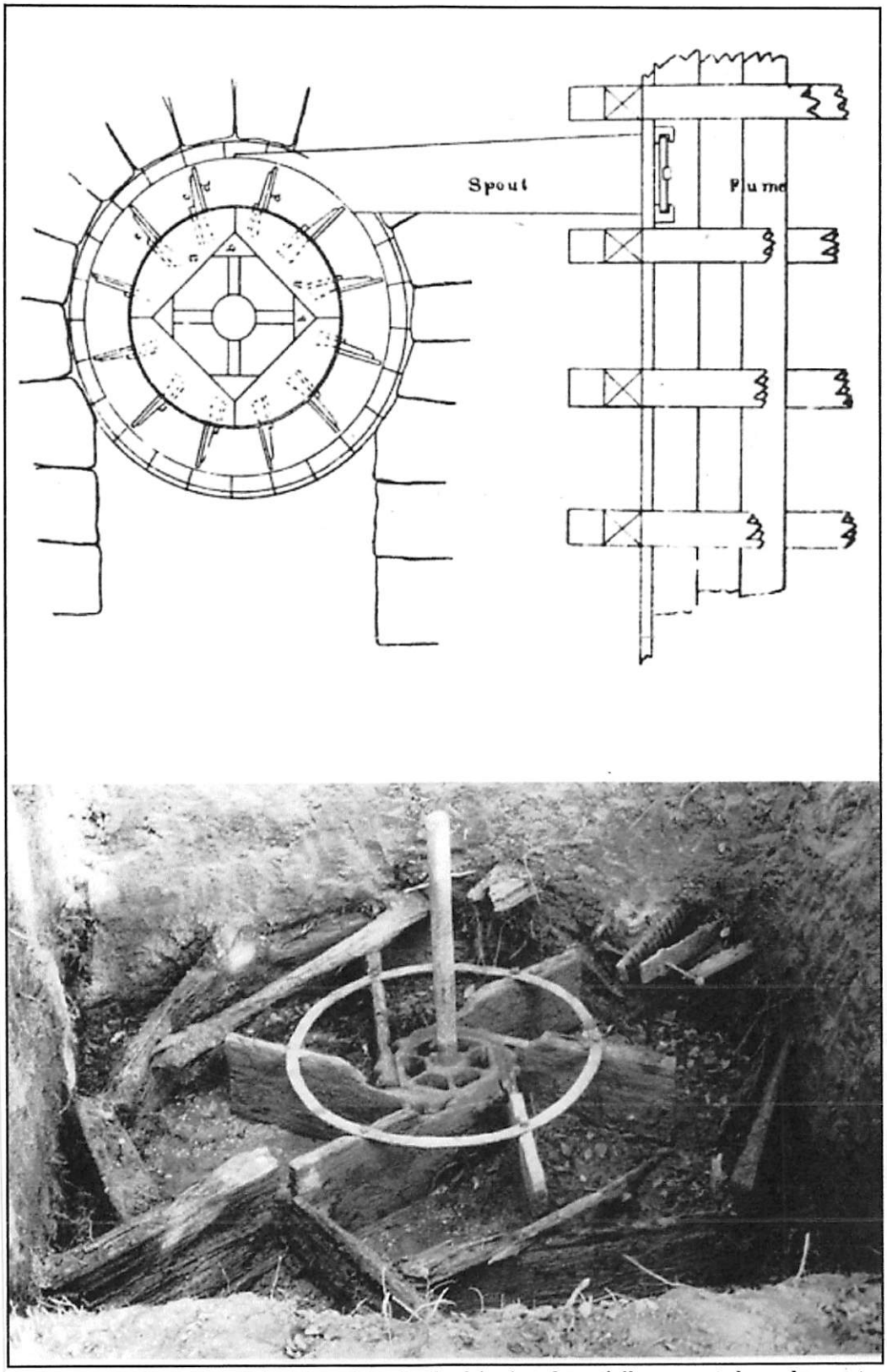

Figure 9. Horizontal Wheels. Plan of a tub wheel (top) **and partially excavated wooden center discharge wheel at Millwood Plantation, Abbeville County** (Newman 1984).

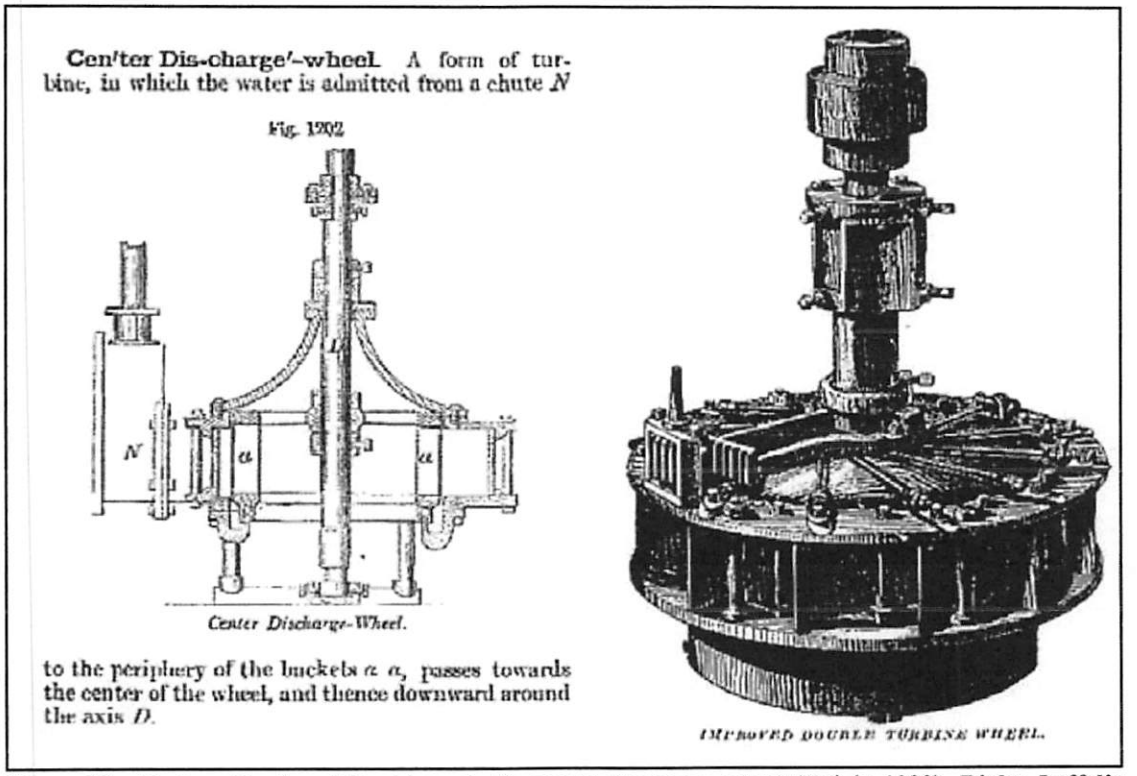

Figure 10. Factory-Produced Turbines. Left: center discharge wheel (Knight 1880). **Right: Leffel's improved double turbine** (Manufacturer and Builder 1872).

(Newman 1984:49, 52). According to the 1880 manufacturing census, center discharge wheels ranged from about 3.5 to 6 ft in diameter and generated between 5 and 24 horsepower.

Reaction wheels, another type of turbine, also powered mills in the study area. Reaction wheels rotated by pressurized water striking the center of the runners, then exiting the sides of the turbine case. Most reaction wheels were 4 and 6 ft in diameter and developed 6 to 20 horsepower. One reaction wheel in Lexington County was 8 ft in diameter, constructed of wood, and developed 18 horsepower (1880 Manufacturing Census).

Turbines were the culmination of water wheel development. As Hunter (1979:305) notes, "the turbine combined the operating virtues of the reaction wheel with the high efficiency and capacity of bucket wheels of the overshot-breast type. Within little more than a decade of its first practical introduction, the new motor was being built with a capacity of hundreds of horsepower, aiding the transition to an ever larger scale of industrial production." The turbine's runners presented curved surfaces against which the water exerted force by pressure and reaction in passing through the wheel (Hunter 1979:321). By the 1860s foundries were mass producing improved turbines.

Numerous forms of turbines were used in the local mills. Turbines can include home-made, generally earlier, inward discharge wheels as well as foundry-made central discharge turbines that were precisely engineered. The 1880 manufacturing census records that nearly 70 percent of the turbines were less than three feet in diameter, but, like the larger vertical wheels, most generated between 4 and 20 horsepower. Excluding the generic term, "turbine," the

manufacturing census lists the following names or types of turbines: home-made, center discharge, center vent, reaction wheel, Burnham, Colier(?), Elipse(?), Hotchicutt(?), Howard, Leffel, Pylant(?), Tadler(?), Timby, and Union (the question marks indicate that the spellings are suspect).

Tables 3-7 provide summary information about Upcountry mills between 1810 and 1880, when small water-powered industries were at their peak.

As shown in Table 7, turbines (including center discharge and reaction wheels) outnumbered other types of motors in 1880. Of note is the high proportion of tub wheels in Lexington, Richland and Edgefield Counties, and the numbers of vertical wheels (overshot and breast) in Anderson, Greenville, Lancaster, Oconee, Pickens and York Counties. Lexington, Richland and Edgefield Counties straddle the Piedmont and Sandhills, so the popularity of tub wheels may be related to gentler stream gradients. Vertical wheels were more practicable in the upper Piedmont counties where the gradient was more pronounced and streams with a dependable flow of water were abundant. It is also worth noting that saw mills outnumbered grist mills in Lexington County (at the head of navigation on the Congaree River), and that most of the saw mills were powered by tub wheels. As mentioned previously, tub wheels were among the simplest to construct and maintain. They also were some of the earliest motors; perhaps their persistence in Lexington County is related to the early settlement of Saxe-Gotha Township.

Millstones

Millstones were arranged in pairs, the upper "runner stone" rotating above the lower fixed "bed stone." Sizes varied but a diameter of about four feet came to be generally accepted as standard. A four-foot stone could weigh over a ton when new and functioned most efficiently at a speed of 125-150 revolutions per minute (Joy et al. 2000).

It appears that most of the millstones in Upcountry grist mills were of local manufacture, although occasionally imported French "buhr stone," a type of silicified sandstone or limestone, was used. South Carolina has its own variety of buhr stone: as shown in *Mill's Atlas* "Rock of a good quality for mill stones," no doubt silicified sandstone or orthoquartzite, occurs in what is now Saluda County on Clouds Creek. Michael Tuomey (1848) cited in Joy et al. (2000) reports other outcrops near Cedar Creek and Dean Swamp (Aiken and Barnwell Counties) that were explored for millstones. Possibly these outcrops supplied mill stones for grist mills in the immediate vicinity, but Tuomey states that "nearly all (millstones) that are not imported are procured from the coarse granites." Also, a mill stone weighing over a ton would have been difficult to transport any distance over unimproved roads. Therefore, most stones probably were quarried and finished locally.

Table 3. Number of Grist Mills and Saw Mills in the Upcountry, 1810 (U.S. Census, Manufactures).

District	Grist Mills	Saw Mills	Totals
Abbeville	—	—	—
Chester	17	10	27
Edgefield	—	—	—
Fairfield	—	—	—
Greenville	—	—	—
Lancaster	—	—	—
Laurens	—	—	—
Lexington	—	—	—
Pendleton	—	—	—
Richland	—	—	—
Spartanburg	49	25	75
York	35	14	49
Totals	101	59	160

Table 4. Number of Mills According to Mill's Atlas (1825).

District	Mills
Abbeville	42
Chester	27
Edgefield	40
Fairfield	22
Greenville	41
Lancaster	6
Laurens	32
Lexington	35
Newberry	42
Pendleton	35
Richland	17
Spartanburg	56
Union	21
York	3
Totals	419

Table 5. Number of Grist Mills and Saw Mills in the Upcountry, 1860 (U.S Census, Industry).

District	Grist Mills	Saw Mills	Totals
Abbeville	11	15	26
Anderson	21	3	24
Chester	14	2	16
Edgefield	14	26	40
Fairfield	—	—	—
Greenville	56	50	106
Lancaster	7	1	8
Laurens	25	12	37
Lexington	—	—	—
Newberry	—	1	1
Pickens	—	1	1
Richland	—	—	—
Spartanburg	34	18	52
Union	11	4	15
York	27	11	38
Totals	206	144	364

Table 6. Number of Grist Mills and Saw Mills in the Upcountry, 1880 (U.S. Census, Manufactures).

County	Grist Mills	Saw Mills	Totals
Abbeville	27	9	36
Anderson	36	10	46
Chester	14	1	15
Edgefield	35	2	37
Fairfield	5	1	6
Greenville	47	13	60
Lancaster	6	0	6
Laurens	23	4	27
Lexington	25	20	45
Newberry	11	1	12
Oconee	23	4	27
Pickens	26	9	35
Richland	10	3	13
Spartanburg	34	20	54
Union	10	2	12
York	32	9	41
Totals	364	108	472

* Note: The number of mills in Fairfield, Lancaster, Newberry and Union Counties appear to be significantly under-represented.

Table 7. Distribution of Mill Types and Power Sources in 1880. (Source: 1880 Manufacturing Census, South Carolina).

Grist Mills										
County	**Tub**	**Undershot**	**Overshot**	**Breast**	**Pitchback**	**Turbine**	**Center disch.**	**Reaction**	**Willis**	**Totals**
Abbeville	—	—	5	1	—	15	3	—	—	24
Anderson	—	—	14	1	—	10	5	1	1	32
Chester	1	—	3	—	—	7	1	—	—	12
Edgefield	8	—	1	—	—	13	2	1	—	25
Fairfield	2	—	—	—	—	—	—	1	—	3
Greenville	—	1	24	5	—	7	1	—	3	41
Lancaster	—	—	5	—	—	—	—	3	1	9
Laurens	3	—	6	—	—	13	2	—	—	24
Lexington	12	1	—	2	1	4	—	3	—	23
Newberry	2	—	—	—	—	6	—	—	—	8
Oconee	3	—	10	—	—	2	5	1	—	21
Pickens	—	—	12	—	—	3	—	—	2	17
Richland	3	—	1	1	—	3	—	—	—	8
Spartanburg	4	—	6	3	—	10	2	—	2	27
Union	1	—	2	—	—	5	1	3	—	12
York	1	—	10	3	4	4	7	—	3	32
Totals	**40**	**2**	**99**	**16**	**5**	**102**	**29**	**13**	**12**	**318**

Table 7. Distribution of Mill Types and Power Sources in 1880. Cont.

	Sawmills										
County	**Tub**	**Undershot**	**Overshot**	**Breast**	**Pitchback**	**Turbine**	**Center disch.**	**Reaction**	**Willis**	**Flutter**	**Totals**
Abbeville	—	—	—	1	—	3	3	—	—	1	8
Anderson	—	—	3	2	—	3	1	—	1	—	10
Chester	—	—	1	—	—	—	—	—	—	—	1
Edgefield	—	—	—	—	—	—	—	—	—	—	0
Fairfield	—	—	—	—	—	—	—	—	—	1	1
Greenville	—	—	6	1	—	4	—	—	—	—	11
Lancaster	—	—	—	—	—	—	—	—	—	—	0
Laurens	—	—	2	1	—	5	—	—	—	—	8
Lexington	11	—	—	—	1	7	—	2	—	2	23
Newberry	1	—	—	—	—	—	—	—	—	—	1
Oconee	—	—	2	—	—	—	—	—	—	—	2
Pickens	—	1	5	—	—	1	—	—	1	—	8
Richland	—	—	1	—	—	2	—	—	—	—	3
Spartanburg	2	—	4	2	—	5	—	—	—	—	13
Union	1	—	1	—	—	—	—	—	—	—	2
York	—	—	4	—	1	1	3	—	—	—	9
Totals	15	1	29	7	2	31	7	2	2	4	100

Gearing

Power to the mill stones, saws and cotton gins was relayed from the motor by gears (although tub wheels could drive mill stones without gearing). In the Colonial period most of the gears were made of hardwood. After the Civil War cast iron replaced wooden gears. By the end of the nineteenth century, drive wheels, line shafts, and leather belting were widely used to run the machinery.

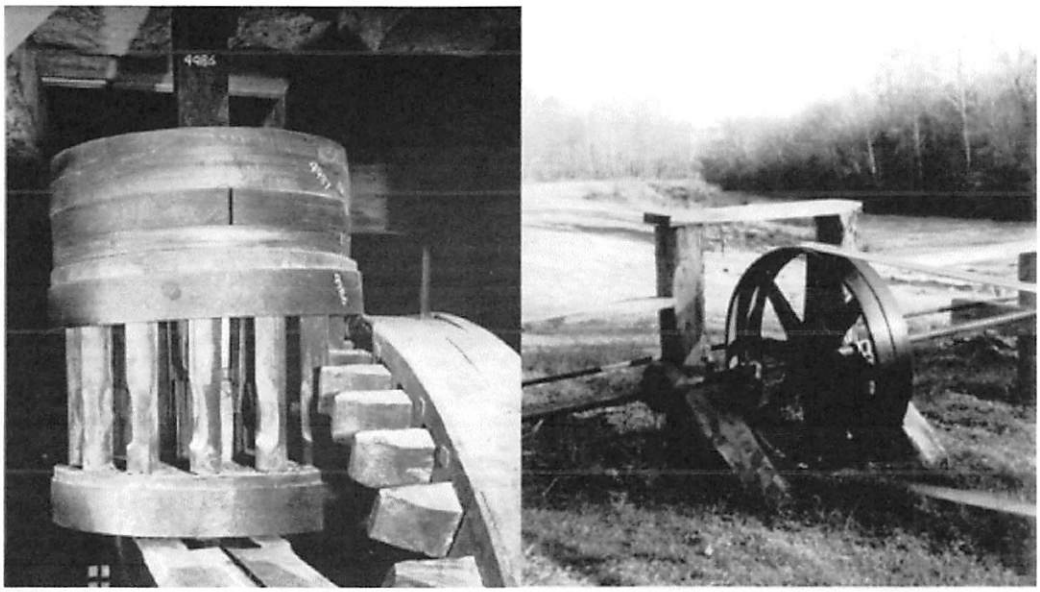

Figure 11. Gearing. Left: wooden lantern and crown gears to a nineteenth century grist mill (Hunter 1979). **Right: metal drive shafts, pulleys and leather drive belts replaced wooden gearing during the late nineteenth century. This powered the cotton gin at Price's Mill in McCormick County** (photo courtesy of Bob Edmonds).